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

<table>
<thead>
<tr>
<th>Meeting #</th>
<th>Date</th>
<th>Place</th>
<th>Abstract Deadline</th>
<th>Program Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>848</td>
<td>April 15-16, 1989</td>
<td>Worcester, Massachusetts</td>
<td>Expired</td>
<td>March</td>
</tr>
<tr>
<td>849</td>
<td>May 19-20, 1989</td>
<td>Chicago, Illinois</td>
<td>Expired</td>
<td>April</td>
</tr>
<tr>
<td>850</td>
<td>August 7-10, 1989</td>
<td>Boulder, Colorado†</td>
<td>May 16</td>
<td>July/August</td>
</tr>
<tr>
<td>851</td>
<td>October 21-22, 1989</td>
<td>Hoboken, New Jersey</td>
<td>August 16</td>
<td>October</td>
</tr>
<tr>
<td>852</td>
<td>October 27-28, 1989</td>
<td>Muncie, Indiana</td>
<td>August 16</td>
<td>October</td>
</tr>
<tr>
<td>853</td>
<td>November 18-19, 1989</td>
<td>Los Angeles, California</td>
<td>August 16</td>
<td>November**</td>
</tr>
<tr>
<td>854</td>
<td>January 17-20, 1990</td>
<td>Louisville, Kentucky</td>
<td>October 11</td>
<td>December</td>
</tr>
<tr>
<td></td>
<td>(98th Annual Meeting)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>March 16-17, 1990</td>
<td>Manhattan, Kansas</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>August 8-11, 1990</td>
<td>Columbus, Ohio</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(33rd Summer Meeting)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>November 2-3, 1990</td>
<td>Denton, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>January 16-19, 1991</td>
<td>San Francisco, California</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(97th Annual Meeting)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>August 8-11, 1991</td>
<td>Orono, Maine</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(94th Summer Meeting)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>January 8-11, 1992</td>
<td>Baltimore, Maryland</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(59th Annual Meeting)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>June 29-July 1, 1992</td>
<td>Cambridge, England</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Joint Meeting with the London Mathematical Society)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>January 13-16, 1993</td>
<td>San Antonio, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(59th Annual Meeting)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>January 5-8, 1994</td>
<td>Cincinnati, Ohio</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(100th Annual Meeting)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Please refer to page 294 for listing of special sessions.
** Please note a change in this date making it later than previously published.
† Preregistration/Housing deadline is June 1

Conferences

May 26–May 30, 1989: AMS Pure Mathematics Symposium on Complex Geometry and Lie Theory, Sundance Resort, Sundance, Utah
June 3–August 5, 1989: Joint Summer Research Conferences in the Mathematical Sciences, Humboldt State University, Arcata, California

July 10–30, 1989: AMS Summer Research Institute on Several Complex Variables and Complex Geometry, University of California, Santa Cruz, California
August 6–7, 1989: AMS Short Course on Cryptology and Computational Number Theory, Boulder, Colorado

Deadlines

<table>
<thead>
<tr>
<th></th>
<th>May/June Issue</th>
<th>July/August Issue</th>
<th>September Issue</th>
<th>October Issue</th>
</tr>
</thead>
</table>

* 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.
ARTICLES

221 Marshall Harvey Stone (1903–1989) George W. Mackey
Marshall H. Stone's contributions to twentieth century mathematics are highlighted.

225 Richard M. Schoen Awarded 1989 Bôcher Prize
Richard M. Schoen is cited for his work on the application of partial differential equations to differential geometry.

227 Everybody Counts: A Report to the Nation on the Future of Mathematics Education Summary
The official National Research Council summary of the report outlines the bold agenda for change in mathematics education over the next two decades.

237 Mathematics: A Challenge for Business, Government, and Academia
The text of the talk given by Vice Admiral William O. Studeman at the Phoenix, Arizona meeting is presented.

FEATURE COLUMNS

241 Computers and Mathematics Jon Barwise
This month's column features two articles by Gene Herman and Mark Sands which address the problems associated with establishing a computational environment for work in mathematics. Barwise's commentary follows.

257 Inside the AMS: Elections Robert M. Fossum
Robert Fossum's report highlights the recommendations presented to the Council at the Phoenix, Arizona meeting by the Committee on Election Scheduling. Allyn Jackson's article about the Council meeting follows.

263 Washington Outlook Kenneth M. Hoffman
In this month's column, Hans J. Oser reports on the Washington press conference, during which Everybody Counts, A Report to the Nation on the Future of Mathematics Education, was released to the public.
Inside the AMS

Since Notices has taken on its new format, the Managing Editor has been responsible for the various commentaries which have appeared in this section, referred to in-house as "page 2." The Managing Editor then was James A. Voytuk, who in January took a new position as Director of Project MS 2000 at the National Academy of Sciences. For the next few issues, I will be providing commentaries for "page 2."

While thinking about the various items I might bring to the attention of the readers of Notices, I kept returning to a fact that has made a very big impression on me in the short time I have been working with the Society. I have been a member of the Society for many years and have served on some of the more active Society committees; however, I had no perception of the breadth of the Society's activities nor the scope of the operations of the Providence and Ann Arbor offices. Also, there is the "Washington presence of the Society" through the activities of the Joint Policy Board for Mathematics and its Office of Governmental and Public Affairs. Most members are aware of the "Washington presence" but may not be familiar with the exact nature of the Society's involvement in these activities. In sharing these early impressions with colleagues and the staff, it was clear that my experience as a member was not unique.

To better acquaint members with the Society, the Notices column "Inside the AMS" will begin a series of articles about the operations and plans of the Society. Readers of Notices can expect to see articles giving an overview of the publication program as well as articles detailing some of the most important operations in the publication area. If you have ever wondered what was involved in the production of Mathematical Reviews and the creation of the MR Database, you will find this in future Notices articles, and I think you will be very pleased with the efforts of the Society in the development and maintenance of this important bibliographic data base. In the latter stages of planning is a system for the electronic exchange of information among mathematicians. I find the Society's plans for this system very exciting.

I could go on listing activities of the Society in which members have expressed interest and which will be reported on in future articles in Notices; however, I think I will close by saying that we do want the members to know about the Society and to be involved in its activities. I hope that future articles featured in the column "Inside the AMS" will help in our communication with members and the readers of Notices.

William Jaco
Executive Director


Assistantships and Fellowships in Notices

I wish to protest the decision to no longer include the listing of “Assistantships and Graduate Fellowships in the Mathematical Sciences” in the December issue of Notices. By publishing this listing separately and charging $9 or $15 for it the Society is doing a major disservice to the mathematical community by limiting access to this information. With the current and projected shortage of mathematicians, the American Mathematical Society should be at the forefront of the effort to attract and encourage talented undergraduates to pursue graduate studies in mathematics. The one avenue most undergraduates have to receive information and advice on a career in mathematics is through their college professors. If we do not receive information on what’s available, we cannot pass it on to our students.

It is ironic that the same issue of Notices [November 1988] which announces this change in format also contains the AMS-MAA Annual Survey. This article by Edward A. Conners contains the statement: “We again express our deep concern at the low number of American citizens receiving doctorates in the mathematical sciences. Tables 4 and 5, and the accompanying graphs, provide cause for alarm within the mathematical community and the many groups it serves. American business, industry, government, and academe must be prepared for the severe effects of this drought.” [pg. 1306]

Edward David’s Keynote Address given at the Centennial Meeting and printed in the October issue of Notices listed an agenda of items the mathematical community should pursue. One of these items is to “find better ways to attract the young” to mathematics. While it is true that money alone will not suffice, I have found that students have been very surprised and impressed with the amount of financial assistance available to graduate students. We need to continue to make this information readily available to interested undergraduates.

In the last several years I have lent my copy of the December Notices to a number of undergraduates, both to seniors who have already decided to pursue the study of mathematics and to sophomores who were uncertain but perhaps interested in mathematics as a career. It think that this information on the available levels of financial assistance encouraged them to seriously consider mathematics as a career. I hate to think that a shortsighted decision on the part of the Society to decrease circulation and increase revenue will have a negative impact on the future supply of mathematicians.

David G. Hartz
College of Wooster
(Received November 28, 1988)

EDITOR’S NOTE: “The decision to remove the information on assistantships and fellowships from Notices was made by the Executive Committee of the Council and the Board of Trustees (ECBT) at their joint meeting in May 1987, and was part of their general consideration of changes in Notices. The ECBT felt that the information on assistantships and fellowships was of serious interest to only a fraction of the full membership, primarily those engaged in advising undergraduate mathematics majors interested in graduate study in mathematics. The consensus was that the December issue of Notices would be more valuable to the full membership if it were a regular issue and carried the standard features, columns, and news items. Furthermore, they felt that those interested in the information could be equally well served by an independent publication. The intention of the ECBT in approving this change was not to raise revenue nor to reduce significantly the general availability of the information.

This year's distribution arrangement provides for five free copies to the mathematics department at colleges and universities which are institutional members, two free copies to each department listing its program in the publication, and from three to five free copies to each department advertising its program in the publication. The motivation for this particular distribution arrangement was to provide copies to institutional members as a benefit of their memberships, to offer an incentive for participation in the survey which gathers the data needed to produce a departmental listing, and to encourage advertising in the publication.”

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. All published letters must include the name of the author.

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.
More on Typesetting

This is an open reply to a Letter to the Editor, printed in the November 1988 AMS Notices on p. 1299.

I found George Bergman's letter on Uniform Style for Papers most interesting. However, I don't share all his views in these matters.

I have been using \TeX\ for seven years now, writing a big book, some journal articles and lots of smaller papers with it.

On point (1), having your formulas distorted by an ignorant typesetter, he is perfectly right of course! I think one of the advantages of using \TeX\ or some similar system is that your formulas appear in print \textit{exactly as you want them}, and not differently.

On point (2), if equations should be numbered on the right or on the left, I disagree with him. I don't think it matters at all, and since there are provisions to get the numbering at any side, I think it is wiser to let people have the equation numbers where they want to!

(3), the use of unreasonably small second order subscripts and superscripts: Agreed on this one!

(4), the use of very thin strokes in some calligraphic letters. He is right again!—But I would like to comment a little more here. I think that a quite bad habit has evolved, trying to mimic in fonts various notations used in handwriting or in ordinary typing. I am aiming at the doubly written letters, which in type preferably could be replaced by boldface. Nowadays you can even see underscored portions of computer typeset, printed text, instead of italicized. If a sort of standard recommendation could be issued, covering some such cases of text editing, I think a certain effort to achieve this would be worthwhile.

(5), the influence of stubborn text editors on the author's choice of particularly marked words, such as \textsc{Theorem}. Of course it is the author, who should decide which words should be marked like this!

(6) the use of extra space around formulas in text. I very strongly disagree on this one! I think it is covered by my comment on point (4) above; it is just a habit from typesetting, where you cannot distinguish between a one-letter word, such as ‘I’ or ‘a’ and a math symbol \textit{I} or \textit{a}. But in typesetting, the latter are italicized, and so the difference is noticeable to the reader. I think an extra space here disturbs the reading more than it helps the reader!

(7). The adding of your electronic mail address is a good idea!

Hans Riesel
Royal Institute of Technology,
Stockholm
(Received December 30, 1988)
Marshall Stone was born in New York City on April 8, 1903. He was the son of Harlan Fiske Stone and Agnes Harvey Stone. Harlan Stone was a prominent jurist who served on the U.S. Supreme Court from 1925 to 1946 and as chief justice from 1942 to 1946. The family lived in Englewood, New Jersey, during Stone's school days and he attended the local public schools. In 1919 at the age of only 16 he entered Harvard University from which he was graduated, summa cum laude, in 1922.

Although it had been assumed that Marshall would follow his father into the law, a growing fascination with mathematics led to an extraordinary arrangement in which he spent the academic year 1922-1923 as a part time instructor at Harvard to find out whether he liked teaching. It turned out that he did and proceeded quickly to write a Ph.D. thesis under the direction of G.D. Birkhoff. The degree was awarded in 1926 but the work was completed rather earlier. The very distinguished mathematical career of Marshall Stone was under way.

Before settling down at Harvard for the thirteen year period 1933-1946 Stone held a variety of positions. He was at Columbia from 1925 to 1927, at Harvard from 1927-1931, at Yale from 1931 to 1933 and at Stanford for the summer of 1933. He became a full professor at Harvard in 1937. These early years were enormously fruitful ones for Stone's career as a research mathematician—so much so that he was elected a member of the National Academy of Sciences in 1938 at the unusually early age of 35.

His first paper was a short note on normal orthogonal sets of functions published in 1925 and by 1928 had published ten more papers on various aspects of the theory of orthogonal expansions—special emphasis being placed on expansions in terms of eigenfunctions of linear differential operators. This was one of the principal interests of G. D. Birkhoff and Stone's work was in the same tradition. Then in 1929 he began to work on the abstract theory of possibly unbounded self adjoint operators in Hilbert space, announcing his results with three notes published in the Proceedings of the National Academy of Sciences in 1929 and 1930. This work culminated in a six hundred page book which is now one of the great classics of twentieth century mathematics. It was entitled "Linear transformations in Hilbert space and their applications to analysis". This comprehensive and beautifully written book has been enormously influential. Modern functional (or abstract) analysis began with the ideas of Volterra on "functionals" in the late nineteenth century and was transformed and given considerable impetus in the first two decades of the twentieth century by the work of Hilbert and F. Riesz. The very different books of Banach (1922) and Stone set the stage for the extensive developments of the past half century.

In his introduction Stone freely acknowledges his scientific debt to J. von Neumann. Von Neumann published a long paper on the same subject in 1929 and it is not easy to disentangle their respective contributions. What is clear is that Stone was originally stimulated by
preliminary work of von Neumann but had many key ideas quite independently. Moreover the whole last half of the book, including the chapter on spectral multiplicity theory and the extensive applications to differential and integral operators, has no counterpart in von Neumann’s writings. The central point of the work of both men was the extension of Hilbert's spectral theorem from bounded to unbounded operators. This extension was made necessary by the problem of making mathematically coherent sense of the newly discovered refinement of classical mechanics known as quantum mechanics. Here an important part of the problem was discovering the “correct” definition of self adjointness for unbounded operators. This correct definition is rather delicate and the extension of the older theory of Hilbert and others was a major task.

The last of the three notes mentioned above was entitled “Linear transformations in Hilbert space III. Operational methods and group theory”. The material it summarized was originally meant to be included as an extra chapter of the book but was omitted for reasons of space. The two theorems it announces are of sufficient importance to be discussed here in some detail.

Three years earlier, in 1927, Hermann Weyl and Eugene Wigner had introduced group theoretical methods into the new quantum mechanics in quite different ways. Weyl’s idea was to use group theory to help clarify the foundations. His paper, written in physicists’ language, implicitly conjectured two theorems about one parameter groups of unitary operators in Hilbert space. Stone’s note states these conjectures as carefully formulated theorems, announces that he is in possession of proofs and gives some indication of their nature. Detailed proofs of both theorems were published in 1932—one by Stone and one by von Neumann. Both theorems were not only important for quantum mechanics, in the manner indicated by Weyl, but were also highly significant early steps in the then nascent unitary representation theory of non compact locally compact groups. One of them also played an important role in the chain of events leading through a note of B.O. Koopman to the ergodic theory of von Neumann and Birkhoff and on to modern ergodic theory.

At this point it is useful to distinguish between two versions of one of Stone’s theorems. The version suggested by Weyl’s paper (and which stimulated Koopman) asserts that for every one parameter unitary group \( t \rightarrow U_t \) there is a unique self adjoint operator \( H \) such that \( U_t = e^{itH} \). The version emphasized in Stone’s note is an analogue of the spectral theorem for one parameter unitary groups. This version has the great advantage that it can be generalized almost verbatim to arbitrary (separable) locally compact commutative groups.

The other theorem—the celebrated Stone-von Neumann uniqueness theorem—states the uniqueness of the irreducible solutions of the Heisenberg commutation relations in integrated form. It may be interpreted as giving a complete determination of all unitary irreducible representation of a certain non compact non commutative locally compact group—now well known as the Heisenberg group. So interpreted, it is the first example of such a determination by about a decade. Finally a series of natural generalizations of the Stone-von Neumann uniqueness theorem culminated in the imprimitivity theorem and the extension of the notion of induced representation from finite groups to general locally compact groups.

In 1934 and 1935 Stone published two more notes in the Proceedings of the National Academy which seemed at first to represent a completely new departure. They were entitled “Boolean algebras and their applications to topology” and “Subsumption of Boolean algebras under the theory of rings”. Actually, just as Stone’s work on spectral theory may be regarded as a natural outgrowth of his earlier work on concrete eigenfunction expansions, so can his work on Boolean algebras be regarded as a natural outgrowth of his work on spectral theory. This is because of the role played in spectral theory by Boolean algebras of projections. In an entirely characteristic attempt to get to the bottom of things Stone undertook a thoroughgoing study of Boolean algebras and made a number of far reaching discoveries relating Boolean algebras to general topology on the one hand and to the theory of rings and ideals on the other.

The discovery of these connections has had significant consequences for all three subjects. One beautiful result is the celebrated Stone-Weierstrass theorem vastly generalizing the theorem of Weierstrass concerning the uniform approximability of arbitrary continuous functions on a finite interval by polynomials. Another is the natural one to one correspondence between all compact Hausdorff spaces on the one hand and certain rings on the other. Stone’s studies of the relationship between compact spaces and rings of continuous functions anticipated important elements in the modern theory of commutative Banach algebras. The detailed development of Stone’s ideas on Boolean algebras, general topology, etc. were published in three lengthy papers in 1935, 1936 and 1937 respectively. The first appeared in the American Journal of Mathematics and the second and third in the Transactions of the American Mathematical Society. Applications of the new ideas to spectral theory were announced in notes published in 1940 and 1941.

Soon after the entry of the United States into World War II the character of Stone’s work underwent a considerable change. For several years he was engaged in secret work for the U.S. government. A year after the end of the war he resigned his position at Harvard to take on the chairmanship of the mathematics department at the University of Chicago. This once great department
Marshall Harvey Stone

had been declining in quality and Stone’s mission was to strengthen it and bring it up to its former stature. In this he succeeded admirably. Before very long it was regarded by many as the best mathematics department in the country and, while a position like that is hard to keep indefinitely, it has remained one of the strongest departments ever since. He brought in André Weil, S.S Chern, Saunders Mac Lane and a number of promising younger men. Moreover in the words of one of the latter “Marshall devoted himself with both intensity and breadth,—from the largest issues to the smallest details—to the Department’s welfare and development”.

In 1952, Stone turned the chairmanship of the Chicago department over to Saunders Mac Lane but continued to be occupied with administrative matters. He was a strong force in reestablishing the International Mathematical Union—was much involved in the drafting of its constitution and served as its president from 1952 to 1954. He also interested himself actively in the problems of mathematical and scientific teaching—especially at the international level—and served on various boards and commissions.

While his various administrative concerns and activities prevented him from working on mathematical problems with his former intensity Stone continued to work and to publish results rather steadily until the early 1960’s. At the same time his mathematical interests tended more and more toward the elucidation of questions of great generality and of an article to the true nature of mathematics and mathematical concepts. There is reason to believe that his publications of the last thirty years give a very incomplete picture of his mathematical activity. At a conference in honor of his second retirement (see below) Stone gave a remarkable two hour lecture outlining his rather unusual and original views on the nature and structure of mathematics.

Stone remained at the University of Chicago until he retired as Professor Emeritus in 1968. At this time there was a week long conference in his honor the proceedings of which were published in 1970 by Springer-Verlag. Felix Browder was the editor. He did not wish to stop teaching however and forthwith began a new career as George David Birkhoff professor of mathematics at the University of Massachusetts in Amherst. No doubt the fact that Amherst, Massachusetts had been his father’s childhood home added to the attractiveness of this move. He taught there for the next twelve years and among other activities supervised two Ph.D. theses. During his final year he was honored with a second retirement conference.

One of the many striking accomplishments of Marshall Stone was a truly extraordinary command of the English language. This gave a special flavor to his book, his mathematical papers and his many writings on other subjects.

His skill with the English language also manifested itself in his lectures which were models of clarity and organization. Stone was only moderately active in supervising Ph.D. theses. Indeed there are anecdotes about his reluctance to do this sort of teaching. On the other hand he did turn out a respectable number of new Ph.D.s and influenced many other young mathematicians by his writings and through informal personal contact.

Stone married young (in 1927) and he and his first wife Emmy raised three daughters. Reports have it that he was serious about fatherhood in a rather old fashioned way. His daughters had regular chores to do and in financial matters were kept on strict allowances. On the other hand he also believed in family fun and one of his many side interests was gourmet cookery. This marriage dissolved in divorce in 1962 but Stone soon remarried. His second marriage, to Ravijojla Kostic, lasted the rest of his life.

Of all Stone’s many interests his love of travel was surely dominant. He began to travel when he was quite young and was on a trip to India when he died. He travelled frequently and extensively and was interested in seeing all parts of the globe. For example he visited the Pacific islands and (while travelling with Ravijojla) was shipwrecked in Antarctica. It is very hard to think of a place that he has not come fairly close to at some time or another.

Stone, of course, was the recipient of many honors. We have mentioned his early election to the National Academy of Sciences. He was also elected, at an early age to the American Academy of Arts and Sciences and to the American Philosophical Society. He was president of the American Mathematical Society (1943-1944) and received many honorary doctorates, both domestic and foreign. In 1982 he was awarded the National Medal of Science. According to Edwin Hewitt, two extra honors that gave him special pleasure were his election to an Honorary Professorship at Columbia Teachers College and to membership in the Explorers Club of New York City.

Marshall Stone was a man with a very broad outlook and wide range of interests who seems to have thought rather deeply about a number of issues. One had only to talk to him at length or read his non mathematical writings to come away with the impression that here was an unusually thoughtful man with a high degree of penetration and insight. More than most he seemed well endowed with a quality which I can only describe as wisdom.

While on a visit to Madras, India he died quickly of a sudden illness on January 9, 1989.

George W. Mackey
Harvard University
Look what's new in

**Mathematical Surveys and Monographs**

The Mathematical Surveys and Monographs series is one you're already familiar with. It's been around since 1943, when *The Problem of Moments* by J. A. Shohat and J. D. Tamarkin was published. The series has grown over the years and includes important mathematical monographs that cover a broad spectrum of areas such as function theory, analysis, approximation theory, algebra, and topology. Each of the books is designed to give a survey of the subject and a brief introduction to its recent developments and unsolved problems.

*The editorial committee...*

Victor W. Guillemin  
David Kinderlehrer  
M. Susan Montgomery (Chairman)

...invites you to participate in the development of this classic series by

- consulting them as reference books
- recommending them to your library to begin a standing order
- using books in this series in your courses
- submitting manuscripts for publication to the Director of Publication at the AMS

**New and Recent Publications in Mathematical Surveys and Monographs**

Each new title is exceptional. All are the high quality mathematical publications you've grown to expect in the Mathematical Surveys and Monographs series. Yet the variety of topics and areas of mathematical interest make them perfect reference books or possible textbooks for graduate level courses.


For information on numbers 1-19, please see the AMS Catalogue of Publications.

Standing orders are accepted for this and any other series published by the Society. Proforma invoices are sent to standing order customers prior to the publication of each new volume. Shipment is made upon receipt of payment and publication. To begin a standing order, please contact the Membership and Sales Department of the AMS.

PREPAYMENT REQUIRED. Order from the American Mathematical Society, P. O. Box 1571, Annex Station, Providence, RI 02901-1571, or call 800-556-7774 from within the continental U. S. (401-351-3544, elsewhere) to use VISA or MasterCard. Prices subject to change. Please add for SHIPPING AND HANDLING: first book $2, each additional $1, $25 maximum. By air, first book $5, each additional $3, $100 maximum.
The Bôcher Prize is awarded every five years for a notable research memoir in analysis which has appeared in the previous five years. The prize honors Maxime Bôcher (1867–1918) who was the Society's second Colloquium Lecturer (1896) and tenth President (1909, 1910), and one of the founding editors of the Transactions. The sixteenth award was made at the Society's ninety-fifth Annual Meeting, in Phoenix, Arizona, on January 12, 1989.

The 1989 recipient is Richard M. Schoen of Stanford University. The Bôcher Prize is augmented by awards from the Leroy P. Steele Fund and currently amounts to $4,000.

The Prize was awarded by the Council of the Society acting on the recommendation of the Committee to Select the 1989 Recipient of the Bôcher Prize, consisting of Paul J. Cohen, Richard B. Melrose, Chairman, and Louis Nirenberg.

The text below includes the Committee's citation, the recipient's response on presentation of the award and a brief biographical sketch of the recipient.

**Citation**


**Response**

It is a great honor for me to receive the Bôcher prize of 1989, and I thank the A.M.S. and the Bôcher Committee for recognizing my work in this way. There is a long tradition of interaction between the cited areas of Differential Geometry and Partial Differential Equations. I will discuss the interaction which centers around nonlinear problems. An early example which illustrates this tradition is H. Weyl’s formulation, in 1916, of the isometric embedding problem for closed surfaces of positive curvature. The geometric problem was reduced to certain estimates which were later obtained by Nirenberg and Pogorelov for smooth metrics. In the meantime Lewy had solved the problem for analytic metrics. This example is typical in that it often happens that a geometric problem can be formulated as a specific problem in P.D.E.; thus from the geometric's point of view P.D.E. often provides the framework necessary to attempt a solution as well as a body of knowledge (estimates, regularity results, and such) and more importantly methods of attack. The interaction benefits both areas because...
Differential Geometry provides a rich class of nonlinear problems which serve as model problems from which a body of knowledge may emerge. The geometric meaning of the solution may lead one toward the correct analytical estimates and theorems.

The Yamabe Problem should be viewed as a part of the variational theory for the Einstein-Hilbert variational problem; the elliptic version of the action principle governing the motion of the gravitational field in General Relativity. Yamabe viewed this general problem as an analytic approach to solving the three dimensional Poincaré conjecture. He formulated the problem which bears his name as a semilinear scalar P.D.E. around 1960 and it was solved in special cases by Trudinger and Aubin over the next 15 years. In its strongest form the solution asserts that critical points of the variational problem which are predicted by Morse theory do, in fact, exist. The proof of this general result involves consideration of large energy solutions, and, in fact, one must consider singular weak solutions of the P.D.E. The structure of weak solutions is an intricate topic about which we have limited knowledge. Additionally, an important role in the derivation of the necessary estimates is played by results from General Relativity involving gravitational energy. Thus we return full circle to the origins of the problem.

Another problem which arises from Differential Geometry and has had substantial impact on the development of P.D.E. is the Plateau problem, or the study of minimal submanifolds. The nonparametric minimal surface equation provided a strong impetus for the development of the theory of quasi-linear elliptic equations in the fifties and sixties. A successful higher dimensional parametric theory was begun approximately 30 years ago through the work of DeGiorgi, Federer, and Fleming. A major outgrowth of this work was the introduction of partial regularity theory into P.D.E. The partial regularity method has become a powerful tool applicable to a variety of nonlinear problems. Finally, the theory of minimal hypersurfaces has been applied to obtain results about manifolds of positive scalar curvatures by S.T. Yau and myself. This application uses the analytic theory (existence and regularity) in an important way. Thus the theory of minimal submanifolds is of substantial importance for both geometry and P.D.E.

A common feature of both the fields of nonlinear P.D.E. and global Differential Geometry is that our knowledge in both areas is very primitive, and there are many more unsolved problems than there are theorems. Specific areas in which new results would be important are quasi-linear elliptic systems (hopefully including the elliptic Einstein equations), nonlinear parabolic and hyperbolic evolution equations, and singularities of nonlinear equations. The problems involving singularities which are important include the study of singular sets for elliptic problems such as those of least area submanifolds as well as singularity development in nonlinear evolution equations. I am confident that the long tradition of interaction between Differential Geometry and nonlinear P.D.E. will continue to be fruitful to both fields for many years to come.

Biographical Sketch

Richard M. Schoen was born October 23, 1950, in Celina, Ohio. He received his B.S. degree from the University of Dayton in 1972 and his Ph.D. from Stanford University in 1976 under the direction of Leon Simon and Shing-Tung Yau. He was a lecturer at the University of California, Berkeley from 1976–1978 and an assistant professor at the Courant Institute from 1978–1980. From 1980–1987 he was a professor at the University of California; in Berkeley from 1980–1985 and in San Diego from 1985–1987. Since 1987 he has been Professor of Mathematics at Stanford University. Professor Schoen has been a visiting member at the Institute for Advanced Study on two occasions, during the 1979–1980 academic year and during the spring semester of 1984. He was a visiting professor at the University of Melbourne in Australia during the fall of 1980 and a visiting professor at Stanford University during the fall of 1983. In the fall of 1985 he was a visitor at the Mittag-Leffler Institute in Sweden and at the Institut des Hautes Etudes Scientifiques in France. Professor Schoen was awarded an NSF Graduate Fellowship in 1972, a Sloan Foundation Fellowship in 1979, and a MacArthur Prize Fellowship in 1983. He was elected to the American Academy of Arts and Sciences in 1988.
In January, the National Research Council (NRC) released a major authoritative report on the state of U.S. mathematics education. Presenting a compelling analysis of the problems and challenges in this area, "Everybody Counts: A Report to the Nation on the Future of Mathematics Education" treats mathematics education as all one system, from kindergarten to graduate school. Not merely a plea for reform, "Everybody Counts" charts a bold agenda for change over the next two decades. The report, three years in preparation, is the joint work of two NRC boards, the Mathematical Sciences Education Board and the Board on Mathematical Sciences, together with the Committee on the Mathematical Sciences in the Year 2000, a joint activity of the two Boards.

What follows is the official NRC summary of "Everybody Counts," consisting of a condensation of the last two chapters of the report, which delineate the challenges of mathematics education, current responses to those challenges, and a national plan of action. The quotes appearing in the body of the summary are extracted from the report. The NRC produced only a limited number of copies of this summary, but reprints are available from the AMS. The summary is reprinted in Notices with the permission of National Academy Press, Washington, DC.

Opportunity . . . tapping the power of mathematics

"Changing demographics have raised the stakes for all Americans. Never before have we been forced to provide true equality in opportunity to learn. The challenge we face today is to achieve what we believe."
the need for calculation (which is now done mostly by machines), that make mathematics a prerequisite to so many jobs. More than ever before, Americans need to think for a living; more than ever before, they need to think mathematically.

Schools

Historically, schools in the United States were designed with a dual mission: to teach all students the basic skills required for a lifetime of work in an industrial and agricultural economy and to educate thoroughly a small elite who would go to college and then pursue professional careers. As the needs of society have changed, the balance of these two goals has shifted. Although schools have adapted somewhat, today’s schools continue to labor under the legacy of a structure designed for the industrial age misapplied to educate children for the information age.

The changing nature of work will make continuing education a lifelong reality for adults. Schools, therefore, will have to provide all students with a strong foundation for continuous learning; colleges and universities will have to educate both young adults and older workers; and industry will have to focus its continuing education on areas that extend, rather than repeat, what schools provide. Education in the future must build continually, from childhood to retirement, on a versatile and unbroken foundation provided by school education.

Literacy and Numeracy

Literacy and numeracy—that is, proficiency in language and in mathematics—are the primary sources of strength and versatility in school education. Schools and colleges will have to meet goals now widely held to be unattainable:

- The level of literacy formerly associated with the few who entered college must become a goal for all.
- The degree of facility with mathematics formerly required only of those preparing for scientific careers is now an essential ingredient in the foundation for working careers in the information age.

Mathematical and scientific literacy form the basis of technological expertise in the workplace. In tomorrow’s world, the best opportunities for jobs and advancement will go to those prepared to cope confidently and competently with mathematical, scientific, and technological issues. As the foundation of science and technology, mathematics provides the key to opportunity.

Opportunity for the Nation

The focus in what follows is on a bold but realistic approach to reforming mathematics education as schools and colleges work toward the demanding objectives now before them. Means must be found for significantly improving student achievement while simultaneously making changes in mathematics education in response to the demands of an increasingly mathematical society. The changes proposed here are:

- rooted in traditional values, yet reflect the greatly increased applicability of mathematics to problems faced almost daily by scientist, engineer, worker, and citizen;
- guided by national goals, but respect state and local autonomy;
- built on the educational reform effort already under way;
- to be carried out locally by the only people who can bring about meaningful and lasting reform—the teachers.

Among the several insights and messages that this report is intended to convey is this uniquely important one: because of emerging general agreement within the mathematics, mathematics education, and related professional communities on the goals for mathematics education and the means for achieving them, the stage is set for the nation to push ahead boldly in this area of education. In the next decade, the United States has a historic opportunity to revitalize mathematics education.

Change . . . mobilizing for reform

“As technology has ‘mathematically’ the workplace and as mathematics has permeated society, a complacent America has tolerated underachievement as the norm for mathematics education. We have inherited a mathematics curriculum conforming to the past, blind to the future, and bound by a tradition of minimum expectations.”

Mathematics education in the United States is facing major challenges on nearly every front:

- Far too many students, including a disproportionate number from minority groups, leave school without having acquired the mathematical power necessary for productive lives.
- The shortage of qualified mathematics teachers in this country is serious, more serious than in any other area of education, and affects all levels from elementary school to graduate school.
• At a time when the percentage of minority students is increasing, the shortage of new minority teachers of mathematics is particularly acute.
• On average, U.S. students do not master mathematical fundamentals at a level sufficient to sustain our present technologically based society.
• When compared with students of other nations, U.S. students lag far behind in level of mathematical accomplishment; the resulting educational deficit reduces our ability to compete in international areas.
• Public attitudes, which are reflected and magnified by the media, encourage low expectations in mathematics. Only in mathematics is poor school performance socially acceptable.
• Curricula and instruction in our schools and colleges are years behind the times; they reflect neither the increased demand for higher-order thinking skills, nor the greatly expanded uses of the mathematical sciences, nor what we now know about the best ways for students to learn mathematics.
• Calculators and computers have had virtually no impact on mathematics instruction in spite of their great potential to enrich, enlighten, and expand students' learning of mathematics.
• Commonly employed methods of evaluation—especially standardized, paper-and-pencil, multiple-choice tests of "basic skills"—are themselves obstacles to the teaching of higher-order thinking skills as well as to the use of calculators and computers.
• Undergraduate mathematics is intellectually stagnant, overgrown with stale courses that fail to stimulate the mathematical interests of today's students.

Counterproductive Beliefs

"As mathematics is more than calculation, so education in mathematics must be more than mastery of arithmetic."

It is mistakenly thought by many otherwise well-informed adults that the mathematics they learned in school is adequate for their children. But mathematics has changed. It is significantly more diverse than it was several decades ago when most of today's adults went to school. The mathematics commonly used today goes far beyond arithmetic and elementary geometry. Members of the armed forces as well as workers in manufacturing and the burgeoning service sector are called upon regularly to operate complex machines and to interpret graphs, data, and probabilities.

Parental and legislative pressures in the past few years, driven largely by frustration over declining test scores, have led to some rash actions:
• Increased numbers of required courses—where there is no agreement on what the added courses should contain or where capable teachers are to be found to teach them.
• Increased reliance on standardized tests—where there is very little understanding of what the tests contain or what they are capable of testing.
• Increased use of test scores, especially for teacher and school accountability—where there is little recognition that the tests reflect only a small part of curricular objectives.

Too often, the results of such actions are unreliable tests, watered-down curricula, and diminished morale. The nation is in the grip of a testing mystique that has led to widespread misuse of standardized tests. Public pressures for "back-to-basics" stem from a very limited understanding of the challenges we face. Carried to the extreme, these pressures could rob our children of the opportunity to learn what they will need to know of mathematics in their adult lives.

Public Understanding

"As children become socialized by school and society, they begin to view mathematics as a rigid system of externally dictated rules governed by standards of accuracy, speed, and memory. Their view of mathematics shifts gradually from enthusiasm to apprehension, from confidence to fear."

Appropriate response to the challenges of mathematics education will require a systematic effort to develop in the public a deeper understanding of the changes and the improvements needed. This will be a formidable task.

Often, public discussion about mathematics education masks a hidden agenda of values that have traditionally been carried forward by the school study of mathematics. Since the demise of Latin as a required school subject, it is to mathematics that many look as a vehicle to instill such qualities as precision, discipline, neatness, and accuracy. Mathematical truth—in popular caricature—is certain, absolute, unchanging, eternal. Mathematics appears to many to be a safe harbor of calm in a turbulent sea of social and educational change.
In spite of the fact that it is constantly expanding and changing, mathematics more than any other science has been taught as an ancient discipline. A nation that persists in this antiquated view of mathematics is destined to fall behind scientifically and economically. Parents who persist in this view are denying their children the opportunity to develop and prosper in the information age.

The American Way

"Why Not Just Imitate Japan? International studies of mathematics and science education show that, when compared with students in other countries, U.S. students do very poorly while Japanese students do very well. One natural response, therefore, is to think that we could improve our educational system by imitating Japan.

These same studies, however, document that the social context of education has a greater influence on student performance than does actual classroom practice. Parental attitudes, student expectations, and teacher self-respect are among the most significant factors in quality education and they depend uniquely on culture.

Imitating others is no solution. The United States must find a strategy that builds on the traditions of this country, one whose strength lies in this nation's unique tradition of local initiative and decentralized authority."

Lessons from the Past

Because of vast differences in both tradition and constitution, a “top-down” approach will not work in the United States. Experience has much to teach us on that score.

Few traces remain of the expensive, major curriculum development projects so prominent in the 1960s and 1970s. These projects tried to develop, on a national scale, complete curricula (including instructional materials) that could be adopted as a whole by school districts. But the theorists and planners who developed these curricula were naive about the process of change; big curricular projects failed to take root in American schools because they were transplanted fully grown into an environment better suited to locally grown methods.

Where teachers were not directly involved in development, where their identification with the product was not ensured, where they considered district acceptance of new curricula as a “top-down” imposition, the revised programs did not last. Where parents could not (or did not) understand the need for change or the reasons new curricular emphases were chosen, resentment and anger resulted and a conviction set in that if “the old math” was good enough for them, it was good enough for their children.

A New Approach

As our country enters a new period of change in mathematics education, we can benefit from several lessons drawn from these previous attempts:

- Free-standing, full-service curriculum development projects adopted intact by school districts do not work.
- A superficial, district-by-district approach to curricular overhaul is potentially disastrous, given the demanding nature of what schools face in mathematics education today.
- Any successful effort to improve mathematics curricula and instruction in the schools will require an extensive public information campaign that reaches all the varied constituencies of mathematics education.
Effective change requires a great deal of the public:

- conviction of the need for change;
- consensus on the importance of high-quality mathematics education for everyone;
- skepticism about "quick fixes" and simplistic solutions;
- awareness of the general nature of the changes needed;
- support for investment of the necessary resources;
- recognition of the need for continuing leadership at the national level.

The time is ripe for a new approach to curricular reform in the United States—one that establishes appropriate national expectations based upon broad public support by all of the constituencies concerned.

Transitions . . . bridges to the 21st century

In order to meet the challenges of our time, mathematics education is beginning already to negotiate several difficult transitions that will dominate the process of change during the remainder of this century.

Transition 1: The focus of school mathematics is shifting from a dualistic mission—minimal mathematics for the majority, advanced mathematics for a few—to a singular focus on a significant common core of mathematics for all students.

"Everyone depends on the success of mathematics education; everyone is hurt when it fails. Mathematics must become a pump rather than a filter in the pipeline of American education."

The needs of industry for a mathematically and technically literate work force compel schools to provide more mathematical education to more students than ever before. Accomplishing this will pose significant challenges to:

- develop a core of mathematics appropriate for all students throughout each year of school;
- educate well a significantly larger proportion of the population;
- stimulate able students with the excitement and challenge of mathematics;
- differentiate instruction by approach and speed, not by curricular goals;
- select topics and approaches of broad interest and effectiveness.

Transition 2: The teaching of mathematics is shifting from an authoritarian model based on "transmission of knowledge" to a student-centered practice featuring "stimulation of learning."

In both schools and colleges, classrooms of passive students who are expected to sit and absorb rules that appear as arbitrary dicta are gradually giving way to learning environments that:

- encourage students to explore;
- help students to verbalize their mathematical ideas;
- show students that many mathematical questions have more than one right answer;
- provide evidence that mathematics is alive and exciting;
- teach students through experience the importance of careful reasoning and disciplined understanding;
- build confidence in all students that they can learn mathematics.

Transition 3: Public attitudes about mathematics are shifting from indifference and hostility to recognition of the important role that mathematics plays in today's society.

Although the burden of unfavorable school experiences continues to color public opinion about mathematics, contemporary events are sending different messages which are gradually being heard:

- in other nations where more is expected, more mathematics is learned;
- as the roles of science and technology expand, so does the importance of mathematics;
- for an informed citizenry, mathematical literacy is as important as verbal literacy.

As attitudes about the importance of mathematics improve, so will expectations for mathematics education.

Transition 4: The teaching of mathematics is shifting from preoccupation with inculcating routine skills to developing broad-based mathematical power.

"Evidence from many sources shows that the least effective mode for mathematics learning is the one that prevails in most of America's classrooms: lecturing and listening."

Broad mathematical power requires that students be able to discern relationships, reason logically, and use a range of mathematical methods to solve a wide variety of nonroutine problems. The repertoire of skills which now
undergird mathematical power includes not only some traditional paper-and-pencil skills, but also many broader and more powerful capabilities. Today's students must be able to:

- perform mental calculations and estimates with proficiency;
- decide when an exact answer is needed and when an estimate will serve the purpose;
- know which mathematical operations are appropriate in particular contexts;
- use a calculator correctly, confidently, and appropriately;
- estimate orders of magnitude to confirm mental or calculator results;
- use tables, graphs, spreadsheets, and statistical techniques to organize, interpret, and present numerical information;
- judge the validity of mathematical and technical information presented by others;
- use computer software for mathematical tasks;
- formulate specific questions from vaguely defined problems;
- select effective problem-solving strategies.

**Transition 5:** *The teaching of mathematics is shifting from emphasis on preparation for future courses to greater emphasis on topics that are relevant to students' present and future needs.*

Most mathematics should be presented in the context of its uses, with appreciation of mathematics as a deductive logical system built up slowly through the rising levels of education. Examples of areas deserving greater emphasis are:

- probability, which facilitates reasoning about uncertainty and assessment of risk;
- exploratory data analysis and statistics, which facilitate reasoning about data;
- model-building, which facilitates systematic structured understanding of complex situations;
- operations research, which facilitates planning complex tasks and achieving performance objectives;
- discrete mathematics, which facilitates understanding of most applications of computers.

These new topics imply that observation and experimentation will be important in future mathematics programs and that school mathematics will draw closer to other school subjects, especially to science.

**Transition 6:** *The teaching of mathematics is shifting from primary emphasis on paper-and-pencil calculations to full use of calculators and computers.*

"As a practical matter, mathematics is a science of pattern and order. Its domain is not molecules or cells, but numbers, chance, form, algorithms, and change."

Mathematics teachers at all levels—from elementary school to university—are adapting their teaching methods to include both new approaches to instruction and new subject matter appropriate to future-oriented curricula. Calculators and computers make new modes of instruction feasible at the same time that they inject into the learning environment the special sense of wonder which goes with the healthy development of mathematical power.

Calculators and computers should be used in ways that anticipate continuing rapid change due to technological developments. Technology should be used not because it is seductive, but because it can improve mathematical learning by extending each student's mathematical power. Calculators and computers are not substitutes for hard work or precise thinking, but challenging tools to be used for productive ends.

**Transition 7:** *The public perception of mathematics is shifting from that of a fixed body of arbitrary rules to a vigorous active science of patterns.*

Mathematics is a living subject that seeks to understand patterns which permeate both the world around us and the mind within us. Although the language of mathematics is based on rules that must be learned, it is important that students move beyond rules to be able to express things in the language of mathematics. This transformation suggests change in both curricular content and instructional style. It involves renewed effort to focus on:

- searching for solutions, not just memorizing procedures;
- exploring patterns, not just learning formulas;
- formulating conjectures, not just doing exercises.

As teaching begins to reflect these emphases, students will have opportunities to study mathematics as an exploratory, dynamic, evolving discipline rather than as a rigid, absolute, closed body of laws to be memorized. They will be encouraged to see mathematics as a science, not as a canon, and to recognize that mathematics is really about patterns and relationships and not merely about numbers.
Action ... a new national strategy

"All students should study mathematics every year they are in school. Secondary school mathematics should provide for all students a core of mainstream mathematics in which different student groups are distinguished not by curricular goals, but only by speed, depth, and approach."

Over the next two decades, all of the major components of mathematics education—curricula, teaching, teacher education, testing, textbooks, and software—must change significantly and in some reasonably coordinated manner. National leadership is needed to coordinate efforts by the primary agents for change and to garner support for them by government, business, industry, and the public.

National Goals

Our national goal must be to make U.S. mathematics education the best in the world. Nothing less will be adequate to fulfill American aspirations. To achieve this goal will require significant actions in response to a three-tiered challenge to:

- make mathematics education effective for all Americans;
- improve significantly students' mathematical achievement;
- put in place new curricula appropriate to the mathematical needs of the twenty-first century.

Actions taken to achieve these broad goals must be based upon an understanding of the total American system of mathematics education, especially understanding of the nature of the changes under way. Unless action is based upon a systematic overview of all of the pertinent issues, it will have very little chance of achieving national impact.

National Strategy

"Few teachers in today's schools have the authority or resources necessary to carry out this agenda. But as schools evolve from a model with teachers as hired hands to one in which teachers function as professional educators, schools should welcome the challenge to implement national standards for mathematics education."

New plans for the renewal of school mathematics must be founded on what we have learned about making changes in the extremely decentralized U.S. system in which local and state agencies control education. Two special strengths of American mathematics education should underpin any movement for renewal:

- The creative efforts of many individuals, schools, and projects around the country, which have begun to move mathematics education through the transitions just described here.
- The unique form of coordinated national leadership, which has evolved within the communities of mathematicians and mathematics educators.

Together, these resources provide an "augmented grass-roots" model of curricular development, coupling national leadership with the flexibility and initiative of the decentralized U.S. tradition.

A national strategy for revitalization which is well suited to the unique strengths and weaknesses of U.S. mathematics must have several major components:

National goals and local implementation. The key to success is voluntary acceptance by school districts of common goals that provide a framework to guide local choices and the construction of detailed programs.

- National Standards. School mathematics programs across the nation need to share a common philosophy and framework—a universal set of interrelated concepts and methods held together by a simple workable philosophy, yet flexible enough to allow for local and regional variations. In a highly mobile society, the basic framework should be transportable and adaptable.
- Local Implementation. Changes in mathematics curricula must be proposed and undertaken freely by those who bear direct responsibility for curricula in the schools. A deep sense of identification with those changes must be developed within the entire school community. In particular, local teachers and parents need to be involved in adaptation and decision-making in a thorough and comprehensive way.

National discipline-based leadership, such as that now being supplied by the mathematics and mathematics education communities—working with leaders from the diverse constituencies of mathematics education—is needed to:

- lay out the consensual framework, including proposed national standards;
- coordinate an effort to build and sustain national consensus on goals and the approach to be used to achieve them;
• provide a continuing national overview and assessment capability for mathematics education.

State and local coalitions, collaboratives, and teacher support networks will be needed to provide similar leadership at these levels.

National, state, and local leadership—provided by the President, Congress, federal officials, governors, chief state school officers, mayors, legislators, school boards, school superintendents, principals, teachers, and college and university faculty and administration—will be of critical importance to the consensus-building effort and to local adoption of the national standards. National and state education-related organizations, parent groups, business, and industry can also play important leadership roles.

National support structures are needed to enable the primary participants—teachers, schools, state and local education authorities—to work successfully toward national goals in their continuous efforts to upgrade mathematics programs. Local, state, and federal resources should be used cooperatively to provide the variety of materials, teacher support, and increased public awareness necessary to enable teachers to adapt curricula and instructional practices within the nationwide consensual framework.

Teacher professionalism must be strengthened through a concerted national effort. This is an essential element of any effective strategy for reforming mathematics education in the United States. It is the teachers on whom the real burden of reform rests. The task we are setting before them is very demanding and will take many years. Teachers need to approach this task in a highly professional way and they need to be given the sustained support and working environments that will make it possible for them to carry out their vital mission. Initiation of the National Board for Professional Teaching Standards is an important step toward enhancing teacher professionalism. Criteria for excellence in mathematics teaching being developed by the mathematics education community should provide part of the foundation for the standards developed by the board as it undertakes the certification of professional teachers.

Leadership in assessment is needed to align state and national testing programs with the goals of mathematics education and enable assessment to be a constructive force in the national revitalization effort. Test designers and test-makers are well aware of the general problems in this area. They need to join together with the leadership of mathematics education in support of a cooperative national board or other mechanism for promoting use of significantly improved types of assessment by localities, states, and national assessment organizations.

A national plan for college and university mathematics must be developed, one which is closely allied with the plan for school mathematics. This is needed not only because there must be consistency at the school-college interface, but also because college and university faculty influence heavily who become teachers, how they teach, and what they teach. Undergraduate mathematics is the bridge between research and the schools and holds the power of reform in mathematics education. The National Research Council (NRC) Committee on the Mathematical Sciences in the Year 2000 (Project MS 2000) is developing such a plan.

Significant movement to implement this seven-part national strategy is under way through the combined efforts of national organizations, including those concerned directly with mathematics and mathematics education, as well as foundations, national education organizations, parent groups, and agencies of government.

Building Consensus

The Curriculum and Evaluation Standards for School Mathematics, developed by the National Council of Teachers of Mathematics (NCTM) and being released in March 1989, is the linchpin of the strategy. It focuses national attention on specific objectives for school mathematics in the 1990s. These standards from the teaching profession provide guides to what constitutes excellence in school mathematics programs designed to serve all students, from kindergarten through high school. Already reviewed extensively in draft form by mathematics teachers and the public, the standards have received widespread support in the mathematical and educational communities. They represent the very first effort to establish national goals for school mathematics. The nation has a unique opportunity to build consensus around these goals.

Generating Dialogue

"Implementation will require more than good will and community dialogue; it will need professional leadership of teachers operating in a transformed school environment. No one should underestimate the complexity of the challenge; effective reform will be truly difficult to accomplish."

The development and publication of the NCTM Standards are part of the national, discipline-based leadership referred to in the strategy. The NRC took two other steps: the establishment in 1985 of the Mathematical Sciences Education Board (MSEB), to provide continuing national oversight and coordination in mathematics education at all levels, and the formation in 1988 of the Committee
on the Mathematical Sciences in the Year 2000, to recommend a revitalization plan for college and university mathematics. Both of these steps were taken at the request of the professional societies in mathematics and mathematics education in the United States.

The NCTM Standards report is one of a series of major reports appearing in 1989, to which Everybody Counts is a public preface. Others are MSEB’s Philosophy and Framework for School Mathematics and Strands of the Mathematics Curriculum.

A related report comes from the American Association for the Advancement of Science’s Project 2061. Called Science for All Americans, it sets forth a vision of what every young person should learn about mathematics, science, and technology.

These reports could join hundreds of other well-meant reports on the nation’s bookshelves or they could make a difference. To bring their messages to the many “attentive publics” of mathematics education and help build consensus on their goals, the Mathematical Sciences Education Board plans to coordinate an intensive Year of National Dialogue that will accompany publication of these reports—a dialogue carried directly to teachers, administrators, policymakers, business, industry, government, and the general public. Professional organizations in the mathematical sciences are making plans for active involvement in this dialogue. Numbers of other national, state, and local organizations will participate.

Taking Action

Current efforts to forge national consensus will not in themselves transform what happens in schools or colleges. Change in the institutions of education must come about as the result of intensive debate within each institution. There is plenty of work for everyone:

Students

• Study mathematics every school year.
• Discover the mathematics that is around us all.
• Use mathematics in other classes and in daily life.
• Study a broad variety of mathematical subjects.

Teachers

• Talk with each other about mathematics.
• Examine current practice and debate new proposals.
• Engage students actively in the process of learning.

Parents

• Demand that schools meet the new NCTM Curriculum and Evaluation Standards for School Mathematics.
• Encourage children to continue studying mathematics.
• Support teachers who seek curricular improvements.
• Expect homework to be more than routine computation.

Principals

• Provide opportunities for teachers to work together.
• Become educated on issues in mathematics education.
• Support innovation.
• Encourage paired teaching in elementary school.

Superintendents

• Stimulate public discussion of mathematics education.
• Provide resources for curricular innovation.
• Support a climate of change.

School Boards

• Establish appropriate standards for mathematics.
• Align assessment with curricular goals.
• Support innovation and professional development.

Community Organizations

• Enrich mathematical opportunities for all students.
• Support local efforts to improve mathematics education.
• Explain to the public the need for change.

State School Officers

• Promote adoption of NCTM’s Curriculum and Evaluation Standards for School Mathematics.
• Encourage use of elementary mathematics specialists.
• Speak out publicly about mathematics education.
• Stress assessment of higher-order thinking.

College and University Faculty

• Make introductory courses attractive and effective.
• Restore integrity to the undergraduate program.
• Lecture less; try other teaching methods.
• Link scholarship to teaching.
College and University Administrators
- Reward curricular innovation and good teaching.
- Recognize that mathematics classes need computer laboratories.
- Diminish reliance on underprepared, part-time faculty.
- Emphasize and improve teacher education.

Business and Industry
- Encourage students to study mathematics and science.
- Do not steal good teachers by hiring them away.
- Support local efforts to secure funds for education.
- Support strong continuing education, not remediation.
- Provide internship opportunities for teachers.

State Legislators
- Work with school leaders to support effective programs.
- Recognize that mathematics education is an investment.
- Resist pressures for simplistic cures.

Governors
- Provide resources to encourage change.
- Demand new standards for mathematics education.
- Lead the public to make wise choices among priorities.
- Create enrichment programs for able students.

Congress
- Stress education as an essential investment.
- Support mathematics education at all levels.
- Reward effective programs.

The President
- Meet with state governors to affirm the national agenda.
- Focus public attention on mathematics education.
- Stress education as crucial to national security.

Conclusion . . . it is time to act
This is just the beginning. Several decades of work lie ahead if we are to translate the ideas put forth here into classroom practice. During that time, continuous change in mathematics programs should be the norm in most of the nation's school districts. Strong national, state, and local leadership will be needed all along the way.

Efforts to bring about lasting change must proceed steadily for many years, on many levels simultaneously, with the broad involvement of all of the constituencies at each stage. First comes serious discussion; then, compromise and consensus; finally, action and change. At national, state, and local levels, significant efforts are under way to improve curricular standards, the teaching profession, and assessment practices. Major projects are being started to help the diverse efforts of business, industry, government, volunteer groups, and educational organizations to focus on common objectives. As there is no royal road to geometry, so there are no “quick fixes” for mathematics education.

Both for reasons of international competitiveness and scientific leadership, the United States must move quickly to improve the state of mathematics education. It takes a generation to complete the mathematical education of a single individual. The first high school graduates of the next century entered elementary school in 1988. No longer can we afford to sit idly by while our children move through school without receiving the mathematical preparation appropriate for the twenty-first century.

The challenges are clear. The choices are before us. It is time to act.
The following is the text of the talk given by Vice Admiral William O. Studeman, Director of the National Security Agency, at the Thursday evening, January 12, open session entitled "Mathematics in the American Agenda," at the Joint Mathematics Meetings in Phoenix, Arizona. The event, which was preceded by an open reception with a Southwestern theme, was sponsored by the American Mathematical Society, the Mathematical Association of America, and the Mathematical Sciences Education Board of the National Research Council.

After six months in my job, I can honestly say that I am extremely humbled to be present in this assemblage of august intellectual ability. To paraphrase President Kennedy: No Director of NSA has been with this much mathematical talent in one room, since our first Director met privately with John von Neumann.

I almost changed the topic of my talk this afternoon. As I was studying my notes and flying to Phoenix, along with other NSA employees, we suddenly had a great idea to patch up Miyaoka’s recent attempted proof of Fermat’s Last Theorem, but it fit in the margin of the notes, so we didn’t think it could be correct.

Thank you for inviting me to speak to you this evening. It is a privilege for me to be at the annual meetings of the math societies, and a wonderful opportunity for me to share with you some issues and concerns on the role of mathematics in the future of American business, government, academia, and, of particular interest to me, its role in the future of American defense.

Many of you are concerned about the proper role of mathematics in defense-supported research. This is an important topic that has been debated at length and which can be divisive, but it is one which I will leave for another time. Tonight I want to tell you about NSA’s role in mathematics and to discuss issues which I believe should unite all who are interested in the future of American mathematics.

NSA’s Role in Mathematics

Years of military training have prepared me for many complex operational and management roles, but it was still surprising to become the leader of the largest and perhaps the most diversely talented group of mathematicians in the United States. As you may know, mathematics is the fundamental basis of our work at NSA, the *sine qua non* fundamental foundation bedrock of our business. Mathematics is the one aspect of NSA which makes us different from other Defense and executive branch departments and agencies, and we are proud of both the documented and unrecorded contributions which our mathematicians (our invisible heroes) have made to the history of national and alliance security over the past half a century and longer. We are America’s largest employer of mathematicians, and we really are employing mathematicians to be mathematicians. We use your theorems, not just your problem solving abilities. NSA must provide more care, feeding, attention, and job satisfaction (particularly job satisfaction) for mathematicians than anyone else, and I believe that this gives us a unique perspective and responsibility on the future of mathematics in the U.S.

The Evidence of Decline

Two recent publications have emphasized the decline that has occurred in American mathematics research and education. The National Academy of Sciences 1984 study, *Renewing U.S. Mathematics* (popularly known as the “David Report”), pointed out the dangerous decline in support to university mathematics research, a decline that may soon drive our nation’s most able researchers into other disciplines that provide adequate resources for their work. The “David Report” spurred my predecessor, General Odom, to make a commitment to mathematics research through the expansion and redirection of our grants program, and by the encouragement of greater involvement on the part of our mathematicians in the national community. This is a commitment I firmly...
support and would like to build upon. In fact, I am proud that the NSA Mathematical Sciences Program has agreed to help support the following study, known colloquially as "David II."

The 1987 report, The Underachieving Curriculum, highlighted the poor achievement of 8th and 12th grade American students in an international comparison. It is ironic that the United States attracts the brightest minds from around the world to study mathematics at our universities, and yet we fail so miserably in providing a basic mathematics education to our own high school students. We have become a Mecca for international students seeking the finest training possible, but we cannot seem to motivate and propel our own citizens into pursuing research in mathematics. I am deeply concerned over the implications of these trends, not only for national security reasons, but also for their portents for American technological research and applications.

The Need for Mathematics
Changes, Challenges, and Opportunities

We are now in a period of vast global, political, economic, military and technological change; change that presents NSA with unique challenges and opportunities. Secure data systems and communications, the availability of timely, accurate intelligence, and information handling and display capabilities are essential to maintaining the fragile peace. Consumer-driven capitalism seems again to have passed the test of time, as countries have become superpowers on the basis of economics alone, and as the economic engines of one after another communist state have failed miserably. Much of this change is driven by or itself influences the pace and direction of technology.

Of particular interest to NSA and defense, the nature of the modern military battlefield is changing. Low intensity conflicts are more likely than superpower war, and the technology of war itself is rapidly changing. These changes include the increasing availability of long range (even short time of flight) precision guided munitions supported by highly accurate targeting means, new and renewed forms of threatening lethality, and other complex factors which impact significantly on the kinematics of modern battle space. The application of stealth is but one example of these modern technologies—but in its purest form, it is a modern warfare approach wherein partial or periodic invisibility nets advantages in surprise, tempo, and timing and creates highly stressful threat detection and response problems. Stealth systems such as today's modern submarine or airplane are the technical analogues of the guerrilla or terrorist which have had such a powerful impact on today world stage.

Similarly, the world geo-political polarity is shifting. Old alliances are moderating on both the Soviet and U.S. sides, new forces are emerging, overpowering military force is appearing less useful than before, and communist countries are clearly concerned about what their poor economic condition holds for their long term power and status. The American system is coping with complex fiscal and technical efficiency problems which challenge our work and market ethics and our competitive abilities.

The challenges NSA face are no less daunting. They include dealing with vast quantities of data in an efficient manner, pulling targets out of complex backgrounds, distinguishing the important from the unimportant, supporting decision making in time-critical environments, converting complex situations and problems into simplified, understandable ideas, and improving the security of communications and information management.

These changes cannot be understood nor these challenges met by relying solely on the theories of the past, but rather we must have fresh insights, new ideas, and a deeper understanding of the way the world works. These, I propose, are tasks uniquely suited for the mathematically trained mind.

Achievements of Mathematicians

The ability to deduce the rules of nature from empirical observation has been the hallmark of mathematicians for millennia. From Euclid's axioms of geometry to Newton's laws of motion and gravity to Einstein's theories of relativity—all have contributed in bringing order from chaos. And yes, there are the elite disciplines of mathematical cryptanalysis and crytography—for cryptanalysis, finding the order of human communications from the chaos of encrypted signals, and for cryptography, creating and reconstructing chaos for secure transmissions. These are vital disciplines that have served our country in peace, have helped save it in war, and could equally doom the nation if their respective successes were to become the order of the day for the other side (as was the case in the heyday of the recent espionage cases).

The Mathematical Workplace

The American workplace has become more mathematical in recent years, and this change can only accelerate. Modern technology and an effective, informed voting public demand a comfortable command of discrete mathematics, statistics, and mathematical modeling—and these are just the entry-level requirements. When we cannot find mathematically literate entry-level workers, when American government and high technology can no longer recruit the mathematically skilled, and when we must finally rely on the scientific insights and advances of other nations, then we will have entered a sad period of technological stagnation and decline.
The Blurring of Pure and Applied Math

There is a great need to move beyond the artificial divisions of mathematics: pure versus applied; defense versus civilian; industrial versus academic; research versus teaching. We must realize that what is good for mathematics in its broadest sense benefits every user, no matter how narrowly focused their application may be.

As an example of the broad application of mathematics, my staff assures me that the solution to one of our important problems critically depended upon an application of Tychonoff’s Theorem.

A little over 40 years ago G. H. Hardy wrote in his masterful book, A Mathematician’s Apology.

I have never done anything ‘useful.’ No discovery of mine has made, or is likely to make, directly or indirectly, for good or ill, the least difference to the amenity of the world.

I wonder how surprised Hardy would be to learn that his beloved Number Theory, which he was so proud to say had done nothing ‘useful,’ is today one of the foundation stones of computer science, cryptography, and communications? Just as the true utility of the Conics of Appolonius was not appreciated until centuries later, so too the pure mathematics of yesterday becomes the foundation of new applications tomorrow.

Mathematics at NSA

The National Security Agency has a long history of demonstrating that mathematicians are the best people to employ in new interdisciplinary initiatives, especially when the problems are very technical, very new, very hard, and not very well understood. For example, our mathematicians have provided fundamental ideas for our work in communications, engineering, speech research, signals processing, and the design and implementation of powerful, specialized computers. But for our primary mission, it is most important that our mathematicians be mathematicians.

The “tools” that we employ to do our job are mathematical. The theories that we need to develop to understand what we are doing are mathematical. NSA has scaled to a vast plateau where there are more application problems than ever before. There is a great need for us to develop new theoretical frameworks for a number of broad, complex problems that we face, and this need is not unique to us.

From a Defense resources and manpower point of view, we are heading into a significant austerity period where no growth at NSA will be the order of the day. Nevertheless, as the largest employer of mathematicians in the United States, I have instructed my personnel office to hire 100 new mathematicians this year, with priority at the masters and doctoral level, if this can be done without lowering our standards. Overall, mathematics is becoming even more essential to our defense, to our industrial competitiveness, and to our nation’s unquestioned leadership in academic research.

The Challenge for Action

The Decline Must Stop

The role of mathematics in the future of American business and government will be central, crucial, and inescapable. Mathematics will be one of the skills that separates service careers from those requiring imagination, creativity, and originality. Supporting and improving mathematics can no longer be merely a slogan, goal or platitude, but rather it must now be an essential objective of any enterprise—business, government, or academia—that expects to remain competitive for the future. We simply must insure that adequate support for mathematics research is an accepted norm, that our standards for pre-college education are equal to our capabilities and needs, and that the definition of “acceptable mathematics activity” is expanded at our universities and even at our high schools to include mathematics education. The decline must stop now, and we each have a role to play.

The Role of Business and Government

American business and government have been accused, with some justification, of taking a limited, narrow approach to mathematics. If the work in question is not “mission oriented,” if it does not increase the next quarter’s profits, if it does not have an obvious application, then it is not worthy of support. We can fall back on the demands of the Congress or of the stockholders, but these answers beg the question. Pure mathematics research benefits everyone, because it creates a fertile field of ideas from which we can draw the solutions to our problems. Mathematics education is the only hope that we have to continue our work—if there is not a sufficient mathematically educated labor pool in the future, then our work today is for naught. Despite the restrictions we believe may limit our actions, we must insure the future of mathematics.

The Role of Academia

Business and government cannot alone face and solve the problems of American mathematics, academia must shoulder its share of the burden. For mathematicians to believe that they deserve unrestricted support simply because they prefer it that way is arrogance, and to think that some special federal dole is appropriate for mathematicians solely because they do good work is
conceit. If mathematics is to be properly supported by society, then mathematicians must not forget their obligations. Universities must move beyond measuring success only in terms of grants or publications, and researchers must recognize their larger obligations. These changes should not be seen as "add-ons" but rather must be an integral part of the job. If we cannot convince our greatest minds to tackle the vital problems of education and the government as well as business then society will invest elsewhere and everyone will be the loser in the long term.

Additionally, mathematics suffers from a significant public relations problem. American researchers yearly solve critical problems, advance theory on every frontier, and stretch the capabilities of the human mind, but the general public (and often the Congress) does not appreciate these achievements. To address this problem, you are supporting a successful public information effort in Washington which must be not only continued but also expanded. I might add that NSA's larger public participation in mathematics was greatly influenced by the Joint Policy Board on Mathematics. If you cannot convince the public that you are doing good work and are solving problems that directly affect them, then your other efforts will be in vain.

**NSA's Response to the Challenge**

It would not be fair for me to stand up here and suggest tasks for you without telling you what we have done to meet the challenge. In 1987 at NSA we held two very successful meetings with American mathematics leaders to explain our uses of and needs for mathematics. We explained, as best we could, what types of mathematics are important to us and we sought advice on how we could better participate in the larger math community. The technical presentations were published in the Proceedings of the NSA Mathematical Sciences Meetings, which is available from our grants office. At that time our grants program was expanded and redirected to support almost exclusively pure mathematics research. We believe that our grants program, the NSA Mathematical Sciences Program, will become an important source of funding for pure mathematics research in those areas that best support our mission.

Through our grants program, we are providing core support to the Mathematical Sciences Education Board for their study and revision of the K through twelve mathematics curriculum for American schools. Our mathematicians have actively participated in a number of national conferences in these areas: "Calculus for a New Century" last year, "Mathematics Education—A Wellspring of U.S. Industrial Strength" this past December, and, as previously stated, we are also supporting the follow-on study to the "David Report." NSA and affiliated mathematicians are attending this forum in some numbers as well.

For decades, NSA has worked closely, profitably, and quietly with university mathematicians—faculty and students, both graduate and undergraduate. We have formal sabbatical programs for visiting and for our own mathematicians. Our academic interactions are assisted by the Institute for Defense Analyses' Communications Research Division in Princeton, which works closely with us. In 1952 we started holding summer workshops for university mathematicians, and since 1959 they have been very successfully conducted in Princeton by C.R.D.

Our mathematicians have been actively supporting the Maryland State Department of Education's summer Gifted and Talented program in mathematics for students in elementary through high school. We are establishing a Speakers Bureau to bring the excitement of mathematics to local high school and middle school students. Finally, we are working with The George Washington University to conduct a summer workshop for regional high school mathematics teachers. It is not possible for us to support all mathematics everywhere, but we believe that we have a particular obligation to encourage mathematics in schools near us.

I hope that our first, halting steps to increase support to mathematics will be taken as a challenge by each institution represented here—a challenge that you will soon meet and surpass to insure that mathematics will indeed have a role in the future of American business, government, and academia.
Computational Environments: a Tale that Wags the Dog

In 1983 I left the Mathematics Department at the University of Wisconsin, Madison, to direct the then new Center for the Study of Language and Information. CSLI is an interdisciplinary research institute devoted to mathematical and computational approaches to understanding language, meaning, information, and representation. I directed it for two years, before returning to research, teaching and less demanding administrative responsibilities. During that time, establishing a suitable computational environment for the Center was one of the responsibilities that weighed most heavily, absorbing countless hours of thought, worry, and discussion, and far too much money.

Last week was a poignant one in this regard. I came back from lunch one day to discover many of the workstations around which we had built our plans lined up by the back door, waiting to be taken off to computer heaven (we'll assume, for charity's sake). Five years after being state-of-the-art computers, these machines had become jokingly referred to as space heaters and door stops. And the uniform computational environment we worked so hard to create has gradually evolved into something quite different.

This experience has left me with a keen interest in the problems associated with establishing a computational environment for work in mathematics, and some pretty definite opinions on these matters. Indeed, one of my motives in agreeing to create and edit this column was to try to drag out of other mathematicians their experiences in creating such environments, so that we do not all make the same mistakes.

In this month's issue I present what I hope will be the first two of many articles addressing the questions associated with these problems. The first is by Gene Herman, and describes the computational environment in place in the mathematics department at Grinnell College. The second is a review by Mark Sands, of Augusta College, of a commercial product around which Augusta's mathematics department has built its local area network (LAN). At the end of this month's column, I exercise my editorial prerogative with a commentary on these models. This is not meant as a criticism of the decisions made in either department, but to point out a few of the decisions one might want to question, especially in a different sort of institutional setting. I hope that these articles and commentary will prompt others to write of their experiences, especially those that differ markedly from that of Grinnell. Write to me at:

Center for the Study of Language and Information
Ventura Hall
Stanford University
Stanford, CA 94305
Email: Barwise@csli.stanford.edu

Another reason for running articles of this kind is to provide mathematicians around the country with ammunition. Take these articles to your administration and say "Look what the competition is up to. We are falling far behind." From this point of view, both models are quite useful since the computational environments they have established are ahead of what most departments have managed to create.

In addition to the two articles just mentioned, this issue contains a review, by Herbert Holden, of FITLIB by PC-Scientific, a program that generates splines for fitting given data. This is the first of several PC-Scientific programs that are in the works.

**TEX, \LaTeX, and \AMS-TEX**

In spite of repeated disclaimers, many readers assume that I must be an expert in everything connected with computers and mathematics, or at least with *some* things so connected. In particular, over the past few months, I have been asked by several people around the country about the differences between \TeX, \LaTeX, and \AMS-TeX. These mathematicians were all somehow involved in choosing among these programs,
either at a personal or departmental level. I have tried unsuccessfully to find someone who would do a comparative review. So what I have done instead is to ask a number of people for their opinions on the relative merits of these three systems, mix this with my own experience, and write it up as a short note. I would like to express my thanks to Ilan Vardi and my other informants, who prefer to remain nameless, for advice and comments. And I should say, right off, that for the past four years my own mathematical writing has been done almost exclusively with \LaTeX, though I have ventured out into \TeX from time to time. I have never used \texttt{AMSTeX} at all. Everything I know about it is from my informed sources.

\TeX

In case there are any Rip van Winkles reading this column, \TeX is Donald Knuth’s typesetting program that has literally revolutionized the typesetting of mathematical text. The stress here is on \textit{typesetting}. It is not an editor; rather it can be used with any editor. Nor is it a typographic designer. It leaves the decisions usually made by the typesetter (like how much space to put below a section heading) up to you. Nor does it generate particular document styles. Creating those is also up to the user. What it does is to provide a powerful set of computational tools that allow you to custom design and typeset your own mathematical documents. And it is a masterpiece.

Actually “\TeX” is ambiguous. On the one hand it refers to the raw \TeX program, which only knows about low-level typesetting primitives. Using this \TeX to typset anything would be almost hopelessly difficult; somewhat akin to setting lead type by hand! To make \TeX a convenient tool one must add to this primitive version of \TeX a collection of so-called “macros” that teach it some of the higher level concepts of typesetting and also instruct it to use a particular output format style. Knuth has provided an excellent vanilla macro package that is variously referred to as “the basic control sequences”, “the plain macro package”, or “the plain \TeX format”. The second, more common usage of “\TeX” is to refer to this enhanced “plain” version of \TeX. This is what we will usually mean by \TeX in what follows.

Many experienced \TeX users find the plain format an ideal environment for most simple typesetting tasks; they can easily add themselves the few extra macros needed to adapt plain to the use at hand. However, for beginners, using even this enhanced \TeX is hard going. And experienced \TeX users too find plain insufficient when they are faced with more demanding typesetting tasks. For plain \TeX does not provide good support either for complex mathematics or for the difficult task of preparing a long and complicated document (e.g., a thesis or multi-chapter book with a table of contents, an index, a bibliography, and forward and backward references to numbered theorems and equations). And this is where other macro packages enter the picture.

\LaTeX

\LaTeX is a program written by Leslie Lamport on top of plain \TeX. It adds to \TeX a rich collection of macros which make using \TeX easier in most situations. Rather than being a typesetting program, it is a full-fledged document preparation system. In fact, it was designed to implement a SCRIBE-like environment within \TeX.

Its most important feature is that it provides a family of ready made document styles (article, report, book, letter, memo, etc.) for you to use, in the form of \texttt{.sty} files. Most of my own writing uses \texttt{article.sty}. These styles set a host of parameters for you, like the way things get numbered, spacing, margins, and the like. Most of these can be modified, though. For example, sections and subsections are usually numbers, but I can leave them unnumbered by simply adding an asterisk in the appropriate command. \LaTeX excels in such things as automatic creation of tables of contents and indexes, footnotes, the handling of automatic forward and backward references to numbered text items (theorems, definitions, etc.), bibliographies, and so forth.

\texttt{AMSTeX}

\texttt{AMSTeX} is also a package of \TeX macros. It was developed by Mike Spivak for the AMS. But its goals are quite different from \LaTeX’s. It is aimed at providing macros which simplify typesetting complex mathematics in \TeX. Its forte is things like matrices and complicated alignments of equations. The AMS finds it very useful in this regard. But it does not provide the kinds of facilities provided by \LaTeX described above.

Relative Advantages

Which of these programs should you learn and use? That will depend on your personality and the kind of mathematics you want to write. If you are a person who likes to build your own stereo, or write your own programs, then probably \TeX is for you. It gives you maximum power and leaves you unconstrained by anyone else’s design decisions. And it is maximally flexible. \LaTeX, by contrast, is pretty rigid. This can be an advantage, in that it keeps you from making all
kinds of mistakes, but it can also feel like a straight jacket if you bump up against something it won’t let you do easily, like turn footnotes into endnotes, or create a one page document without a page number.

But most mathematicians want a program that puts as little between them and writing mathematics as possible. For such mathematicians, I think \LaTeX is probably \TeX. This was demonstrated (\TeX does) or he may choose it. On the other hand, if you are writing a short article with lots of displayed equations, \AMS-\TeX is probably more useful. In between it is a matter of taste.

Another main point in favor of \LaTeX is the manual which is extremely well written and is designed to teach you about how to use the program, not to teach you all about typesetting. This is extremely helpful for anyone who wants to get something done within a short time of starting with the program. The \AMS-\TeX manual (The Joy of \TeX) and the \TeX manual (The \TeXbook) are also very well-written, but the \TeXbook suffers from trying to be both a users guide for plain \TeX, but at the same time a reference manual for the extremely complex \TeX program. These two rôles are often incompatible. There has long been a good elementary introduction to plain \TeX available from TUG, the \TeX Users Group, ("First Grade \TeX: A Beginner's \TeX Manual", by Arthur L. Samuel), but true to its name it will only barely get you going and has almost no information about typing mathematics. Very recently Michael Doob of the University of Manitoba (mdoob@uofmcc.bitnet) has written a first rate seventy page users manual for plain \TeX (A Gentle Introduction to \TeX), and very generously placed it in the public domain.

Macro packages such as \AMS-\TeX and \LaTeX are almost always add-ons to plain \TeX, that is they are built "on top" of it. But the author of any given package may either choose to remain compatible with plain \TeX (as \AMS-\TeX does) or he may choose to redefine certain macros in ways incompatible with plain \TeX (as \LaTeX does). Aside from displaying really complicated mathematics, the one clear advantage of \AMS-\TeX over \LaTeX is that the former is a strict extension of \TeX, the latter is not. Lamport has removed part of \TeX from \LaTeX, so you cannot learn \LaTeX first and then simply add various \TeX commands as you need them. For very complicated things that can’t be done in \LaTeX, you have to figure out which \TeX commands you can use, and which you can not.

Why not simply combine the \LaTeX and \AMS-\TeX macros? Unfortunately, two different macro packages as complicated as these are unlikely to be compatible with each other unless they were created with careful joint planning. And, sad to say, \LaTeX and \AMS-\TeX were created independently and are incompatible. However, I understand that Spivak is at work on a package called \AMS-\TeX that combines the best features of \LaTeX and \AMS-\TeX. This was demonstrated at the recent annual meeting in Phoenix, and although I missed it, I hear that it looks very promising.

In addition, AMS has chosen to create a \LaTeX style file embodying \AMS-\TeX's mathematical formatting abilities while retaining \LaTeX's easy-to-use document formatting strengths. The Society plans to make an \AMS-\TeX \LaTeX style file available to the mathematical and \TeX communities this spring. The AMS will continue to use \AMS-\TeX for its publications but it will also accept authors' electronic files prepared with \LaTeX's \AMS-\TeX style file.

So my recommendation to mathematicians who do not want to pay a lot of attention to typesetting nitty-gritty: start with \LaTeX. It will let you do 99% of what you want to do, and you can always write your way around the other 1%. After you have been using it for a few months and start bumping up against its limitations, get the \TeX book and add that extra 1%.

Grinnell College's MathLAN

Gene Herman
Grinnell College

The Setting
Grinnell College is a private, four-year, undergraduate, liberal arts institution of 1200 students. The department of mathematics has approximately 8 full-time equivalents, including the mathematics faculty...

*Gene Herman is Professor of Mathematics at Grinnell College. He received his Ph.D. in functional analysis from the University of California at Berkeley in 1964. He is the author of MAX, the MAtriX Algebra Calculator, which was named in the 1988 EDU-COM/NCRIPTAL awards as “Distinguished mathematical software.” He is currently editor of “Computer Corner” in the College Mathematics Journal, and a member of the MAA Committee on Computers in Mathematics Education.
who teach computer science and statistics. We graduate between 15 and 25 mathematics majors each year and also teach a large number of nonmajors. Our greatest enrollments are in Calculus I (175 students in 1987–88), Calculus II (170), Linear Algebra and Differential Equations (95), Series and Differential Equations (46), Computer Programming with Pascal (90), and Introduction to Statistics (175), although the enrollment figures for Statistics include sections taught by faculty in other departments. The scholarly activities of the faculty include mathematical research, reviewing and editing for journals, expository writing, textbook writing, and software development.

Our physical facilities are new. We occupy the top floor of a wing of the science building, where we have 10 offices, 4 classrooms, a computer lab, and a small unstaffed department office. On the floor below is our secretary whom we share with another department. On the floor below that is our machine room. We moved into the building in June, 1987, and the first phase of our computer network, which we call MathLAN, was installed in October, 1987.

The Impetus

We have used computers in our department for years, but our use accelerated rapidly in the early 1980s, when we first got computing equipment in our offices and classrooms. In 1982, we got computer terminals in our offices, which connected us to a central PDP minicomputer. Then, in the summer of 1984, our terminals were upgraded to Rainbow microcomputers which doubled as terminals. A year later we got dot-matrix printers for our offices, and some of us got graphics boards and color monitors for our micros.

Although we had one classroom with a terminal as early as 1975, few of us did any computing in the classroom until the fall of 1981, when we installed an Apple II in each of two classrooms. We added two terminals in the summer of 1983. However, we went several years with inadequate projection equipment, until December of 1985, when we installed high quality Electrohome monitors in our classrooms and a switch box that let us choose whether the monitors would display output from the microcomputer or the terminal.

Even in the early years of our computer use, we had quite a variety of software. By 1985, we had both a simple word processing package and one that could produce fairly good mathematical output (MASS-11), an electronic mail system for on-campus communication (DREAMS), programming languages, a graphics subroutine package (the Core System), several statistical packages (including MINITAB and SAS), a spreadsheet and graphing package (Research System 1), a matrix analysis package (MAC, later renamed MAX), a computer algebra system (MACSYMA), and a number of Apple II packages that we used primarily for displaying graphics in the classroom.

Then in the fall of 1985, we learned we would be moved to a new wing of the science building. For several reasons, this was the perfect opportunity for us to plan a new computer system for the department. Most obviously, we would be able to design our new quarters to house computers comfortably rather than continue to struggle with the inadequate wiring, lighting, temperature control, and physical space in our old building. Also, for the preceding year the College had been studying the possibility of installing a local area network (LAN) on campus. So the administration was ready to consider a department-size LAN, and we were ready because we had been involved in the study.

Another set of reasons for our interest in a new computer system were our existing system's inadequacies, which had become more obvious as our use increased. For example, the Apple IIs in our classrooms were incompatible with both the Rainbows in our offices and the central minicomputer. The number of microcomputers on campus was so small that most of our classes could not be asked to use them to do assignments, and file transfer between micros or between a micro and the mini was tedious. The screen resolution on both types of micros was low and their computational speed was slow, which made them unsatisfactory machines for much of our graphical use. Graphics on the central minicomputer was no better, as timesharing slowed its responses. Also, the response time of the mini sometimes slowed our classroom presentations. Most frustrating of all, interesting new software was coming out that would not run on our small, outdated micros and would either run slowly or not at all on the timesharing mini. In short, our existing computer system lacked local power, uniformity, accessibility, and interconnectedness.

The Plan

During the 1985–1986 academic year and part of the next, we planned a new computer system, wrote grant proposals to the National Science Foundation and several private foundations, and worked with an architect to design our new space so it would support the kind of computing we envisaged. Our plan called for workstations with central file servers, so we could have both local power and the convenience of a single location for all software. These would be connected together by a local area network to which peripherals
would also be attached. Furthermore, the network would be bridged to the central minicomputer (now a VAX 8600), so we could continue to use its facilities. A principal criterion in the choice of a vendor was the availability of appropriate software, especially software for mathematics and computer science.

We settled on a network of 50 Sun 3/50 monochrome workstations and three file servers, plus two Apple LaserWriter printers, a high-speed Printronix line printer, and a Hewlett-Packard 8-pen spooled plotter. These are linked by an Ethernet, which is bridged to the VAX by a fiberoptic cable. The workstations are distributed as follows: one in each of the 10 mathematics faculty offices, one in each of our 4 classrooms, 18 in a public terminal room that doubles as a lab for math courses, 15 in a computer-equipped classroom, two that drive printers, and one for our secretary. The file servers are in the basement machine room, one LaserWriter is in our department office so faculty alone can use it, and the remaining peripherals are in the public terminal room. We also continue to use our old dot-matrix printers, which are now driven by our office workstations. Projection equipment for the classrooms was again hard to find, but eventually Moniterm came out with monitors that can keep up with the Sun’s high scan rate. In a typical 40-student classroom, we have four 25” monitors overhead.

The mathematical software on MathLAN consists of MATLAB (for graphics and numerical linear algebra), SMP (computer algebra), MAX (matrix analysis), and S (statistics). We also have TeX for mathematical word processing. For programming, we have C, Pascal, LISP, FORTRAN, and a few more exotic languages. Finally, we have SunLink DNI (Sun’s implementation of DECNET) for communicating with the VAX, which we use for electronic mail and for its various special-purpose front ends that would be wasteful or impossible to duplicate on our system.

The computer center pays the maintenance contracts for our hardware, and their technicians provide routine maintenance. Their staff also hires and pays student User Consultants, who help others in our public terminal room. We, however, provide much of the system maintenance. That is, a member of the department creates accounts, installs software, does backups, writes supplementary documentation, runs workshops, and troubleshoots software problems.

The Current State
This past semester, the fall of 1988-1989, was the first one in which we completely moved over from our old computer system to MathLAN. During that semester, all of the mathematics faculty used the new system and about 40% of our students did. Average faculty use was about 6 hours a week, with about three-fourths of that related to teaching, and average student use was somewhat over 1 hour per week.

Our system’s hardware is working very well, although a few problems remain. The principal one involves our computer-equipped classroom; the workstations are so bulky that they interfere with lines of sight. On the other hand, all the major benefits that we expected of our new hardware have indeed come about. Wherever we are—in our offices, a classroom, or the lab—we have enormous local power at our fingertips. Complex graphics and long computations are completed quickly; multiple processes are carried out simultaneously (or so it seems) and results easily transported between them; and heavy use of the system has no noticeable effect on response time. The uniformity, accessibility, and interconnectedness of the system have made instructional use particularly effective. We can prepare computer-based assignments in the privacy of our offices, demonstrate them in class without any need to move equipment or files, and have our students carry them out in the lab. Since the equipment is identical in all three locations, compatibility problems never arise.

Most of our software is working as well as expected to. We will probably switch to a different computer algebra system, and some of our other packages (S, SunLink DNI) await updates that promise to cure their most serious deficiencies. MATLAB, MAX, TeX, electronic mail, and the language compilers—the software we use most heavily—have been excellent. MATLAB is not easy for a computer novice to use, but, because it is programmable, Emily Moore of our department has been able to create a number of special-purpose front ends that are indeed easy to use. As a result, MATLAB is now our most heavily used graphical and numerical package. MAX, the MAttriX Algebra Calculator, is a package that I designed on our previous computer system and moved over to our new one. We use it extensively in teaching linear algebra. For mathematical word processing, many in our department are so comfortable with TeX that they use it themselves all the time, while others have our secretary do most of their TeXing. One use of electronic mail and SunLink DNI, then, has been to exchange files between ourselves and our secretary. SunLink’s terminal emulator has also allowed us to continue using MINITAB in our Statistics course, even though we have this statistics package only on the central VAX. Thus, we can still demonstrate MINITAB in our classrooms and have
students practice it in a supervised lab. However, we expect to make increasing use of S in the future.

Underlying all of our software, of course, is Sun’s Unix–based SunOS operating system and SunView windowing system, which have their good and not-so-good aspects. On the one hand, this is powerful software that supports multiple windows, multiple processes in each window, and easy communication between processes. On the other hand, not all of us are sufficiently interested in either the details or the sophisticated concepts of Unix to learn to use it well. Also, SunView does not hide enough of the Unix details from us, nor does it provide as uniform and easily understood an environment as, for example, the Macintosh windowing system does. We hope that Sun’s new Open Look system will be a significant improvement.

Perhaps the most intimidating problem for us has been the amount of time we have had to invest in managing our computer system. Fortunately, the College has provided a few short-term reduced teaching loads for us and has tentatively agreed to a substantial long-term teaching reduction for one member of our department, John Stone, to be system manager. Also, we hope to turn over the more routine technical aspects of system management, such as doing backups, to the computer center.

The Impact

The completeness and uniformity of MathLAN has encouraged the mathematics faculty to use computing more heavily yet. We want even better software, of course, and we want the system to be even easier to use, but the workshops we run for ourselves and the tailoring we do on packages such as MATLAB have been helping us make good use of our system quickly. For example, our dependence on mathematical word processing software is complete. (All our classroom handouts, exams, and preprints look beautiful!) We are also more likely than ever to use the computer spontaneously in class for graphing and numerical computations. And, for the first time, we have been thinking seriously of getting large classes such as Calculus using the computer.

However, the greatest impact on our courses continues to be at the sophomore level. MAX has helped us improve our Linear Algebra and Differential Equations course, as we could never do without the computer. We now emphasize eigenvalues and eigenvectors, realistic applications, and the interplay of linear algebra with differential equations. The software lets students easily get the results of otherwise tedious computations, so they can spend their time more productively on planning their computations, interpreting the results, and trying to understand the concepts.

The succeeding semester, in Series and Differential Equations, we have students use the graphical and numerical capabilities of MATLAB to aid them in understanding convergence in many of its guises. The course covers both the pure mathematics, such as uniform convergence, Taylor series, and Fourier series, and numerical aspects, such as numerical solution of differential equations and numerical summation. Such a course is hardly conceivable without the computer. But with MATLAB, students are able to carry out projects and exercises that help them gain insight into analytic processes.

We also use MATLAB, at least for its graphics, in Calculus. However, in most sections last semester, this simply meant that the instructor used it for classroom demonstrations. In only 3 of our 8 sections did instructors have the students carry out graphical exercises using MATLAB. Still, it is clear that the computer is rapidly changing our attitude toward graphing in calculus, inclining us to treat graphing as a tool for analyzing functions and not as an end in itself.

On the other hand, we are less certain of the role of computer algebra systems in calculus. Existing software of this type requires one to learn many fussy details and a powerful but subtle command language. So before we impose such software on our students, we need a better understanding of its potential benefits. By contrast, students quickly pick up MAX and MATLAB just by watching the instructor use them in class.

The computer lab has been a great convenience, but especially for the Statistics and Programming with Pascal classes, which had only marginal lab facilities previously. Also, the superior programming environment on the Suns have helped us raise the level of our programming classes. The interactive debugger and the powerful Unix utilities have been particularly valuable.

Our MathLAN computer system has also given students and faculty in the department a stronger sense that we are working together in a common environment toward common goals. We take pride in having put together such an extraordinary resource, but we are certainly not complacent; the job of improving and making better use of computing goes on and on.

Professor Gene Herman
Department of Mathematics
Grinnell College
Email: Herman@grin1.bitnet
Reviews of Mathematical Software

NetWare by Novell
Mark Sand

Introduction
NetWare by Novell, Inc. is a software package designed to allow IBM or IBM-compatible microcomputers to share common resources. NetWare has been widely used in business applications for several years, and is now breaking into the educational market.

While a true network would allow information on screen or in storage to move directly from one computer to another, NetWare achieves an interconnection through a file server system. This means that one computer, containing a hard disk drive with a large storage capacity, is dedicated to serving as the storage medium for all connected machines. Then this stored information can be accessed from the file server by anyone with the proper security clearance.

In the October, 1988 issue of Notices, R. Palais detailed the advantages of networks, so I shall attempt to describe the usage of, advantages of, and problems with this particular networking system. I would like to thank Loren Koepsell, our Director of Academic Computing, for his assistance in using NetWare and in writing this article.

Hardware And Software Requirements
To use NetWare it is necessary to have an 80286 or 80386 computer with 2 Mbytes of memory and a large hard disk to function as the file server. The computers connected to this server, referred to as workstations or nodes, can be any IBM-compatible computers, must have enough memory to run whatever applications are desired, and must be fitted with an expansion card called a NIC card. NetWare comes in many versions, with widely varying capabilities. These start at the cheaper and less-complex end with ELS, for “Entry Level System,” go through the standard versions, and end with the most-powerful versions, referred to as SFT NetWare for “System Fault Tolerance.” In SFT NetWare v2.1, the version used at Augustana, there can be up to 256 workstations physically connected to the server, with up to 100 of them actually “on-line” at a time. More than this number of workstations can be served, but only by chaining together more file servers. In contrast, ELS v2.0a restricts the network to linking only eight workstations and allows only four of them to be “on-line.”

System Configuration
Each of the classroom buildings at Augustana has a computer classroom with Compaq computers and a NetWare-controlled file server containing a 130 Mbyte hard disk. These are used for teaching in all disciplines, independent student work, departmental administration, and some faculty research. Each file server also drives two or three printers.

Accessing The System
In order to access the system, I insert a floppy disk into the disk drive of a workstation and turn on the power (the file server is always powered-up). This disk contains MS-DOS to boot the workstation and the programs which connect the workstation to the server. A batch file executes these in the proper order, clears the screen, and gives the prompt: Enter your login name. After typing marks and pressing “Enter” the system checks to see if my account is secured by a password. Finding that it is, it gives the prompt: Enter your password. Upon typing the password, which doesn’t show on the screen, and pressing “Enter” again, I am connected to the file server and can access some of its files.

The system comes in a standard configuration in which retrieving files or programs from the file server and manipulating them is done through commands given on a command line, similar to using DOS. In fact, NetWare acts as a “shell” around DOS, so that it recognizes all DOS commands and some additional network ones.

With hundreds of users, each having a subdirectory in which to store information, and dozens of application programs stored on the disk, it is not surprising that the directory structure on the disk can be very complicated. To make it a little easier to move around this directory, a system of “drive pointers” is used. Suppose that I routinely need to use files in the Package\Private\Lotus and Package\Public\Pcfile subdirectories. Instead of having to type cd\Package\Pcfile for example, to move from one to the other, these can be assigned to letters. If I type map F: = \Package\Private\ and map G: = \Package\Public\Pcfile for example, to move from one to the other, these can be assigned to letters. If I type map F: = \Package\Private\Lotus and map G: = \Package\Public\Pcfile, then merely typing F: or G: will move me from one place to another, similar to switching from drive A to drive B on a computer with two floppy disk drives.
Another feature which makes the complicated structure easier to use is the “search drive.” This is similar to the PATH command in DOS, but is necessitated by the fact that PATH can only affect the drives that are local to the workstation, not a network drive. For example, suppose that there is a file in my personal directory, \Faculty\ Marks, called novell.tex that I want to edit with the word processor PC-Write, and PC-Write is located in the directory \Package\Public\Pcwrite. If I type ed novell.tex then nothing happens because the program named ed (which invokes PC-Write) is not in the currently active directory. So I first type map s1: = \Package\Public\Pcwrite to make the files in the \Package\Public\Pcwrite accessible from any other directory. This makes ed novell.tex the proper thing to type from the directory containing novell.tex.

Menus
All of these details seem like a bother, and they certainly can be just that. But the above description is of the default setup, which can be substantially changed to exactly fit each individual user’s needs. Menus can be used to avoid the command-line input altogether. When I log onto the system, NetWare looks for my “login script,” which is a sequence of commands to be executed in order to automatically set up the drive pointers and search drives that will help me. This script then invokes a menu of choices, similar to the one shown in figure 1.

The top line of the menu is highlighted, and I use the cursor keys to move the highlight to the desired line. Pressing “Enter” causes execution of whatever commands are stored for that line. Possible results are: (1) If the line contains the name of an application program, that program is invoked. (2) If the line contains a network operation, such as changing my password, those network commands are executed. (3) If the line contains a general topic, a sub-menu is shown where a further selection can be made. This third outcome is shown in figure 2.

After an operation is completed or an application program is exited, I am returned to the menus and can either select another application or log off the system. Also, to access something not included in the menus, I use the “Escape” key to exit the menu structure and return to the command-line interface.

Any user can create his or her own menu structure to be invoked upon login. However, this task involves some familiarity with the details of the NetWare system, and is usually reserved for a very small subset of users that are referred to as “supervisors.”

But What Good Is It?
Our network has been used more for teaching than for any other purpose. Although features such as sharing of data and electronic mail make research and administration more efficient, I shall refer the reader to the article by R. Palais on these matters and describe how we are using the network for education.

Teaching
After using the networked classroom the first time, it was disappointing to not be able to use it every day. Of course, in some classes, there probably isn’t a reason to use it every day. But having each computer used by only one or two students in class allows for much more investigation than a demonstration performed by the lecturer. What goes on is what I think of as “guided individual instruction.” What I mean is that instead of leading the students through a fixed series of examples or problems, each student can ask a different question or have different questions asked of them, and then use the resources at their fingertips to find the answers. For example, when teaching the Trapezoidal rule or Simpson’s rule for approximate integration, each student is able to take an existing program in BASIC (or other language) and customize it to find the areas of those regions that they find interesting.

If the application program currently being used isn’t the right one to help, they can immediately switch to another one which is better. There is no conflict over a small number of machines that contain the necessary hardware and software. Even an exam can be customized so that each student receives a different set of problems, which are then graded right on the computer.

Reducing paperwork can be another result of using the network. A special subdirectory can be created for a specific course, where the instructor can store files containing notes and assignments. In return, the students can “hand in” their homework by storing it in this directory instead of submitting a paper copy. This is especially nice for computer programming assignments, since they can then be individually test run—a much better method than checking over a stack of program listings. A network of personal computers has an advantage over a mainframe in this area, since some of the students and faculty have similar computers at home and can all work simultaneously with no competition for terminals or phone lines to the mainframe.
Laboratory Use
When the classroom is not occupied with a class, it is available for use by any student or faculty member on a walk-in basis. As the sample menus show, the system is used for many purposes. They can be put into four categories, each of which serves an important role: (1) The standard applications of word processing, spreadsheet, and database software are available, of course. These are used both to prepare assignments for the courses that teach these applications, and to assist in projects in almost every discipline. (2) Programming, for Computer Science course assignments and for problem-solving in other science courses, is done in the available languages. (3) A few special-purpose packages, such as a CADD program or MathCAD are available for advanced students. (4) Tutorials in many disciplines are loaded onto the network. Some of these were commercially produced and some were written by a faculty member in that discipline.

Help for the Novice
For the true beginner, who has never used a computer, the command-line interface of NetWare would seem truly frightening. But because of the menus described above, a computer novice may be better off using a NetWare workstation than a stand-alone PC. Everything that a beginner would need to do can be accomplished by choosing the correct lines from the menu. I have found that when working with novices, it is only necessary to give them a five-minute introduction to logging onto the system and what the menus can do, and they are then able to get to work on some application program or tutorial. In general, it takes much longer to become familiar with a typical application, such as a word processor, than to become comfortable with accessing that application on the network. The only areas in which most users need occasional reminders are in storing and printing files.

Supervisors and Security
NetWare can be fairly accurately described by the one word “security.” When a new account is created, say Johndoe, the user Johndoe has very few capabilities other than logging onto the system and changing his password. So a list of “trustee rights” is assigned to his account by someone who is designated as a “supervisor” and has been given access to all accounts and files on the network. This means calling up the account name Johndoe from a NetWare menu utility named SYSCON (for SYStem CONfiguration) and entering the path to the desired directories and application packages into a list under the heading “trustee assignments.” It is also necessary to create a separate subdirectory under some proper category in which Johndoe will be able to store files, for example \ Student\ Johndoe.

For each directory in the trustee assignments list, there are eight different rights which can be granted or revoked for a user. These include such capabilities as Searching the directory, Opening a file, Creating a file, Reading a file, Writing to a file, Deleting files, and others. So there is great flexibility in making the assignments. For example, the rights Read-Open-Search are commonly given for a directory in which there is an application program which the user should be able to use but not alter in any way. In contrast to that, Johndoe needs to have all rights to the directory \ Student\ Johndoe.

Only a minute or so is needed to create a new account with the proper assignments. However, to create many accounts at one time by this method would take too long, so there are ways to make it much more efficient. A NetWare utility called MAKEUSER can be used, or the users can be assigned to an existing group of users, or both. The one-at-a-time method is best reserved for only a few special situations.

The NetWare security is present at several levels: First, there is an account name and preferably a password required for access to the system (although students being a friendly lot, these are often not kept secret). Secondly, a user is given access to only that information which the supervisor allows. A third method of security is also available, that coming on the file level. In any directory, the files can be “flagged” with certain attributes. They may be “sharable” or “non-sharable” (many simultaneous users or maximum of one user), and they may be “read-write” or “read-only” (files may or may not be altered). As necessary as all this security is, even in an educational setting, it can have the effect of discouraging some from using the network.

Documentation
As you may suspect, NetWare comes with an entire fleet of manuals to describe all the aspects of the system. In fact, one of the manuals is entitled “Guide To Manuals.” This includes a glossary of the terms used in all the manuals, and some advice on where to look for various problems that might arise. It refers to eight installation manuals (not touched except by the single installer), four manuals for supervisors, and four manuals for users. All are supplemented by “Quick Reference Cards.” I have found the manuals somewhat daunting just by their sheer volume, but those that I am familiar with (which is most of them)
are very easy to understand. The writers must have realized that a sloppy presentation can obscure the many details being described, and were extra careful to not let that happen. Each section begins with a summary of the purpose and use of the command or utility being described. The available options are then listed, followed by an example of the use of the command. The examples are truly detailed—in comparison, they are much more informative than the examples given in a standard DOS manual. Also, those statements that would be typed by the user are printed in red ink. Other products should have such a clear presentation of what the user sees on the screen and what is entered from the keyboard.

Actually, most users never need to refer to a manual, since all of the software that they use can be accessed through the menu system that is set up by the supervisor, and other capabilities of the network are needed infrequently. The more that the supervisor is familiar with the network and can customize it to the users, the less that the users need to know about the manuals and the details they contain.

Difficulties Encountered

Network Configuration
Other than the frequency with which students forget their account names or passwords, probably the most inconvenient aspect of our network is that a separate floppy disk is required to boot up the workstation and establish its connection to the file server. An “auto-boot” card can be installed in each machine, at additional cost, to establish this connection upon turning on the workstation.

Using Application Software
To use any software package, it is merely loaded onto the file server in the same way that it would be loaded onto the hard disk of a separate microcomputer. However, we have found that the directory tree on the file server, being more complex than the directory tree found on most hard disks, makes some packages more difficult or impossible to use. One package we tried wouldn’t run when placed deeper into the tree than the root directory. Another package, a calculus tutorial program, will only run on the workstations from a floppy disk (which is about one-tenth as fast as using the file server). The problem is that the program always looks for its data files on disk drives A and B, and there is no way to re-route the data searches to the network drive. Thus we have found that some packages are not sophisticated enough to be able to use the network in the most efficient way.

Legalities
The capabilities of a LAN make it easy for unscrupulous users to ignore software copyrights. Some steps must be taken to insure that the copyrights are protected for all software that is not shareware. If users at all workstations need to simultaneously access a software package, then a registered copy of that package must be purchased for each workstation, even though only one gets loaded onto the file server. If only one copy is purchased and stored on the server, then those files must be flagged as “non-sharable” so that only one user at a time can access them. Also, the executable program files have extensions of either .exe or .com. These need to be given the “execute-only” attribute by the supervisor, which prevents them from being copied off of the disk. This helps to assure the software-writing companies that networks are not merely places for easy illegal copying.

Printing
In our experience, the aspect of the system that has caused the most headaches is printing. Since most of our software packages are the same ones used on stand-alone computers, they have no special provisions for printing from a network. A newer “network version” of any software package will almost certainly make printing less painful.

Printing is done by using one of two possible methods. Some packages won’t print on the network (only to a locally-connected printer), so the output is stored on a newly-created file, and then the network directed to print the file. If the file is named test.tex, for example, the necessary command is nprint test.tex p=0. The p=0 ending to the command sends the file to a printer queue numbered 0. There can be several printers connected to the file server, each served by one or more queues operating under the expected first-in first-out order. The second method is for packages that will print on the network, the problem being that the output must be routed to the desired printer. This requires that a command such as capture p=0 be typed before the application program is invoked. Then any printer output is directed to printer queue 0. The menu system can take care of both of these methods automatically, of course.

Various printing problems can occur, most of them difficult to explain but relatively harmless. The most serious problem that we have frequently seen can occur when a user makes a mistake while programming in a language. For example, it is fairly common for a
student to unknowingly create an infinite loop in a BASIC program. If that loop contains an LPRINT statement, then the output enters the printing queue and the printer "gets stuck" into printing that user's output forever. Then the printer must be left off, which blocks anyone else from printing until this infinite loop can be removed from the print queue. The quickest solution is to ask the user owning the offending program to delete that file from the print queue, by using the NetWare utility PCONSOLE. However, the user may not realize the problem or may leave exactly because of the problem. In that case, any supervisor or other user designated as a "print queue operator" can delete the unwanted file from the queue.

Summary

I do not have personal experience with other networking software packages. However, I have contacted several people familiar with both NetWare and other packages, and all agreed that NetWare has more power and flexibility than the software they have used. It is a very good system, and also very complex, which makes the job of system supervisor extremely important. Working from the command line, NetWare is much less user-friendly than DOS. However, if a user's login script is properly written, and the menus are detailed enough to contain all of the needed options, then the user is fairly well insulated from the details of the system. Knowing the difference between the choices available on the menus is all that is needed to use the network, and this can even be discovered by experimentation. We have found that students and faculty members alike become quickly accustomed to using the system, and are now competing for the available access. The success of the network encourages us to look forward to the day when the entire campus will be linked with NetWare.

Product Availability

NetWare is available from Novell, Inc. at 122 East 1700 South, Provo, Utah 84601. Retail prices range from $595 for ELS NetWare v2.0a to $4695 for SFT NetWare v2.1. Novell currently has an educational discount program in order to get into the education market, and many colleges and universities have received the software free of charge. Other retail prices are: $395 for the workstation NIC card, $895 for the file server connection card, and $1600 for the repeater box to extend the network beyond 600 feet.

A newer version, v2.12, has been released which clears up a few bugs in the accounting capabilities and makes installation easier. Version 2.15, which the company expects to release during the winter or spring, will allow Macintosh computers to be connected to the file server while still using the standard Mac windows, and will store Macintosh files. However, it will not automatically convert them into DOS files. To accomplish that will still require additional software.

Mark Sand is Assistant Professor of Mathematics at Augustana College in Sioux Falls, South Dakota.

FITLIB - PC Scientific

Herbert L. Holden

FITLIB provides the user with FORTRAN subroutine libraries in both source code and object code format for the purpose of fitting data with tension splines. Both periodic and nonperiodic data may be processed and the data may be interpolated or smoothed. While there are no explicit provisions for variable tension splines, there are instructions for modifying source code to accommodate them. There are subroutines for both curve and surface fitting and the fitting function may be specified in a variety of formats with as many dependent and independent variables as is mathematically reasonable.

In addition to the subroutine libraries, there are nine tutorial programs, fifteen example programs, and 72 "skeleton" programs which contain variable declarations, initialization, and error checks to facilitate the production of user programs. This is a most welcome feature. The source code is well written, well commented, and carefully documented.

FITLIB requires an IBM PC (or compatible) and a FORTRAN compiler. The following compilers are supported:

- Microsoft FORTRAN Version 3.31 or Version 4.01
- IBM FORTRAN Version 2.00
- Ryan-McFarland FORTRAN Version 2.42
- Lahey F77L FORTRAN Version 2.22 (requires coprocessor)
The operating system requirements and minimal memory requirements are determined by the particular compiler used.

A math coprocessor is optional since two versions of the subroutine libraries are provided: one for computers with a math coprocessor and one for computers without. Parameters to the subroutines are single precision whether or not you use a coprocessor. The coprocessor can process single precision variables in its extended format much faster than the 8088 or 8086 can and there is also some advantage in computing intermediate results in a higher precision.

The documentation indicates that a hard disk is recommended but not required. However, I would be most reluctant to compile and link without one since the multiple support libraries are quite large. There is graphics output to the screen in the tutorial programs and some monochrome or color graphics capability is desirable.

There are no plotter drivers provided. It is up to the user to write subroutines which can plot points and lines or save output on disk for later processing to produce graphics. I have a strong preference for the later technique since it accommodates minor plotting disasters (such as running out of ink) and makes the results readily available for repeated processing in various formats.

Most software vendors indicate that users should be “experienced”. In the world of personal computers we have at one end of the skill scale the “novice” who has recently learned to operate a PC and chew gum at the same time without crashing either system. At the other extreme we have the “black belt power user,” whatever that is. All intermediate skill levels are called “experienced”.

Here is my opinion (Procrustean as it may be) of the necessary background for a user of this software. The user should have knowledge equivalent to a three credit semester course in FORTRAN, have written at least 5000 lines of FORTRAN code, and performed the compile and link process on a PC at least 10 times. To take full advantage of this program, the user should have been introduced to spline fitting via a numerical analysis course (or advanced engineering mathematics) and not feel severe emotional distress in reading source material such as:

Schweikert, D.G. - An interpolation curve using a spline in tension, J. Math. and Physics, 45 (1966) 312-317

However, the documentation for FITLIB contains extensive, meticulous, and well written discussions of the tutorial programs which provide an excellent vehicle for learning about spline fitting given a modest background in calculus. Users of glitzy, pop-up, pull-down, window-oriented packages designed in total ignorance of the basic principles of communication arts and requiring the use of protective eyeware may be disappointed but I found the tutorials effective and easy to use with information displayed in a clean, uncluttered, simple format.

FITLIB is a PC version of the mainframe software product FITPACK which was developed by A. K. Cline and distributed by NCAR (National Center for Atmospheric Research). The package appeared in embryonic form in 1972 and six program units from this package appear as Algorithm 476 in the issue of Comm. ACM cited above. A nice discussion of the techniques appears in

Cline, A.K. - Curve Fitting Using Splines Under Tension, Atmospheric Technology No 3 Sept 1973 60-65

By 1977 the package was rewritten and expanded to 25 subroutines and in 1985 it was converted to run on a IBM PC by PC Scientific with minor modifications (respecifying constants, etc.) to the source code (which now consists of some 20,000 lines) and the addition of object libraries, tutorials, skeleton files, etc. to support the PC environment.

Thus, the software has a long history of successful application. It is used in contour mapping programs at NCAR and is used in software packages marketed by other commercial vendors not all of whom extend the courtesy of acknowledging its use. (Courtesy: Old earth custom popular in the slower-paced societies which existed before the computer revolution.)

The product is available on 5 1/4 or 3 1/2 inch disks (the software occupies ten 5 1/4 inch disks) and is accompanied by a Reference Manual (427 pages) and a Users Guide and Tutorial (286 pages) published by McGraw-Hill. (A note on the McGraw-Hill announcement of mathematical software available from PC Scientific appears in Academic Computing Jan 1989 p6.) The manuals (5 1/2 by 8 1/2 page size) come in three ring binders with ample sized D rings for easy page turning and the plain text is in 10 pt type. (Since I often read manuals in poor light I would have preferred 12 pt type.) There is a good bibliography and relatively few typos.

I had occasion to call PC Scientific with questions regarding their product and the impression I received was one of a congenial and knowledgeable staff.
Current pricing for the FITLIB product (or the technical support by phone which is available for an additional fee) can be obtained from:

Alyce Grover, Sales Manager
PC Scientific, Inc.
6 Pine Tree Drive, Suite 250
St. Paul, MN 55112
Phone: (612) 490-0615

Other sources of information can be found in advertisements which appear in the January issues of journals such as NASA Tech Briefs, Pers. Eng. and Inst. News, Sci. Comp. and Auto., SIAM News, and Tech Minnesota.

Herbert Holden authored a text on FORTRAN IV (Macmillan 1970). He has served as chief of applications programming at UC Davis, senior programmer at SRI International and is currently associate professor of mathematics at Gonzaga University.

Three Issues for Computational Environments in Academic Departments

The above article by Gene Herman, and the review by Mark Sand report the creation of computational environments in two college mathematics departments. In an effort to get a discussion going, I want to make explicit three of the many issues that are implicit in these articles.*

Shared vs. homogeneous environments

While there are a number of differences in the systems created at Grinnell and Augusta, there are a number of similarities. One of the most striking is the decision to opt for what I would call a homogeneous environment, one where isomorphic machines are hooked together by a LAN. There are a number of things to be said for such a system. Herman ends his article with an eloquent statement of the attitude such a system is creating in his own department. A major advantage is that people can work together building up a stock of shared programs and other resources. Another virtue is that it can reduce costs in various ways; maintenance agreements are usually cheaper in bulk, and it takes fewer people to become experts with such a system involving one kind of machine than it does with a system using several radically different machines. Also, dead machines can be cannibalized to repair other machines.

These are all sound reasons for seriously considering a homogeneous environment. At least I hope so, since they are the considerations that were behind our decision to opt for such a system in the early days of CSLI. However, I discovered the hard way that there are serious problems with such a system, problems that eventually doomed ours.

One problem is that in most academic settings there are widely divergent computational needs and abilities. A few users will use computers only for email. Many will use it only for mail and tex processing. But many others will use it in research. And some will even use it in teaching. So a fair number will be actually doing computations, either symbolic or numerical. The problem with a homogeneous environment in such a setting is that inevitably some users are going to be using machines that are inappropriate to their needs or abilities. What a waste of a workstation to give it to someone who does nothing but read mail. And what a waste of a mathematician to force him to carry out memory intensive computations on a small personal microcomputer.

A related problem stems from the fact that many mathematicians already have a stock of programs, either purchased or created, that they use regularly. It is unlikely that a newly created homogeneous environment is going to support them all. So either people will not switch to the new environment, or else there will be a tremendous waste of previous investment in hardware, software, and learn time.

Similarly, what is going to happen to the homogeneous environment in two or three years? The computers that make it up are no longer state of the art, or start failing. As you replace them, do you start over again, or give up homogeneity and evolve into a heterogeneous system?

These pressures have led to the heterogeneous system now in place at CSLI: a hodge-podge of terminals, Macintosh Pluses, SE's and II's, some IBM PC's, and various high-end workstations, all connected by ethernet to a large file server which doubles as a time-sharing host, as well as highpowered workstations of various sorts (SUN, HP, Xerox), all linked together over a LAN to a pair of central mainframes which double as file servers. While there are some economic

---

*I would like to thank Bill Croft of CSLI for helpful comments on a draft of this editorial.
disadvantages of such a system, still it is cheaper than if we were all using the most expensive sorts of workstations, on which many of us were unhappy anyway. And for the most part, people have gravitated to the kind of machine on which they are most comfortable. We have not lost the sense of a shared environment, due to the extensive use of electronic mail, common programs like \LaTeX, and the file servers which allow us to work collaboratively.

So my experience makes me wonder whether or not a strictly homogeneous environment is the best use of resources, and whether or not it is stable over time, especially in departments with widely divergent computer use. Technology becomes obsolete so quickly and user demands vary so radically that it is seldom wise to put all your eggs in one basket. I think it is more prudent to spread the risk around with a heterogeneous system, and not to spend too much money all at once. And if you want to hedge a bit on the technology, invest in known standards, such as ethernet, TCP/IP, common lisp, C, Prolog, X windows, UNIX, \LaTeX, etc. Then as the hardware changes you will be able to port your work to new platforms.

Computers in classrooms
First, a distinction. There are currently four ways to get computer technology into the mathematics classroom. Type I: One method is to have individual classrooms equipped with a single, permanent computer (or maybe two, of different kinds) and projection equipment of some sort. Type II: Another method is to have a classroom set up with a bevy of computers, so that the instructor and students can all use them in class. Type III: the computer lab, which is not really intended for class use, but for individual use. Type IV: Finally, at the other extreme, we have rooms that have no permanent computer equipment, but where the equipment is wheeled in on carts on an ad hoc basis.

Notice that while a room of Type II can be used as one of Type III, and vice versa, the optimum arrangements for each type differ. For example, a lab might have a variety of computers, for use with different kinds of software. And it might have things set up without any regard to lines of sight, perhaps having machines around the wall, or back to back.

Grinnell and Augusta have each set up a Type II classroom. I used to think this the way to go. However, my experience here at Stanford (not particularly at CSLI, where there is little teaching) has led me to question it, on several grounds.

First, just try giving a lecture in a room with 20 or 25 computers running. The noise (and heat) are something to contend with, as are the various things the students can find to play with on the machines, and the line-of-sight problems mentioned in Herman’s article.

Second, as far as I can tell, few teachers actually take advantage of the student machines, especially in college level math courses. What they want is the ability to illustrate their lectures on the computer. But for this, all they need is one computer with an overhead projector. At best, the students’ computers sit silent.*

Third, when a Type II room doubles as a Type III room, there is competition for space. True computer labs are busy night and day around here. It is very frustrating for a student in the middle of an assignment to have to leave, making room for a class, when they know perfectly well that the machines are not going to be used by that class.

Fourth, any Type II classroom is going to be based on some particular type of computer. This means that at least half the available courseware will not run on the machines in your classroom. So instead of buying two computers that, between them, run 90% of all courseware, you have purchased 25, which run less than 50%. Something seems wrong there.

Fifth is loss of room space. At Stanford, we are very short of classrooms. Setting up a classroom with individual computers cuts the classroom capacity in half, at least.

Personally, I favor a combination of rooms of Type I and III. This is the route Stanford is (slowly!) following. I reserve a room for the term that has the kind of computer I need for my courseware. (In addition, I reserve one of the computer labs to hold a problem session once a week when needed.) However, there should be a back-up system, in case the computer or projection system fails. Last term, the projector in my classroom went out the week before school started, and was repaired just in time for the final. In between, zilch, since there was no back-up system. I had to completely rethink the course, getting by with computer lab work on the student’s part.

For some schools, a Type IV system might prove workable, at least for starters. You can get going with fewer computers, and there are fewer installation costs. However, compared with a type I system, it

* Of course, it could be argued that this represents a lack of training or imagination on the part of the faculty, but I am not convinced.
does put one more obstacle between the instructor and using computers in the classroom, and every such obstacle looses people who might otherwise take the plunge.

Costs
Cheap as they are becoming, relatively speaking, computers still cost a lot of money in absolute terms, especially by mathematics department standards. And common wisdom is that they last three to five years, on the average. And they take good people to keep them running. This makes the creation and maintenance of an adequate computational environment an very expensive proposition. Especially given the kinds of money schools are used to spending on mathematics, compared with the other sciences.

Is it worth it? Or should we just let those mathematicians that really use computers buy them on their own, or perhaps with grants? I suppose the answer to this is still out. Herman's essay says that 40% of their students use the departments computers outside of class, and then for an average of one hour a week. That does not seem like very much time. And yet Herman's essay makes clear that his department feels the payoff is more than worth the investment. My own experiences with the use of computers in logic classes bears this out. Part of what happens is that computer use is very uneven during the term. Parts of the course are computation intensive, others are not, very much like a chemistry lab in a chemistry course.

If we are going to justify the expense of these systems, we must learn to use them effectively. But we must also stop thinking of mathematics as the cheap science, the one that can be done only with a pencil, paper, and waste basket. The computer is changing all that forever. We must learn how to make the case to the university or college administration, to government agency, and to the public, that mathematics has the same need for computational support as any other science, including computer science. Only when we believe this ourselves will we be able to convince others, and so get the resources that are necessary.

Questions, not answers
As I said earlier, these remarks are by way of raising questions. I am not pretending to know the answers. My own experiences have led me to have strong opinions, but I would be the first to admit that they are not thoroughly tested. I am also aware that conditions vary a great deal from institution to institution. I hope some of you with different or more informed views will express them here.

Mathematical Freeware and Shareware

MathReader
In January, Wolfram Research announced that they are distributing MathReader, a program for use in viewing Notebooks prepared with Mathematica, free of charge. Although actual calculations require the full Mathematica system, MathReader allows a user to view notebooks prepared Mathematica. It supports text outlining and graphics animation, but not editing or printing of documents. The Macintosh version is available with a Mathematica demonstration disk that runs on any Macintosh. To obtain, contact Christine Schankin at Wolfram Research, (217) 398-0700.

CC
The Calculus Calculator (CC) evaluates algebraic and transcendental functions, computes integrals and derivatives, solves equations, and displays graphs in both cartesian and polar coordinates. It will also graph parametric equations. CC can perform these operations on any single-variable function that you define, including functions with derivatives and indefinite integrals. It was designed to be used by calculus students, and the distribution disk includes a 50 page manual showing how many different calculus problems can be solved with CC.

CC runs on any IBM-compatible PC with at least 512K of memory and one of the standard video graphics systems (CGA, Hercules, EGA, or VGA). Printer output is supported.

Copies may be obtained from:
David Meredith
Mathematics Applications Group
Department of Mathematics
San Francisco State University
1600 Holloway Avenue
San Francisco, CA 94132

Requests should included a return envelope and a blank 5 1/4" disk.

Rubik Algebra
Rubik Algebra is primarily a tool for illustrating, motivating and exploring a variety of ideas and basic theorems from elementary group theory, using Rubik's cube. The program allows the user to see the results of applying arbitrary sequences of face rotations to Rubik's cube. More important, however, is the facility to decompose an arbitrary sequence of face rotations into disjoint cycles. One can use the visual image of Rubik's cube along with cycle decompositions to...
The second section deals with an extraordinary conference held at Princeton in 1946 to commemorate the university’s bicentennial. The war had just ended, mathematicians had returned to their university positions, and a large number of veterans were beginning or resuming graduate work. The conference brought together many of the leading mathematicians of that era to take stock of open problems and to try to chart the future course of research in nine broad areas. Reprinted here are written versions of the discussions in which von Neumann, Weyl, Whitehead, Hopf, Courant, Zariski, Gödel, and many others pondered the present and future of mathematical research. Providing a fascinating glimpse into the mathematical world of 1946, the discussions are put into a contemporary context with commentary by current leaders in these areas.

In the last section, various aspects of America’s mathematical past are explored on the political, social, and scientific levels. The influence of women in American mathematics, the burgeoning of differential geometry in the last 50 years, and discussions of the work of von Kármán and Wiener are among the topics covered.

Also included are the Joint AMS-MAA Invited Addresses presented at the AMS Centennial Celebration.

Mathematicians, historians of science, and students alike will find this book illuminating and rewarding, and it would make an excellent addition to any library collection. That the lessons of the past can guide the resolution of future problems makes this book important reading for all who are concerned with the development of mathematics.

1980 Mathematics Subject Classification: 00
ISBN 0-8218-0130-9
ISSN 0899-2428
578 pages (hardcover), January 1989
Individual member $42, List price $70,
Institutional member $56
To order, please specify HMATH/2NA
Shipping/Handling: 1st book $2, each add’l $1, $25 max.
By air, 1st book $5, each add’l $3, $100 max.
Prepayment required. Order from AMS, P.O. Box 1571,
Annex Station, Providence, RI 02901-1571, or call
800-556-7774 to use VISA or MasterCard.
Elections

Robert M. Fossum

The Committee on Election Scheduling reported to the Council at its Phoenix meeting on 10 January 1989. The Committee consists of Jane P. Gilman, Irwin Kra, William P. Thurston, William A. Veech, and James A. Voytuk. Below I present the recommendations of the Committee. Preceding each recommendation, the current practice regarding the item addressed is stated in capsule form. Immediately following this article is another article written by Allyn Jackson about the Council meeting. In Jackson’s article, one can find comments on this report that were made during and after the Council meeting.

The Nominating Committee.

There is no mention of the Nominating Committee in the Bylaws of the Society. Currently the Nominating Committee consists of eight members, each with a two-year term. Four members are elected by preferential ballots in the annual election held by the membership each fall. The newly elected members of the committee take office on 1 January of the year following election. Six candidates for the election are named by the President. Nomination by petition is allowed, but if fewer than two candidates are nominated by petition, then the President names enough candidates so that a slate of eight is presented for election.

This method of electing the Nominating Committee was decided upon by the Council in August 1975 upon recommendation of the Committee of Committees, which had delivered an extensive report to that Council.

The report of the Committee on Election Scheduling concerning the Nominating Committee is as follows:

1. Nominating Committee.
   (a) The term of members of nominating committee shall begin on 1 September of each year.

(b) The term of office for nominating committee shall be three years. Three members shall be elected each year, so that the total membership is 9.

(c) Phase-in. At the time this provision is enacted, the President shall designate one member of the first-year class of the nominating committee, and two members of the second-year class, to have their terms extended to the 31 August following the previous expiration date of their term. Afterward, the schedule will be in a steady state.

It should be noted that recommendations (b) and (c) were passed by the April 1988 Council. The January 1989 Council approved (a). It is expected that this change will go into effect for the next election.

Vice-President.

The office of Vice-President is named in the Bylaws. Currently there are three Vice-Presidents at any one time, each with a term of two years. In the years that the Society elects a President-Elect, two Vice-Presidents are elected. In the other years, one Vice-President is elected. Elections are contested, and candidates can be nominated by petition. The report of the Committee on Election Scheduling concerning the Vice-Presidents is as follows:

2. Vice President.
   (a) The term of office for Vice President shall be increased to three years.

(b) Alternative I. One Vice President shall be elected each year. In the year that this provision takes effect, the President shall designate one or two of the current Vice Presidents, as necessary, to have their terms extended to three years so that the term of office of one Vice President expires in each of the current years, the following year, and the year after the following year.

(b) Alternative II. In each year that a President is elected, one Vice President shall be elected, while
in every other year, two Vice Presidents shall be elected. Vice Presidents holding office before the provision lengthening their term takes effect shall serve for two years, while Vice Presidents elected after this provision takes effect shall serve for three years.

Treasurer and Associate Treasurer.
Both the Treasurer and Associate Treasurer are named as officers in the Bylaws. Each has a term of two years. Candidates have run in uncontested elections in the past. The report of the Committee on Election Scheduling concerning the Treasurer and Associate Treasurer is as follows:

3. Treasurer and Associate Treasurer.
   (a) The term of office for Treasurer and Associate Treasurer shall be five years. A Treasurer or Associate Treasurer may be re-elected for at most one additional term.
   (b) Phase-in. At the time this provision takes effect, the current term of the Associate Treasurer will be extended by two years. A Treasurer or Associate Treasurer, at the end of a term of less than five years, who has served a total of three or more years may be elected for at most one additional five-year term, and any Treasurer or Associate Treasurer who has served two years or less may be elected for two additional five-year terms.
   (c) Treasurer-designate and Associate Treasurer-designate. One year before the end of the last term of a Treasurer or Associate Treasurer, as determined either by a letter of intent to resign or by the provisions above, a Treasurer-designate or Associate Treasurer-designate shall be elected. The Treasurer-designate and Associate Treasurer-designate will be a nonvoting member of all bodies on which the corresponding officer is an ex officio member.
   (d) Ex Officio membership. The Treasurer and Associate Treasurer shall be ex officio members of the Board of Trustees, but not the Council. This provision shall take effect at the beginning of the term following the first election after it is enacted.
   (e) Number of Candidates. Two qualified candidates shall be sought for each election for a Treasurer-designate, a Treasurer when there is no Treasurer-designate, an Associate Treasurer-designate, or an Associate Treasurer when there is no Associate Treasurer-designate.

Fine Adjustments to terms of office.
Currently, all terms of office (with very few exceptions) in the Society end on 31 December and new terms begin on 1 January. This includes most of the terms for committee membership. The Committee on Election Scheduling makes the following recommendation for terms of office:

4. Fine adjustments to terms of office. Terms of office for Council, Vice Presidents, and Presidents shall begin on 1 February following the election. In the year that this provision takes effect, all terms which were to expire on 1 January are extended by one month, to expire on 1 February.

Presentation of candidates to the membership.
At present, candidates for election to the offices of the Society are named in some appropriate issue of Notices. Biographical material and statements by the candidates are included in the material that is mailed, along with the ballots, to the membership. The Committee on Election Scheduling recommends the following procedures for presenting the candidates to the membership:

5. Presentation of candidates to the membership.
   (a) The statements and biographical material on candidates shall be published in Notices at least two weeks before ballots are mailed, and the material shall also be included with the ballots.
   (b) The candidate material should be gathered and organized in accordance with the discussion below, and discussion in Council. A committee of the Council shall be established to help with the gathering and reorganization of candidate material, in cooperation with the Secretary and the AMS staff.
   [The “discussion below” to which the recommendation alludes is not included here. Briefly, it asks that more complete biographical material be gathered and that an “interview” with the candidates for President-Elect be published.]

President.
The office of President is named in the Bylaws. The term of office is two years. In each odd calendar year a single candidate is presented for election by the membership to the position of President-Elect. In the year following election the person elected serves as President-Elect. The President-Elect takes over the office of President at the beginning of the next calendar
year. After serving two years as President, this person then serves for one year as Ex-President. Thus, at any time, the Society has a President and either a President-Elect or an Ex-President. That a single candidate is presented for election is based upon tradition. The Bylaws do not call for an uncontested election. The report of the Committee on Election Scheduling concerning the President is as follows:

6. President. The nominating committee and the Council shall put forward two candidates for President.

Executive Committee.

The Executive Committee of the Council is named in the Bylaws. It consists of four elected members and the President, the Secretary, the President-Elect (during even-numbered years), and the Ex-President (during odd-numbered years) as ex officio members. The Executive Committee of the Council is empowered to act for the Council on matters which have been delegated by the Council. Any member of the Council who is not an ex officio member of the Executive Committee is eligible for election to the Executive Committee. One person is elected each year for a term of four years. The Committee on Election Scheduling makes the following recommendation concerning the Executive Committee. If passed, it would require a change in the bylaws:

7. Executive Committee.
(a) The term of office for Council representatives on the executive committee shall be increased to five years, beginning with the first member chosen from Council after this provision is enacted.
(b) At the time that the fifth 5-year member is chosen, the Secretary shall become a nonvoting member of the EC.

Election results.

The current practice regarding the results of the election is to announce the numerical tallies to the Council, but to announce only the winners in Notices.

The report of the Committee on Election Scheduling concerning the Election results is as follows:

8. Election results. The numerical tallies of elections for officers shall be available to any Society member on request, and shall be distributed as an attachment to the regular Council agenda.

It should be noted that this has already been adopted by the April 1988 Council. It is mentioned here only for reference, since it is the last formal recommendation of the Committee.

The Council would be happy to receive comments from the membership on these recommendations. Comments may be directed to any member of the Council, a list of which is found elsewhere in this issue of Notices, or they may be sent directly to the Secretary, who will forward them to the Council.

Discussion on these items will take place at the April 1989 Council, which will be held in Worcester, Massachusetts on 15 April 1989, at 7:00 p.m. at the Howard Johnson’s Motor Lodge adjacent to the Holy Cross campus.

Any final action that may require changes in Bylaws will take place during the August 1989 Council meeting, which will be held on 6 August 1989, in Boulder, Colorado.

Phoenix Council Meeting

Allyn Jackson

A typical agenda for the AMS Council runs about half an inch thick, replete with proposals, ideas, and reports to be discussed and considered. With about 35 of the 42 members present at the Council meeting in Phoenix in January, the discussion ranged from animated to unfocused to acerbic to humorous. The meeting lasted 7 1/2 hours, so a portion of it was bound to be soporific, but for the most part the interest and commitment of the members brought the meeting to life.

At the meeting, a host of issues were discussed, from ways to make the research announcements in the Bulletin more accessible, to adoption of an endorsement of school mathematics standards prepared by the National Council of Teachers of Mathematics, to selling \TeX\ software to South Africa. Among those presenting reports were Kenneth M. Hoffman of the Joint Policy Board for Mathematics, who updated the Council on the Washington scene; Marcia P. Sward of the Mathematical Sciences Education Board at the National Research Council, who described a plethora of projects of that Board; and Ronald G. Douglas of the State University of New York, Stony Brook, who reported on the deliberations of the AMS Committee on Science Policy.

Focus on Election Procedures

Despite the various questions competing for the Council's attention, there was one set of issues that formed the focus of the meeting: election procedures for AMS
officers, and, specifically, the merits and disadvantages of contested elections. Though these topics have surfaced repeatedly in recent years, the current discussion began last April, when the Council considered a number of proposals put forth by Council member Irwin Kra of the State University of New York, Stony Brook, and AMS Vice President William P. Thurston of Princeton University. As a result, the Council appointed the Committee on Election Scheduling, the charge of which went considerably beyond the question of scheduling to explore other election matters. Besides Kra and Thurston, the Committee members were Jane P. Gilman of Rutgers University, William A. Veech of Rice University, and James A. Voytk, then associate executive director of the AMS.

Given that only about 3700 out of 22,500 AMS members voted in the last election, perhaps some background on election procedures is in order. Currently, the President, Treasurer, Associate Treasurer, Secretary, and Associate Secretaries (there are four) are chosen in uncontested elections.

These offices are filled by de facto appointments by the AMS Nominating Committee, for, although the candidates appear on AMS ballots, there is no minimum number or percentage of membership votes required to approve the Committee’s choices. Write-in candidates are permitted for all positions, but fewer than 20 write-in votes are cast for uncontested offices in a typical election. The Vice Presidents (there are three at any given time) and the Members-at-Large of the Council are chosen in contested elections from a pool of candidates twice as large as the number of positions to be filled. The names come either from the Nominating Committee or from petitions submitted by members.

The Committee on Election Scheduling presented to the Council a report which made several recommendations on such matters as the length of terms of office, the number of vice presidents, and the number of members on the Nominating Committee. In addition, the report presented views on election procedures solicited from a number of prominent members of the mathematical sciences community. But perhaps the most controversial provision of their report was the proposal to hold contested elections for AMS president. Also controversial but drawing less debate was the proposal that contested elections be held for treasurer and associate treasurer. The report also recommended exploring in future years the idea of contested elections for the Board of Trustees and Secretary.

In preparing the report, the Committee on Election Scheduling investigated the practices of 11 other scientific societies—among them the American Chemical Society, the American Physical Society, the Association for Computing Machinery, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics—and found that all had contested elections for president. In addition, most had contested elections for vice president, but there was variability for the offices of secretary and treasurer. During the meeting, Council member Lawrence Corwin of Rutgers University pointed out that most learned societies in nonscientific areas such as history and philosophy also choose their presidents in contested elections.

However, AMS Vice President Barry Simon of the California Institute of Technology noted that the practices of other organizations may provide little insight into what is appropriate for the AMS. He said that because the top researchers in other scientific areas are likely to run laboratories or other research facilities, they are usually more accustomed to administrative work than are mathematicians. In addition, their research can continue at the laboratory or facility even if they are not personally overseeing it. “It’s a different culture in other sciences,” said Simon. “Mathematicians’ research is much more exclusive. If a mathematician doesn’t do the research, it doesn’t get done, so it’s more difficult to make the time commitment necessary to be President.” In comments presented in the report, Past-President G. D. Mostow of Yale University noted that “the principal responsibility and time commitment [of the AMS President] remains to his (or her) mathematical research.” Both Mostow and the current President, William Browder of Princeton University, have indicated that they would not have run in contested elections. Several former presidents have indicated that they would have run had their elections been contested, but others said they might have declined.

An Honorary Office

One of the main arguments for keeping the presidential elections uncontested is that the office has historically been an honorary, rather than a policy-making, one, so asking candidates to compete for the position is inappropriate. Many have said that, given the time commitment involved, few individuals of the appropriate stature and distinction would run for the office unless it were seen as a singular honor.

Those favoring contested elections believe that someone who really wants to be president should run for the office. In comments presented in the report, Council member Richard S. Palais of Brandeis University says that while being named as president...
is an honor, “there is certainly much more honor in the vote of confidence one receives by being truly elected, rather than virtually appointed. And if one is going to transact the business and spend the money of the Society, one will do it with more confidence and a better spirit if really chosen for that task by the members.”

At the Council meeting, Thurston said that while the AMS has been fortunate to have had good, hard­working officers, institutional constraints are ham­pering the Society’s effectiveness. “There are many issues facing the community—the declining number of people entering the profession, the lack of women and minorities, tight funding for research, the poor school curriculum,” he said. “If we had contested elections, we would get officers with a more active involvement in solving the problems of the mathematical community.” Thurston is also a strong supporter of one of the report’s provisions recommending a more in-depth presentation of presidential candidates, including statements and biographical material presented in Notices. In addition, he favors the idea of publishing informal interviews with the candidates.

Some are fearful that contested elections would inject an unhealthy element of politics into the AMS. In comments presented in the Committee’s report, David Sanchez of Lehigh University said that contested elections were unnecessary and possibly detrimental. “I imagine that the vast number of loyal, hardworking AMS members out there in the hinterlands would be hard pressed to decide between two eminent academi­cians, both of whom they have likely never heard, never met, and never understood,” he wrote. “To create the possibility of deals, campaigns, and propaganda needed to enlist these loyal members is moving the AMS in a direction fraught with danger and may cross the line from greater participation to greater politicization.”

Some also say that there are very few math­ematicians of appropriate stature and distinction to represent the Society, so that if two names were put forth in each election, the AMS would run out of suitable candidates in a few years. Some call this argument specious, saying that, with a membership of 22,500, the Society should have no problem finding suitable candidates. Two “unwritten rules”—that the president should be a member of the National Academy of Sciences and a former AMS vice president—reduce the pool of names to draw from. Though many feel that the Academy rule provides added insurance that the president would be a respected member of the larger scientific community, others believe that the rule is “elitist” and provides no insurance that a candidate has the necessary qualifications to be president.

**Issues External to the AMS**

Is the entire debate about election procedures deflect­ing attention from more important issues? Council member Michael C. Reed of Duke University said at the meeting that he fears contested elections may increase infighting. “We mathematicians love to argue and feel righteous,” he said. “Will there be a pro-SDI and an anti-SDI candidate? A pro-South Africa and an anti-South Africa candidate?” In addition, he believes that placing so much emphasis on internal AMS procedures may be counterproductive. “This debate can detract from the outward issues such as education, government funding, and relations with the public and other areas of science. We may be setting ourselves up for more bickering that will impair our ability to act in concert on these important issues.” Echoing this view, Associate Secretary Lance W. Small of the University of California at San Diego said after the meeting, “There are so many problems in the mathematical community, and the Council is arguing about whether to have 3 vice presidents or 4.”

Nonetheless, the debate has generated some excite­ment and interest that demonstrates the commitment of the Council members to their role in the Society. At the Phoenix meeting, the Council adopted one proposal of the report, which called for increasing the size of the Nominating Committee from 8 to 9 members and moving the start of their terms to September 1 to allow the Committee more time to consider candidates for elections. The remaining pro­posals concerning contested elections will be settled at the Council meeting in August in Boulder, Colorado. If the report’s provisions are adopted, the first presi­dent to be chosen in a contested election would take office in 1991.
ANNOUNCING...

MathSci™ on CD-ROM

Now you can access Mathematical Reviews (MR) and Current Mathematical Publications (CMP) on CD-ROM (Compact Disc-Read Only Memory). The CD, called MathSci Disc, will combine the searching features of online MathSci with the browsing ease of printed MR. For a fixed annual fee, MathSci Disc can be used at leisure without access charges or telephone connections.

Semi-Annual Issue

MathSci Disc will be produced by SilverPlatter® and will be issued semi-annually. The first MathSci Disc, available in January 1989, will contain all the reviews and abstracts from MR 1985 through 1988 and over 68,000 entries from CMP. The July disc will have all the information on the January disc plus the January-June updates. Access to current information between successive CD issues is available online from MathSci, which is updated monthly on DIALOG, BRS, and ESA.

Easy-to-Operate

MathSci Disc will be available for both the IBM PC and the Macintosh. SilverPlatter's user-friendly CD software with help screens and menus will make MathSci Disc 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 the CD to the hard disk for editing or for processing with $\TeX$ software into typeset form with mathematics.

Fixed Cost

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

The 1989 MathSci Disc 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 first MathSci Disc subscription: $1,685*

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

For more information on MathSci Disc 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; FAX: 401-331-3842.

™ - MathSci is a trademark of the American Mathematical Society  
® - SilverPlatter is a registered trademark of SilverPlatter International N.V.
Everybody Counts: Three-year Study of U.S. Math Education Released

At a Washington press conference, held jointly by the National Academy of Sciences and the National Academy of Engineering, the long-awaited report, Everybody Counts, A Report to the Nation on the Future of Mathematics Education, was released to the public on January 26. Prepared jointly (under the auspices of the National Research Council) by the Mathematical Sciences Education Board (MSEB), the Board on Mathematical Sciences (BMS), and the Committee on the Mathematical Sciences in the Year 2000, the report outlines a strategy for reforming math instruction in our schools and colleges over the next two decades.

In the foreword to the report, the President of the National Academy of Sciences, Frank Press, signals the commitment of the two Academies and the Institute of Medicine to participate in the long-term work of rebuilding mathematics education in the United States.

The press conference was opened by Robert M. White, President of the National Academy of Engineering. He praised the panels' work and echoed the message put forth by Frank Press. White had encouraged the mathematics education community, during an earlier gathering at the Academy, to be a pump, not a filter, in the process of educating our young people in the sciences and engineering.

In a departure from the usual format, the press conference began with a live class, consisting of eight sixth-graders and their teacher, Paula Duckett, from River Terrace Community School in Northeast Washington. During a 25-minute period, the students took measurements of each others' shoulder widths and arm lengths. After entering the measurements for each person (using a pocket calculator), they discussed the numbers with their teacher. They speculated on the proximity of the ratio to the golden mean which they had discussed previously in the context of art and architecture. Shirley Hill, Chair of the MSEB, stated that the purpose of this classroom demonstration was to show that group learning and interaction can lead to better involvement by the students. The demonstration also signals a departure from the traditional doctrine of teaching "the way it was taught": in this exercise, the students developed an appreciation for the magnitude of numbers and a critical attitude toward accepting measured results, and demonstrated that learning mathematics is not necessarily restricted to the individual, but that it can be a collective effort by a group learning together.

In separate statements, the Chair of the BMS, Phillip Griffiths, and Fred Bucy, Chair of the Committee on the Mathematical Sciences in the Year 2000 (usually referred to as MS 2000), offered their assessments for the need of substantial reform. They conveyed a sense of urgency and a commitment among the teachers of mathematics, to begin the long process of changing the curriculum for the year 2000 and beyond.

While admitting that the situation in the U.S. is unique among nations with its highly decentralized educational system, all speakers were confident that the proposed reforms would be adopted in due time without massive infusion of new federal money. To the contrary, Bucy said, there is now $330 billion being spent for education in the U.S. and spending it more wisely will allow carrying out part of the reforms within the current system. (Of that amount, more than $25 billion is spent for math education nationwide.)

Other members of the panel were Marcia Sward, Executive Director of the MSEB, and Ronald Douglas, State University of New York at Stony Brook. Reporters from national and local news media raised
the (rather anticipated) question whether calculators in the classroom prevent students from learning the "basics." Behind this question looms the suspicion that our children must be trained exactly the same way we learned mathematics in school. What needs to be understood is that mathematics did not stand still and that exciting developments have taken place in the past few decades that need to be taught. Getting the students to participate in discovery, rather than drilling them mindlessly, will be the challenge for teachers in the 1990s and beyond. No longer can we accept the excuse "My child does not have any aptitude for math," or we shall find a majority of high school graduates entering the work force as "innumerates." Industry now has to retrain high school graduates in order for them to develop the skills necessary to operate complex machinery, to diagnose malfunctioning components in measuring instruments, and to be able to decide when intervention is necessary in automated manufacturing systems.

Asked by reporters what kind of math is not now being taught, the panel suggested that students have to get better at problem solving and to appreciate mathematics for its significance for the understanding of real world problems in biology, the environment, economics, manufacturing, science, and engineering. Current attitudes must be changed, said Shirley Hill, and the pressure has to be kept on the system at all levels and in all components, including the textbook publishers, testing services, parents, teachers, and students. The momentum for reform is there; it is important not to lose it. The future of our children and the country depends on a successful reform in the way we teach and in what we teach.

As math instruction in the secondary schools improves, less time will be needed for remedial teaching in the colleges, thus allowing teachers to spend more time with individual students. We cannot envision future math teachers without at least a bachelor's degree in mathematics teaching our high school students. A lack of appreciation of new developments in mathematics, science, and engineering on the part of teachers is often cited as a reason why high school science and math are being perceived as dull and irrelevant. We must change that attitude.

It is appropriate to mention that there is still another player in the league of science education who is equally committed to reform: the National Science Foundation. NSF Director Erich Bloch, in a dinner speech the night before the release of the report, endorsed its main objectives, the new standards of instruction, upgrading of the teaching profession, and development of more effective procedures for assessing student proficiency. He called the report a milestone and praised the mathematics research community for its readiness to be influential in effecting the changes in math education that are imminent both at the precollege and undergraduate levels. He warned the audience, however, that this report was just the beginning, and that continuous involvement by all participants will be necessary. NSF, he said, expects to be a part of this effort.

**Academies Offer White Papers to the New President**

Late last year, the National Academy of Sciences (NAS), the National Academy of Engineering (NAE), and the Institute of Medicine (IOM) issued four white papers to the then President-Elect George Bush. The white papers deal with policy issues the three bodies urge the new president to consider because of the urgency with regard to the health of science and the nation in general.

The IOM and NAS, in a joint white paper, recommend action with regard to HIV infection with AIDS, issues that these two bodies have studied since 1985. Specific steps are suggested to the new administration ranging from the effective use of the National Commission on AIDS to patient care, education, research, and international health efforts.

The NAS, NAE, and IOM, in another white paper, recommend that the new President’s science adviser be given high-level status in the White House. Without the status of Assistant-to-the-President, the paper states, the science adviser could not effectively deal with issues such as industrial competitiveness, weapons programs, setting of budget priorities in the $62 billion federal R&D program, AIDS, changes in the global environment, or establishing national goals for space exploration, to name the most pressing ones.

The NAS, NAE, and IOM, in a white paper on Global Environment Change, warn that global climate warming, ozone depletion, tropical deforestation, and acid depletion are issues that need attention early in the new administration. The issue of global environment change and the development of responsive policies must figure more prominently in the scientific, political, and foreign policy agendas of the United States. The three bodies recommend the establishment of a central point for oversight of national efforts toward the global environment in order to improve coordination and allocation of resources among related activities in government and to foster linkages between scientific understanding and policy options.
The academies also recommend that specific steps be taken in the near term (which is Academy-speak for saying action is urgent):

- Policies to foster energy efficiency and conservation
- Deeper reductions in emissions of ozone-destroying chemicals, and the eventual phaseout of chlorofluorocarbons in accord with the Montreal Protocol
- A plan for agriculture, water resources, forestry, coastal protection, and other climate-sensitive activities
- National policies to reduce acid deposition
- Increase of investment in research and monitoring of the global environment

The NAS and NAE, in a fourth white paper, offer recommendations for the Civil Space program. The two academies call for a commitment of $30 billion over the next decade to move ahead with a manned space station, without waiting for the final configuration to be determined now. Two structural components must be assured for the future space programs: the first, a base program that ensures the U.S. competence in all space activities. The recommended level of funding: about $10 billion annually. The second component consists of long-term special initiatives that serve U.S. scientific, political, cultural, and foreign policy objectives. These, the two Academies say, should be funded separately from the base program to ensure that operational expediency does not again erode the nation’s basic capabilities in space.

Each special initiative would require an additional $3 billion to $4 billion in peak years. Examples are the space station and human exploration of Mars or the Moon.

International partnership with other space-faring nations such as the Soviet Union, Western Europe, Japan, and China, should yield cost savings and political, scientific, and technical benefits not otherwise achievable.

Recommended Actions: In consultation with Congress, the Administration should establish long-term goals for space. Such goals might include automated scientific exploration; human exploration of the Moon or Mars in the next century, for which a space station is a prerequisite; expanded monitoring of the Earth for environmental and scientific purposes. Configuration and deployment of the Space Station should follow from these goals.

The four white papers are available from the National Academy Press. Telephone: (202) 334-3313 (or 3113).

JPBM’s Washington office now has email addresses. The Office of Governmental and Public Affairs is now connected to the ARPA and BITNET electronic mail systems. Ken Hoffman, Hans Oser, Kirsten Sampson, and Katherine Molloy can be reached at JPBM@UMD2.UMD.EDU on the ARPANET or at JPBM@UMD2 on BITNET. Try it some time. We’d enjoy hearing from you!

CLASSICAL GROUPS AND RELATED TOPICS
Alexander J. Hahn, Donald G. James, and Zhe-Xian Wan, Editors
(Contemporary Mathematics, Volume 82)

During his lifetime, L. K. Hua played a leading role in and exerted a great influence upon the development in China of modern mathematics, both pure and applied. His mathematical career began in 1931 at Tsinghua University where he continued as a professor for many years. Hua made many significant contributions to number theory, algebra, geometry, complex analysis, numerical analysis, and operations research. In particular, he initiated the study of classical groups in China and developed new matrix methods which, as applied by him as well as his followers, were instrumental in the successful attack of many problems.

To honor his memory, a joint China-U.S. conference on Classical Groups and Related Topics was held at Tsinghua University in Beijing in May 1987. This volume represents the proceedings of that conference and contains both survey articles and research papers focusing on classical groups and closely related topics.

ISSN 0271-4132
272 pages (softcover), January 1989
Individual member $17, List price $26, institutional member $22
To order, please specify CONM/82NA

Shipping/Handling: 1st book $2, each additional $1, maximum $25; by air, 1st book $5, each additional $3, maximum $100
Prepayment required. Order from American Mathematical Society, P.O. Box 1571, Annex Station Providence, RI 02901-1571, or call toll free 800-556-7774 to charge with Visa or MasterCard
Frank Adams, one of the world’s most brilliant and influential algebraic topologists, died in an automobile accident on January 7, 1989. His work was the dominant force in the creation of the modern subject of stable homotopy theory, and his ideas and contributions pervade virtually every area of algebraic topology.

Adams was educated at Bedford School and Trinity College, Cambridge. His first teaching position was at Trinity Hall, Cambridge. He spent the years 1962–1970 at the University of Manchester, first as Reader and later as the Fielden Professor of Pure Mathematics. He returned to Trinity College and Cambridge University as the Lowndean Professor of Astronomy and Geometry in 1970. He was elected to the Royal Society in 1964 and was awarded its Sylvester Medal in 1982. He was elected a foreign associate of the National Academy of Sciences in 1985.

Adams regarded himself primarily as a problem solver, and he first became famous for his solutions to the Hopf invariant one problem and to the vector fields problem. One version of the former problem asks which dimensions are possible for a division algebra over the real numbers (answer: 1, 2, 4, or 8). The latter problem asks how many linearly independent vector fields there are on the n-sphere for each n.

In the course of solving the first of these problems, Adams developed the theory of higher order cohomology operations and invented what is now called the Adams spectral sequence, which has become the most fundamental tool in stable homotopy theory. In the course of solving the second of these problems, he introduced what are now called the Adams operations in topological K-theory.

In a fundamental series of papers, Adams posed what is now called the Adams conjecture, a basic assertion about the relationship between vector bundles and spherical fibrations, and developed its consequences. The later proofs of this remarkable insight led to such major mathematical developments as Sullivan’s construction of localizations and completions of topological spaces and Quillen’s invention of higher algebraic K-theory.

Adams was intensely interested in all developments in algebraic topology, and his expository lecture notes and monographs on a variety of topics in the subject are a vital part of the current literature. He took great pains to ensure that his own work met the highest standards of rigor, elegance, and clarity of exposition, and he expected others to at least attempt to measure up to the same high standards. His influence was exerted not only through his publications, but also through the refereeing of papers, which he took very seriously, and an enormous volume of mathematical correspondence.

Adams was a long time member of the American Mathematical Society and a frequent visitor to the United States. He spent the year 1957–1958 at the Institute for Advanced Study, and he was for many years a regular spring visitor to the University of Chicago.

J. Peter May
University of Chicago

Ronald J. DiPerna
1947–1989

Ronald J. DiPerna, who at a young age was already a major figure in analysis and nonlinear partial differential equations, died on January 8, 1989 at the age of 41. Ronald DiPerna was a professor of mathematics at the University of California at Berkeley and was a member of the Institute for Advanced Study in Princeton, N.J. at the time of his death. His wife, Maria Schonbek, is a professor of mathematics at the University of California at Santa Cruz.

DiPerna was born in Somerville, Massachusetts in 1947 and received his Ph.D. in 1972 from the Courant Institute of Mathematical Sciences of New York University. He held faculty positions at Brown University, the University of Michigan, the University of Wisconsin and Duke University.

DiPerna was best known for his development of the method of compensated compactness. This is a very powerful method for controlling oscillation and thereby proving existence theorems. DiPerna proved existence of weak solutions in the large for equations of compressible gas dynamics and he obtained important results concerning uniqueness.
of solutions, their large time behavior and their local regularity as elements of BV spaces. His recent work concerned the Boltzmann equation (jointly with P. L. Lions) and the two dimensional Euler equation (jointly with A. Majda).

DiPerna liked hard problems and he persevered to conquer them. His courage and mathematical vision will stand as an inspiration to all who were privileged to know him and to those who will learn from his works.

James Glimm
SUNY, Stony Brook

1989 Wolf Prizes

The Wolf Foundation has announced the 1989 prize winners in mathematics. The $100,000 prize in mathematics will be shared by Alberto P. Calderon of the University of Chicago and John W. Milnor of the Institute for Advanced Study, Princeton.

Alberto P. Calderón

Born in Mendoza, Argentina in 1920, ALBERTO P. CALDERÓN has been selected for his “groundbreaking work on singular integral operators and their application to important problems in partial differential equations.” His work has had a lasting impact on the shape of contemporary Fourier analysis and on its connections with real variables, complex analysis, and partial differential equations. In particular, his contributions to the theory of singular integral operators have been decisive, both by bringing to the theory the sharpest technical tools and by applying the theory in imaginative ways to important problems in partial differential equations. He received the Böcher of the AMS in 1978 for a paper on the Cauchy integral on Lipschitz curves. A student of Antoni Zygmund, Professor Calderón received his Ph.D. from the University of Chicago in 1950.

John W. Milnor

John W. MILNOR, born in Orange, New Jersey in 1931, was recognized for “his ingenious and highly original discoveries in geometry which have opened important new vistas in topology from the algebraic, combinatorial, and differentiable viewpoint[s].” His work has exerted a major influence on the development of contemporary mathematics. The current state of the classification of topological, piecewise linear, and differentiable manifolds rests in large measure on his research in topology and algebra. Professor Milnor’s work on “exotic” differentiable structures (i.e., those different from the standard structures) launched the subject of differential topology. His research in algebraic geometry on singular points of complex hypersurfaces relates exotic spheres to links around singularities. In combinatorics, he disproved the longstanding conjecture of algebraic topology known as the Hauptvermutung. Professor Milnor received his Ph.D. from Princeton University in 1954.

The awards will be presented by the President of Israel, Chaim Herzog, in May during ceremonies at the Parliament in Jerusalem. The Wolf Foundation, an Israel-based, international organization, presents annual prizes for achievements in chemistry, agriculture, medicine, physics, mathematics, and the Arts.

Established in 1975 by the late Dr. Ricardo Wolf to “promote science and art for the benefit of mankind,” the Wolf Foundation also grants stipends each year to hundreds of students and researchers in Israel. Dr. Wolf, a German-born chemist, philanthropist, and diplomat, emigrated to Cuba before World War I and became Cuban Ambassador to Israel in 1961. He died in Israel in 1981.

1989 MAA Awards

The Mathematical Association of America (MAA) presented its Award for Distinguished Service to Mathematics and the Chauvenet Prize at its 72nd annual meeting in Phoenix on January 13.

IVAN NIVEN, Professor of Mathematics at the University of Oregon, Eugene, Oregon, received the Distinguished Service Award in recognition of service that has had significant nationwide influence on mathematics.
News and Announcements

and mathematics education. In addition to serving as President of the MAA (1983-1984), Professor Niven has been a member of the Association's Board of Governors since 1982 and has served on at least 30 MAA committees. As President, Professor Niven was influential in the creation of the American Mathematics Project, which seeks new ways to improve the teaching of mathematics at the secondary and primary levels. He has also served as chair and governor of the Pacific Northwest Section of the MAA and on numerous sectional committees. The author of seven books and some 70 papers, Professor Niven received his B.A. from the University of British Columbia in 1934 and his Ph.D. from the University of Chicago in 1938.

Jacob Korevaar, Professor of Mathematics at the University of Amsterdam, received the Chauvenet Prize for his paper, "Ludwig Bieberbach’s conjecture and its proof by Louis de Branges," which appeared in The American Mathematical Monthly in 1986. The prize is given yearly to the author of a noteworthy expository survey paper. Upon making its selection, the Committee on the Chauvenet Prize said of Korevaar's paper, "... we are reminded that the beauty and power of a few simple ideas can sometimes lead to very deep results that can even be understood by students just starting to seriously study mathematics. Elegant arguments like those included in this paper are one of the best ways of attracting students to mathematics." Professor Korevaar's research areas are complex analysis and approximation theory, with a focus on Tauberian theorems and Muntz-type approximation. Born and educated in the Netherlands, he spent 25 years in the U.S., mostly at the University of Wisconsin at Madison and the University of California, San Diego. Since 1974 he has been at the University of Amsterdam. He is a member of the Netherlands Academy of Sciences.

ACM Awards

Three mathematical scientists received awards from the Association for Computing Machinery at the ACM Computer Science Conference in Louisville, Kentucky on February 22, 1989.

Ivan Sutherland has received the 1988 ACM Turing Award for his pioneering and visionary contributions to computer graphics. This award, the highest honor in computer science research and applications given by the ACM, has been presented annually since 1966 for contributions of lasting and major technical importance to the computing field. The prize is named for the British mathematician A. M. Turing, whose pioneering work was instrumental in the development of computer science and applications. Sutherland, Vice President and Technical Director of Sutherland, Sproull, and Associates, Incorporated, is the inventor and developer of the interactive graphics program called Sketchpad. The ACM Awards Committee cited Dr. Sutherland for the many innovations in Sketchpad, including "a display file for screen refresh, a recursively traversed hierarchical structure for modeling graphical objects, recursive methods for geometric transformations and an object-oriented programming style. Later innovations include a 'Lorgnette' for viewing stereo or colored images and elegant algorithms for registering digitized views, clipping polygons, and representing surfaces with hidden lines.”

Guy L. Steele, Senior Scientist at the Thinking Machines Corporation, received the 1988 ACM Grace Murray Hopper Award for “his general contributions to the development of Higher Order Symbolic Programming, principally for his advancement of lexical scoping in LISP.” The Hopper Award, established in 1971, recognizes young individuals who have made outstanding technical contributions to the computer industry by age 30. Steele has published more than two dozen technical papers on the subject of LISP, in addition to three books on LISP and other computer science topics. At Thinking Machines, he works with parallel programming languages and other systems software for the Connection Machine. He received his A.B. in applied mathematics from Harvard University (1975) and his S.M. (1977) and Ph.D. (1980) degrees in computer science and artificial intelligence from the Massachusetts Institute of Technology.

Charles L. Bradshaw, Chairman of the Computer Science Department at Mississippi State University, received the 1988 ACM Distinguished Service Award for “over thirty-five years of valuable and lasting contributions and service to the government, academic, and professional computing community as a computer scientist, educator, administrator, and ACM leader.” With service to ACM spanning more than 25 years, Bradshaw’s career in scientific computing has centered primarily on various space flight projects. From 1971 until 1988 he was Director of Computing at Vanderbilt University. Bradshaw received his B.S. degree in mathematics from Tennessee Technological University in 1947 and his M.A., also in mathematics, from the University of Tennessee in 1950.

Fulkerson Prizes Awarded

The Fulkerson Prize for outstanding papers in the area of discrete mathematics is sponsored jointly by the Mathematical Programming Society and the American Mathematical Society. The prize was established to encourage mathematical excellence in the fields of research exemplified by the works of Delbert Ray Fulkerson and is awarded for papers that have been published in a recognized journal during the preceding
six years. Beginning in 1979, up to three awards are presented at each (triennial) International Symposium of the Mathematical Programming Society.

The 1988 Fulkerson Prizes were awarded to ÉVA TÁRDOS of Eötvös Lorand University, Budapest, Hungary, and to NARENDRA KARMAKAR of AT&T Bell Laboratories, Murray Hill, New Jersey. Professor Tardos received the award for her paper “A strongly polynomial minimum cost circulation algorithm”, Combinatorica, Volume 5 (1985) pages 247–256; and Dr. Karmarkar received the award for his paper “A new polynomial-time algorithm for linear programming”, Combinatorica, Volume 4 (1984) pages 373–395. The prizes were awarded on the recommendation of a committee consisting of M. Padberg (chairman), M. Grotschel, and G.-C. Rota.

U.S.S.R. Academy of Sciences Elects 16 Americans

The U.S.S.R. Academy of Sciences recently announced the election of 44 foreign members. Sixteen of the newly elected foreign members are from the U.S. Prior to this election, there were only 13 U.S. members (out of a total of 93 foreign members). The Soviet academy said the honor had been bestowed upon them for outstanding achievements in the natural sciences and humanities and also for the promotion of international cooperation. The election is generally regarded as another sign of the continuing improvement in relations between the U.S. and the U.S.S.R.

The Americans elected to the U.S.S.R. Academy of Sciences who are of particular interest to readers of Notices are: LARS V. ALFORS, Harvard University; PETER D. LAX, Courant Institute of Mathematical Sciences; EDWARD N. LORENZ, Massachusetts Institute of Technology; FRANK PRESS, National Academy of Sciences; and J. ROBERT SCHRIEFFER University of California, Santa Barbara.

Honors for Soviet Women Mathematicians

Olga Oleinik, Head of the Department of Differential Equations at Moscow State University, was awarded the U.S.S.R. State Prize for her achievements in mathematical research.

In addition, Oleinik and Olga Ladyzhenskaja of the Leningrad Branch of the Mathematics Institute were elected to the Academy of the Lincei, a scientific academy in Rome, Italy. Both participated in the ceremonies in Rome on November 26, when the President of the Republic of Italy presented them with the insignia and documents of membership in the Academy.

NSF-CBMS Regional Conferences in the Mathematical Sciences

To stimulate interest in mathematical research, the National Science Foundation (NSF) is sponsoring 10 regional conferences between May 1989 and January 1990. A panel chosen by the Conference Board of the Mathematical Sciences, under a contract with the NSF, made the selections from among submitted proposals.

Each five-day conference typically has about 25 participants, and features 10 lectures presented by a single guest lecturer. The lecturer subsequently prepares and submits to the Conference Board a paper based on these lectures, which normally is published as a monograph as part of a regional conference series. Depending on the Conference topic, publication is sponsored by the American Mathematical Society or the Society for Industrial and Applied Mathematics, or jointly by the American Statistical Association and the Institute of Mathematical Statistics.

See the Funding Information for the Mathematical Sciences section of this issue of Notices for the announcement inviting proposals from prospective institutions for next year’s Regional Conference.

The regional conferences for this coming year are:

Discrete Groups, Expanding Graphs and Invariant Measures, at the University of Oklahoma, with Alexander Lubotsky as lecturer. Andy Magid is the Principal Investigator (405-325-2052). May 1989.

Function Estimation in the Context of Independent and Dependent Observations, at the University of California, Davis, with Murray Rosenblatt as lecturer. George Roussas is the Principal Investigator (916-752-8142). June 1989.

Harmonic Analysis, Real Function Spaces and Related Areas, at Auburn University, with Guido Weiss as lecturer. Geraldo DeSouza is the Principal Investigator (205-826-4290). June 12–16, 1989.


Algebraic Ideas in Ergodic Theory, at the University of Washington, with Klaus Schmidt as lecturer. Douglas Lind is the Principal Investigator (206-543-1723). July 17–21, 1989.


Singular Integral Operators, at the University of Montana, with
News and Announcements

The Board of Governors of IMA in its last meeting in October 1988, has approved a proposal for Applied Linear Algebra as the annual program for 1991-1992. The organizers are: Richard A. Brualdi, George Cybenko, Alan George, Gene Golub, Paul van Dooren, and Mitchell Luskin.

The board also approved Time Series and Radar and Sonar as topics for the summer of 1990. The Radar and Sonar program is being organized by: Alberto Grunbaum, Marvin Bernfeld, Richard Blahut, and Richard Tolimieri (June 18–29). The Time Series program is being organized by: Emanuel Parzen, David Brillinger, R. Gnanadesikan, Murray Rosenblatt, Murad Taqqu, and John Geweke (July 2–31).

The annual program for 1989-1990 is Dynamical Systems and Their Applications and for 1990-1991 is Phase Transitions and Free Boundary Problems. The Institute is open to suggestions of new proposals, for both annual and short term programs. People interested in writing up a proposal should contact the Director, Avner Friedman.

It was recently decided to have two additional workshops in the spring of 1989: "Microlocal Analysis and Nonlinear Waves" (May 15–19) organized by: M. Beals, R. Melrose and J. Rauch, and "Symbolic Computation Methods and Differential Equations" (June 26–30) organized by: R. Caviness and M. Singer.

U.S.—U.S.S.R.
Algebraic Geometry Symposium

The Mathematical Disciplines Center and the Department of Mathematics of the University of Chicago will hold a joint Soviet and American symposium on algebraic geometry from June 19 through July 14, 1989. The National Academy of Sciences and the Academy of Sciences of the U.S.S.R. gave their joint endorsement of the symposium at their annual interacademy meeting in December 1989. Partial funding has been requested from the NSF.

The main purpose of the Symposium is to assemble as strong a group of algebraic geometers as possible from each of the two countries and to do all that is possible to allow them to work together for a substantial amount of time. Although some of the invited participants will give talks, most of the time will be devoted to discussions, informal and formal, especially about open problems and directions for future work. There will be plenty of time for small groups to work on joint projects. Thus the emphasis will be more on participation in research than on transmittal of information.

Different broad areas of algebraic geometry will be emphasized during different phases of the Symposium. The main emphasis of the first week will be arithmetic algebraic geometry. Tentatively, the second week will emphasize applications to physics, K-theory, and representation theory. Other topics of discussion will include motivic cohomology, Hodge theory, intersection homology, perverse sheaves, D-modules, three-folds and higher dimensional varieties, and recent progress in such classical geometric topics as curves, surfaces, rationality and birationality questions, Abelian varieties, projective geometry, moduli questions, vector bundles, fundamental groups, etc.

About 25 Soviet algebraic geometers and 35 American algebraic geometers have been invited to participate (not including the expected Chicago area participants).

The organizers are S. Bloch, W. Fulton, R. Swan, and J. P. May. Mathematicians wishing to participate should write the organizers at the Department of Mathematics, the University of Chicago, Chicago, Illinois 60637 or call 312-702-7100.

Society for Mathematical Biology

The Society for Mathematical Biology, in conjunction with the Institute for Mathematics and its Applications, is sponsoring a meeting entitled "Classics of Theoretical Biology," in Oxford, England during July 3–8, 1989. The speakers and topics include John Rinzel and Jack Cowan, Neurophysiology; James Murray, Development; William Reed, Bioeconomics; Robert May, Ecology; Roy Anderson, Epidemiology; and William Provine, Population Genetics. The proceedings will be published as a special issue of the Bulletin of Mathematical Biology and as a separate volume by Pergamon.

Funding for partial travel support for graduate students is available from the Society for Mathematical Biology (see the Funding Information for the Mathematical Sciences section of this issue of Notices for further information).

For more information, contact Marc Mangel, Department of Zoology, University of California at Davis, Davis, CA 95616, 916-752-8830 (email msmangel@ucdavis).

Joint Meeting with LMS in 1992

For the first time, the AMS and the London Mathematical Society (LMS) will collaborate on a joint conference to be held in the summer of 1992 in Cambridge, England. The meeting
will feature five, one-hour invited addresses by mathematicians from the United States and Great Britain, in addition to Contributed Papers and Special Sessions. There will also be a festive banquet.

This auspicious event indicates the spirit of cooperation between the AMS and the LMS and the importance of strengthening ties in the international community of mathematical scientists. The friendly relationship between the two societies has a long history, for it was the LMS that inspired the founder of the AMS to establish in 1888 a mathematical society in the United States.

The meeting will be held June 29–July 2, 1992. Mark your calendars now, and watch for more information on this historic meeting.

Pi Mu Epsilon Diamond Jubilee Celebration

In celebration of its 75th anniversary, Pi Mu Epsilon (PME), Incorporated, the international honorary mathematical society, will hold a Diamond Jubilee celebration, which will take place at the Joint Mathematics Meetings in Boulder, Colorado, August 7–10, 1989. As part of the celebration, PME is planning a number of special scientific and social events.

To mark this special event, the AMS has provided funds for a new Diamond Jubilee commemorative prize. The $1000 prize will be administered and awarded annually by PME, beginning this year.

In Boulder, the celebration will include an expanded scientific program, featuring the J. Sutherland Frame Lecture by Jane Cronin Scanlon of Rutgers University. In addition, Joseph A. Gallian of the University of Minnesota-Duluth will present a special AMS-MAA-PME address. A series of contributed paper sessions will give undergraduate students an opportunity to present papers.

Several social events are planned for Boulder. The celebration kicks off with a reception on August 7, and there will also be the PME banquet and other activities. “We hope it will be a mathematically enriching and festive time,” says Eileen Poiani, President of PME.

In addition to the events at the Boulder meeting, PME plans to issue a special commemorative issue of the *piμe Journal* as part of the Diamond Jubilee. PME has published the semiannual journal since 1952.

PME was founded in 1914 at Syracuse University with the goal of promoting scholarship in mathematics. Through its more than 260 chapters nationwide, PME seeks to encourage more students to persist in mathematics and to pursue careers in mathematics research and related areas. Members are generally inducted into PME as undergraduate students and remain members for life. However, individuals need not be students to join, and they need not be affiliated with academic institutions.

PME encourages colleges and universities to send undergraduate student speakers and delegates to the Diamond Jubilee. There will be travel grants available for delegates and for students selected to present papers at the meeting. Information about the travel grants will be sent this month to colleges and universities across the nation.

For more information, contact Eileen Poiani, President of PME, Saint Peter's College, 2641 Kennedy Boulevard, Jersey City, NJ 07306; or Robert Woodside, Secretary-Treasurer of PME, Department of Mathematics, East Carolina University, Greenville, NC 27858, telephone 919-757-6414.

Science Literacy Conference

"Strategies for Change," a conference on improving science literacy, will be held March 13–15, 1989, in Washington, DC. The American Medical Association and several other groups concerned with science literacy are sponsoring the conference as part of the National Initiative for Science and Technology Education. The conference will serve as the initiative’s genesis for formulating a national agenda and specific strategies for raising the science literacy of the general public. Covering the mathematical sciences on the program will be Lynn Arthur Steen of St. Olaf College.

The registration fee for the conference is $225. For more information, call 800-621-8335. In Illinois, call collect, 312-645-4987.

Database Connects Jobseekers and Employers

The AMS recently signed an agreement with an organization that manages a resume data bank used primarily by non-academic employers interested in hiring professional personnel with training in mathematics, science, and engineering. AMS members may now use this service free of charge.

The service, called Scientists and Professional Engineering Employment Registry (SPEER), includes a computerized database of resumes from a cross section of professionals interested in career opportunities. Employers specify their requirements for a particular job, and SPEER selects the individuals having the skills, experience, education, salary requirements, geographic preferences, and other characteristics matching the job requirements.

To indicate their interest in a particular individual meeting their job requirements, employers send to SPEER a “contact request.” SPEER mails the request to the jobseeker, who is then free to respond directly to the company to arrange an interview. If the individual is not interested in the position, SPEER notifies the employer of the decision, and the individual remains anonymous. In addition, the resumes are specially coded so that a jobseeker’s current
employer will not view the individual's resume.

Employers pay a flat-rate subscription fee to use SPEER, but there is no cost or obligation to the job-seeker. Individuals may update their resumes on file at SPEER and may have their names removed at any time.

For more information about SPEER, AMS members should write to AMS-SPEER, c/o Career Technologies Corporation, 138 Old River Road, Andover, Massachusetts 01810 or call (508)683-0098.

**Mathematics Makes a Showing at AAAS Meeting**

Ten thousand people turned out for the largest meeting in two decades of the American Association for the Advancement of Science (AAAS). Holding the meeting in San Francisco probably boosted attendance, but even those who came only for some mild California weather in the middle of January found much of interest on the extensive scientific program. Unlike most scientific conferences, AAAS meetings cover a broad range of disciplines and therefore provide a way for researchers to learn of developments in areas other than their own.

The several sessions in the mathematical sciences were well-attended and attracted many nonmathematicians. One program, entitled "Logic Today" and organized by Harvey Friedman of Ohio State University, focused on a number of current topics in mathematical logic and the implications for computer programming. "Mathematics and Molecular Biology" was organized by Michael S. Waterman of the University of Southern California, featured topics ranging from how knot theory has elucidated DNA recombination to the use of statistical methods in analyzing heredity. In addition, there was a 3-day session on chaos and dynamical systems, a host of talks on neural networks, and programs focusing on statistical methods.

Michael H. Freedman of the University of California, San Diego presented one of the "Frontiers of the Physical Sciences" lectures. His talk on an application of topology to incompressible fluids balanced geometric intuition and technical details to make the content accessible to mathematicians and nonmathematicians alike. Wang Yuan, professor at the Institute of Mathematics at the Chinese Academy of Sciences and President of the Chinese Mathematical Society, was one of the members of the Chinese delegation attending the meeting. He spoke on advances in number theory in China and their applications to numerical analysis.

AAAS meetings also provide a forum for discussion and analysis of broad issues of science policy. One session entitled "Federal Funding of the Academic Physical Sciences" featured six panelists, among them William P. Thurston of Princeton University and Richard M. Karp of the University of California at Berkeley; Barbara L. Simons of the IBM Almaden Research Center in San Jose, California was the moderator. The lively discussion ranged over such topics as setting priorities among federally funded science projects, the increasing proportion of academic research funded through military agencies, and the changing role of universities in the science research endeavor of the nation.

Several interesting sessions on education and pipeline issues indicated the broad attention such matters are receiving in the general scientific community. One session on minorities in science and engineering featured Los Angeles mathematics teacher Jaime Escalante, whose story was told in the movie Stand and Deliver. Arnold Ross of Ohio State University assembled a panel of prominent mathematicians and scientists who described the early experiences that had stimulated their interest in their disciplines. A session entitled "Women in Physics—Why So Few?" included a presentation by Mary Beth Ruskai of the Courant Institute of Mathematical Sciences. Though focusing on physics, the session provided insight into the particular challenges faced by women in all areas of science and mathematics.

Overall, the meeting offered much of interest to the mathematical sciences community. In addition, with over 600 reporters in attendance, the meeting provided an excellent opportunity to develop public awareness of science and mathematics.

Section A, the mathematics section of AAAS, is interested in promoting and increasing the participation of the mathematical sciences community in future AAAS meetings. Warren Page, Secretary of Section A, says that he has found the AAAS program committee to be genuinely interested in having more symposia on mathematical topics of current interest. He noted that the success of the mathematics programs at the San Francisco meeting showed that top mathematical researchers can communicate effectively to a broad audience of scientists. "I need and welcome suggestions from the mathematics community on possible topics and individuals to serve as organizers," he said.

Plans are now being formulated for mathematics sessions to be held at the next meeting in New Orleans on February 15–20, 1990. Those who have ideas for possible topics are urged to contact Warren Page, Secretary (Section A), New York City Technical College, CUNY, Department of Mathematics, 300 Jay Street, Brooklyn, NY 11201; telephone 914-476-6446.

**Math Awareness Week 1989**

This year Mathematics Awareness Week will be held April 23–29, 1989. An effort to improve public understanding of mathematics, this national event gives the mathematical
to celebrate mathematics and to communicate to the public the importance, relevance, and beauty of the discipline. The theme for 1989 is “Mathematics: Discovering Patterns.”

Last year’s Mathematics Awareness Week proved very successful and brought high-level exposure to mathematics. For example, the National Academy of Sciences exhibited a number of mathematical works of art, including the AMS Centennial poster and colorful fractal images. Fifty-seven radio stations in Pennsylvania carried a spot prepared and distributed by the public information office at Pennsylvania State University. The spot featured George Andrews commenting on the impact of mathematics in everyday life. A news story on Mathematics Awareness Week was fed to outlets of United Press International nationwide. Many colleges and universities across the nation sponsored special events for high school students and teachers.

The Joint Policy Board for Mathematics is promoting the participation of the mathematical sciences community in Mathematics Awareness Week by supplying ideas for various activities that mathematics faculty can undertake during this week. Some of these ideas are:

- Inviting the general public to a computer demonstration.
- Hanging a banner proclaiming “Mathematics Awareness Week” outside mathematics department offices.
- Initiating an effort to secure a local, city, or state proclamation declaring April 23-29 Mathematics Awareness Week.
- Asking local public television stations to run (or rerun) the series, “For All Practical Purposes: Introduction to Contemporary Mathematics.” This series of 26, half-hour programs are free to PBS stations. For information, contact the Consortium for Mathematics and Its Applications at 617-641-2600.

These are just a few possibilities for ways of celebrating during Mathematics Awareness Week. For more information, contact Kirsten Sampson, Mathematics Awareness Week Coordinator, Office of Governmental and Public Affairs, Joint Policy Board for Mathematics, 818 Connecticut Avenue, N.W., Suite 515, Washington, DC 20006; telephone 202-659-6444. For those who do sponsor activities for Mathematics Awareness Week, the Board would appreciate receiving written descriptions of the activities and their success.

Voytuk New Head of MS2000

James A. Voytuk, former Associate Executive Director of the AMS, has been named as Project Director of Mathematical Sciences in the Year 2000: Assessment for Renewal in U.S. Colleges and Universities. Known as MS2000, this project is jointly sponsored by the Board on Mathematical Sciences and the Mathematical Sciences Education Board of the National Research Council (NRC). Voytuk, who joined the AMS staff in 1985, also served as Managing Editor of Notices. Before taking his position at the Society, Voytuk was Executive Officer and Associate Professor in the Mathematical Sciences Department at Rensselaer Polytechnic Institute.

Voytuk succeeds Bernard L. Madison, who served as the first director of MS2000 and who has now returned to the University of Arkansas. Over the next few years, the project 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.

One of the major events in which MS2000 was involved was the national colloquium, “Calculus for a New Century,” held in October 1987. In addition, MS2000 cosponsored, along with the two NRC boards, the recently-released “Everybody Counts: A Report to the Nation on the Future of Mathematics Education.” MS2000 is currently working on a report, due out this spring, on talent flow in the mathematical sciences.

Richard Nicholson Named Director of AAAS

Richard S. Nicholson has been selected as Executive Officer of the American Association for the Advancement of Science (AAAS). Nicholson succeeds Alvin W. Trivelpiece, who left the AAAS position late last year to become director of the Oak Ridge National Laboratory.

Nicholson will assume the AAAS office on or before April 15. He is currently Assistant Director for Mathematical Sciences in the Year 2000: Assessment for Renewal in U.S. Colleges and Universities. Known as MS2000, this project is jointly sponsored by the Board on Mathematical Sciences and the Mathematical Sciences Education Board of the National Research Council (NRC). Nicholson began at the NSF in 1970 as director of the chemical analysis program in the chemistry division. He became deputy director of the chemistry division in 1975 and director of the division two years later. He held a number of other positions at the Foundation before he was named assistant director.
Prior to joining the NSF, Nicholson was in the chemistry department of Michigan State University. He received his B.S. in chemistry in 1960 from Iowa State University and his Ph.D., also in chemistry, in 1964 from the University of Wisconsin at Madison.

New Head of NSA Math Program

Marvin C. Wunderlich, former Deputy Director of the Mathematical Sciences Program at the National Security Agency, is now the director of that program. He succeeds S. Brent Morris, now the executive secretary of the agency's scientific advisory board.

U.S.-U.S.S.R. Symposium Held

A joint U.S.-U.S.S.R. Symposium on Mathematics and its Applications to Physics was held at the University of Pennsylvania December 9-10, 1988. The speakers were Raoul H. Bott, Ljudvig D. Faddeev, Charles L. Fefferman, Izrail' M. Gel'fand, Elliott H. Lieb, Yuri I. Manin and Sergei P. Novikov, Over 180 mathematicians and physicists participated. The Symposium was sponsored by the Department of Mathematics and the Natural Science Association of the University of Pennsylvania with partial support from several National Science Foundation grants.

NSF Graduate Fellow Commemorative Lectures

At the Joint Mathematics Meetings in January, two of the AMS Invited Addresses were designated as National Science Foundation (NSF) Graduate Fellowship Commemorative Lectures. The distinction was granted to mark the 25,000th award in the Foundation's Graduate Research Fellowship Program, which began in 1952. The two designated lecturers are former NSF Graduate Fellows who have gone on to distinguished careers in mathematical research. They are David S. Fried of Boston University (Fellow, 1971-1973) and Peter S. Landweber of Rutgers University (Fellow, 1960-1962).

Errata

In the February 1989 issue of Notices, page 165, the Colloquium Lecturer at the August 1989 meeting in Boulder was incorrectly identified. The Colloquium Lecturer will be William P. Thurston.

News and Announcements

Representation Theory and Number Theory in Connection with the Local Langlands Conjecture

J. Ritter, Editor

(Contemporary Mathematics, Volume 86)

The Langlands Program summarizes those parts of mathematical research belonging to the representation theory of reductive groups and to class field theory. These two topics are connected by the vision that, roughly speaking, the irreducible representations of the general linear group may well serve as parameters for the description of all number fields. In the local case, the base field is a given $p$-adic field $K$ and the extension theory of $K$ is seen as determined by the irreducible representations of the absolute Galois group $G_K$ of $K$. Great progress has been made in establishing correspondence between the supercuspidal representations of $GL(n, K)$ and those irreducible representations of $G_K$ whose degrees divide $n$. Despite these advances, no book or paper has presented the different methods used or even collected known results.

This volume contains the proceedings of the conference "Representation Theory and Number Theory in Connection with the Local Langlands Conjecture," held in December 1985 at the University of Augsburg. The program of the conference was divided into two parts: (i) the representation theory of local division algebras and local Galois groups, and the Langlands conjecture in the tame case; and (ii) new results, such as the case $n = p$, the matching theorem, principal orders, tame Deligne representations, classification of representations of $GL(n)$, and the numerical Langlands conjecture. The collection of papers in this volume provides an excellent account of the current state of the local Langlands Program.

1980 Mathematics Subject Classifications: 11S37, 11S40, 11S45, 20G25, 22E50
ISBN 0-8218-5093-8, LC 88-39030
ISSN 0271-4132
280 pages (softcover), January 1989
Individual member $17, List price $28,
Institutional member $22
To order, please specify CONM/86NA

Shipping/Handling: 1st book $2, each additional $1, maximum $25; by air, 1st book $5, each additional $3, maximum $100
Prepayment required. Order from American Mathematical Society, P.O. Box 1571, Annex Station Providence, RI 02901-1571, or call toll free 800-556-7774 to charge with Visa or MasterCard
Funding Information for the Mathematical Sciences

Travel Support for Foreign Graduate Students

The Society is pleased to announce that travel support for foreign graduate students attending 1989 conferences is expected to be available again this year through a grant from the STEP program of the Institute of International Education. An application has been filed by the Society for foreign students attending the AMS Summer Research Institute, the AMS-SIAM Summer Seminar, and the AMS-IMS-SIAM Joint Summer Research Conferences. Full information on these conferences may be found in the November issue of Notices, pages 1374-1380, and subsequent issues.

To be eligible for these grants, the foreign student must be enrolled in full-time graduate studies at a U.S. institution of higher education. Students are ineligible if they are receiving any U.S. government funds for academic support or if they are on refugee, immigrant, or tourist visa status. Previous recipients of STEP awards are ineligible for a second grant.

To apply for a STEP grant: First, follow the application procedure for the conference you wish to attend outlined in the announcements in this issue. Second, enclose with your application to the conference coordinator a letter stating your name, home country, student status, the name of the institution at which you are enrolled, the name of an official at the institution who can verify your status and financial situation, and the name of the AMS conference you plan to attend.

Proposals for the NSF’s Division of Mathematical Sciences

Proposals submitted to the National Science Foundation (NSF) for support of research in the mathematical sciences should be submitted six to nine months prior to the expected start date to ensure timely notification of outcome. The Division of Mathematical Sciences (DMS) will accept such proposals at any time of the year. The program officers in the DMS are listed below:

Algebra and Number Theory
Jonathan Lubin 202-357-3695
Ann Boyle

Applied Mathematics
Peter Bates 202-357-3686
Bart Ng

Classical Analysis
John Ryff 202-357-3455

Computational Mathematics
Raymond Chin 202-357-3691

Geometric Analysis
Russell Walker 202-357-3451

Modern Analysis
William Paschke 202-357-3697

Special Projects
Deborah Lockhart 202-357-3453
Elbert Walker

Statistics and Probability
Mary Ellen Bock 202-357-3693
Peter Arzberger

Topology and Foundations
Ralph Krause 202-357-3457

Program officers may be contacted via electronic mail. To form an individual’s address, take the first initial and last name, and append @note.nsf.gov for Internet, @nsf.arpa for CSNET, or @nsf for BITNET. For example, to contact Jonathan Lubin by Internet, use the address jluhin@note.nsf.gov.

Mittag-Leffler Institute 1989–1990 Grants

The Mittag-Leffler Institute announces a number of grants for the year 1989–1990. The program of the institute starts on September 1 and ends on May 31. The grants are intended for recent Ph.D.’s or advanced graduate students and amount to 8,500 Swedish crowns per month, or 85,000 for those who attend for the duration of the program. Housing on the premises of the institute can be offered to some of the participants.

The subject for 1989–1990 is Hyperbolic geometry and quasiconformal mappings.

Several aspects of the field will be treated, such as

- Riemann surfaces
- Kleinian groups
- Teichmüller spaces
- Hyperbolic manifolds
- Quasiconformal groups
- Quasiregular mappings

The following experts in the field have already agreed to take part in the program for an extended period:

Lars V. Ahlfors, Boris Apanasov, Lipman Bers, Adrien Douady, Clifford J. Earle, David B. A. Epstein,

The following Scandinavians also plan to stay at the institute during some period:

Kari Astala, Kari Hag, Juha Heinonen, Tero Kilpeläinen, Tapani Kuusalo, Peter Lindqvist, Jouini Luukkainen, Olli Martio, Raimo Nääkkä, Marijatta Näätäinen, Mika Seppälä, Tuomas Sorvali, Matti Vuorinen.

Application forms can be obtained from the institute and should be returned to: The Board of the Mittag-Leffler Institute, Auravägen 17, S-182 62 Djursholm, Sweden, before March 31, 1989. Telephone (46) 80-755 1809.

**DOD Announces New URI Competition**

The Department of Defense (DOD) has announced a new competition for 1989 in its University Research Initiative (URI) program. The URI is intended to strengthen the capability of universities and colleges to perform basic multidisciplinary research in areas important to national defense. Since its inception in 1986, the URI has made almost $300 million available to U.S. universities. For fiscal year 1989, the program is budgeted for $5 million.

The awards will range from $50,000 to $250,000 per year. The new program will place special emphasis on education and human resources and will provide substantial funds for equipment. In addition, the new URI is directed at institutions that have the capability to perform defense research, but may lack resources to assemble multidisciplinary teams. The competition is open to historically black colleges and universities, other minority institutions, and any academic institution that received less than $4 million from the DOD for research and development in either 1986 or 1987.

The deadline for proposals is **March 30, 1989**. The four main DOD agencies that fund basic research will handle the URI program. Each agency has specified certain research areas in which mathematical scientists might have an interest. These are listed below with the appropriate contact person in each agency.

- **Army Research Office**, smart materials and structures. Contact Andrew Crowson, Materials Science Division, ARO, P.O. Box 12211, Research Triangle Park, NC 27709-2211.
- **Office of Naval Research**, physical and structural acoustics. Logan Hargrove, Physics Division, ONR, 800 North Quincy St., Arlington, VA 22217-5000.

**Society for Mathematical Biology Travel Awards**

The Society for Mathematical Biology has funds to partially support the travel of graduate students to meetings co-sponsored by the Society including the Institute for Mathematics and its Applications meeting in Oxford, England (July 3–8, 1989), the Fortieth Annual Meeting of the American Institute of Biological Sciences in Toronto, Canada (August 6–10, 1989), and the Second Annual Meeting of the International Neural Network Society (September 5–9, 1989). Graduate students who wish support may apply to: Michael C. Reed, Department of Mathematics, Duke University, Durham, NC 27706.

The application, which should be received by **May 1, 1989**, should include a one page research summary and one letter from a faculty sponsor.
1989 AMS Elections

Nominations by Petition

Vice-President or Member-at-Large
Two positions of vice-president and member of the Council ex officio for a term of two years are to be filled in the election of 1989. The Council intends to nominate four candidates, whose names may be expected to appear in the June issue of Notices, which is scheduled to be mailed by the printer on 25 May. Nominations by petition as described in the rules and procedures are acceptable.

Five positions of member-at-large of the Council for a term of three years are to be filled in the same election. The Council intends to nominate seven candidates, whose names may be expected to appear in the June issue of Notices. Nominations by petition, in the manner described in the rules and procedures are acceptable. The Council has stated its intent to have at least ten candidates and will bring the number up to ten if the nominations by petition do not do so.

Petitions are presented to the Council, which, according to Section 2 of Article VII of the bylaws, makes the nominations. The Council of 23 January 1979 stated the intent of the Council of nominating all persons on whose behalf there were valid petitions. The Council of 20 January 1987 established a policy that, beginning with the interval 1987–1996, the Council intends to approve no more than two nominations by petition of the same individual in any ten year period.

Prior to presentation to the Council, petitions in aid of a candidate for the position of vice-president or of member-at-large of the Council must have at least 50 valid signatures and must conform to several rules and operational considerations, which are described below.

Editorial Boards Committee
Two places on the Editorial Boards Committee will be filled by election. The new members will be elected in a preferential ballot. The President will name three candidates for these two places. The names may be expected to appear in the June issue of Notices. Nominations by petition, in the manner described in the rules and procedures, will be accepted. Should the final number of candidates be less than six, the President will bring it up to six.

The name of a candidate for member of the Nominating Committee may be placed on the ballot by petition. The candidate’s assent and petitions bearing at least 100 valid signatures are required for a name to be placed on the ballot. In addition, several other rules and operational considerations, described below, should be followed.

The Nominating Committee for 1990
Three places on the Nominating Committee will be filled by election. There will be six continuing members of the Nominating Committee, namely:

<table>
<thead>
<tr>
<th>Joan S. Birman</th>
<th>Victor Klee</th>
</tr>
</thead>
<tbody>
<tr>
<td>James E. Humphreys</td>
<td>Alan O. Weinstein</td>
</tr>
</tbody>
</table>

Two members to be named by the President.

The new members will be elected in a preferential ballot. The President will name five candidates for these three places. The names may be expected to appear in the June issue of Notices. Nominations by petition, in the manner described in the rules and procedures, will be accepted. Should the final number of candidates be less than six, the President will bring it up to six.

The name of a candidate for member of the Nominating Committee may be placed on the ballot by petition. The candidate’s assent and petitions bearing at least 100 valid signatures are required for a name to be placed on the ballot. In addition, several other rules and operational considerations, described below, should be followed.

Rules and Procedures
Use separate copies of the form for each candidate for vice-president, member-at-large, or member of the Nominating and Editorial Boards Committees.

1. To be considered, petitions must be addressed to Robert M. Fossum, Secretary, P. O. Box 6248, Providence, Rhode Island 02940, and must arrive by 6 July 1989.

2. The name of the candidate must be given as it appears in the Combined Membership List. If the name does not appear in the list, as in the case of a new member or by error, it must be as it appears in the mailing lists, for example on the mailing label of the Notices. If the name does not identify the candidate uniquely, append the member code, which may be obtained from the candidate’s mailing label or the Providence office.

3. The petition for a single candidate may consist of several sheets each bearing the statement of the petition, including the name of the position, and signatures. The name of the candidate must be exactly the same on all sheets.

4. On the next page is a sample form for petitions. Copies may be obtained from the Secretary; however, petitioners may make and use photocopies or reasonable facsimiles.

5. A signature is valid when it is clearly that of the member whose name and address is given in the left-hand column.

6. The signature may be in the style chosen by the signer. However, the printed name and address will be checked against the Combined Membership List and the mailing lists. No attempt will be made to match variants of names with the form of name in the CML. A name neither in the CML nor on the mailing lists is not that of a member. (Example: The name Robert M. Fossum is that of a member. The name R. Fossum appears not to be. Note that the mailing label of the Notices can be peeled off and affixed to the petition as a convenient way of presenting the printed name correctly.)

7. When a petition meeting these various requirements appears, the Secretary will ask the candidate whether he is willing to have his name on the ballot. Petitioners can facilitate the procedure by accompanying the petitions with a signed statement from the candidate giving his consent.
NOMINATION PETITION FOR 1989 ELECTION

The undersigned members of the American Mathematical Society propose the name of _______________________

as a candidate for the position of (check one):

- [ ] Vice-President
- [ ] Member-at-Large of the Council
- [ ] Member of the Nominating Committee
- [ ] Member of the Editorial Boards Committee

of the American Mathematical Society for a term beginning 1 January, 1990; or 1 September, 1990, in the case of member of the Nominating Committee.

Name and Address (printed or typed, or Notices mailing label)

_________________________________________________________

Signature

_________________________________________________________

Signature

_________________________________________________________

Signature

_________________________________________________________

Signature

_________________________________________________________

Signature

_________________________________________________________

Signature
Meetings and Conferences of the AMS

FUTURE MEETINGS

Worcester, Massachusetts
April 15–16

Chicago, Illinois
May 19–20

Invited Speakers and Special Sessions

FUTURE CONFERENCES

Pure Mathematics Symposium
Sundance Resort, Sundance, Utah, May 26–30

Summer Research Institute
University of California, Santa Cruz, July 10–30
Coming Events

With a scientific program of superior quality and a setting of breathtaking natural beauty, the August meetings in Boulder promise to be among the best. Especially exciting will be the debut of the new AMS lecture series *Progress in Mathematics*, featuring Dusa McDuff of the Institute for Advanced Study, who will speak on recent developments in symplectic geometry, and Haim Brezis of the University of Paris, who will speak on liquid crystals. (More information on this lecture series appears on page 149 of the February issue of *Notices*.)

The popular series of AMS-MAA Invited Addresses on the history and development of mathematics will continue with four excellent speakers covering a broad range of topics. Speakers include John Conway, Serge Lang, and Jean Taylor. Persi Diaconis will present the MAA's Hedrick Lectures, and William P. Thurston will be the AMS Colloquium Lecturer.

Such an outstanding program makes the Boulder meetings a must! Mark your calendars now and be sure not to miss the June 1 deadline for preregistration and housing. A full announcement of the Boulder meetings, including the Preregistration/Housing Form, will appear in the next issue of *Notices*. 
Program

The eight-hundred-and-forty-eighth meeting of the American Mathematical Society will be held at the College of the Holy Cross in Worcester, Massachusetts, on Saturday, April 15, and Sunday, April 16, 1989.

Invited Addresses

By invitation of the Committee to Select Hour Speakers for Northeast Sectional Meetings, there will be four invited one-hour addresses. The speakers, their affiliations, the titles of their talks, and the scheduled times of presentation are:

Igor Frenkel, Yale University, *Vertex operator algebras and quantum groups*, 11:00 a.m. Sunday.

Adrian Ocneanu, Pennsylvania State University, *The structure of symmetries of quantum space*, 11:00 a.m. Saturday.

Thomas H. Parker, Michigan State University, *The geometry of the Yang-Mills moduli space*, 1:30 p.m. Saturday.

Karl Rubin, Columbia University, *The arithmetic of elliptic curves*, 1:30 p.m. Sunday.

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 are as follows:

- **Operator algebras, Galois theory and representations**, Richard Herman and Adrian Ocneanu, Pennsylvania State University.
- **Infinite-dimensional symmetries in mathematics and physics**, James Lepowsky, Rutgers University.
- **Gauge theory and differential geometry**, Thomas H. Parker.
- **L-functions and arithmetic**, Karl Rubin, and Glenn Stevens, Boston University.
- **Knot theory and algebraic geometry in the large**, Lee Rudolph, Clark University.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Late papers will not be accommodated.

Council

The Council of the Society will meet at 7:00 p.m. on Saturday, April 15, 1989, in Sturbridge Rooms A and B at the Howard Johnson's Motor Lodge, located at 800 Southbridge Street, Worcester, MA 01610, which is adjacent to the College of the Holy Cross campus.

Other Events of Interest

From 9:00 a.m. to 3:00 p.m. on Saturday, April 15 and 9:00 a.m. to noon of Sunday, April 16, there will be several tables set up in the atrium in Swords Hall with a selection of AMS publications and information about member services. Several electronic and optical retrieval systems for accessing MathSci will also be demonstrated, including the online and the new CD-ROM systems for browsing and searching Mathematical Reviews and Current Mathematical Publications. Information on TeX software will also be available. All participants are invited to visit the display.

Registration

The registration desk will be located in Swords Hall and signs will be posted directing participants to the meeting registration area. The meeting registration desk will be open from 8:00 a.m. to 3:00 p.m. on Saturday, April 15, and on Sunday, April 16, from 8:00 a.m. to 11:00 a.m. The registration fees are $30 for members of the AMS, $45 for nonmembers, and $10 for students or unemployed mathematicians.

Social Event

The Department of Mathematics will be hosting a Beer, Soft Drink and Pizza party which will take place on
Meetings

Saturday evening, April 15, in the Atrium which is located in Haberlin and Swords Halls. The department will be providing the pizza for the guests of the meeting but it should be noted that beer and soft drinks will be available for purchase on a cash basis during the party. To insure that an ample amount of pizza is ordered, it is requested that members intending to attend the social please so indicate when registering on Saturday.

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 Phoenix meeting announcement on page 1502 of the December 1988 issue of Notices.

Accommodations
There are no accommodations available for housing on campus during the meeting.

Rooms have been blocked at the Howard Johnson's Motor Lodge adjacent to the campus. Participants should make their own reservations directly with the motel of their choice and identify themselves as attending the meeting of the American Mathematical Society at the College of the Holy Cross. The deadline for reservations at these locations was February 28. The rates below are subject to change and do not include applicable taxes.

Howard Johnson's Motor Lodge
800 Southbridge Street
Worcester, MA 01610
Telephone: (508) 791-5501

Single $49 Double $53

The following motels are located between two and five miles from campus. Although rooms have not been blocked at any of these locations, they are included here for information purposes.

Best Western Centrum Inn
110 Summer Street
Worcester, MA 01610
Telephone: (508) 757-0400

Single $52 Double $58

Days Lodge of Worcester
50 Oriol Drive
Worcester, MA 01610
Telephone: (508) 852-2800

Single $56.88 Double $61.88

Howard Johnson's Motor Lodge
West Boylston Street
West Boylston, MA 01583

Telephone: (508) 835-4456
Single $59.50 Double $71.50

Sheraton-Lincoln Inn
500 Lincoln Street
Worcester, MA 01610
Telephone: (508) 852-4000

Single $85 or $95 poolside
Double $95 or $105 poolside

Worcester Marriott
10 Lincoln Square
Worcester, MA 01610
Telephone: (508) 791-1600
Single $115 Double $127

Yankee Budget Motor Lodge
531 Lincoln Street
Worcester, MA 01610
Telephone: (508) 852-5800

Single $33.73 Double $38.29

Yankee Drummer Inn
624 Southbridge Street
Auburn, MA 01501
Telephone: (508) 832-3221
Single $74.90 Double $79.90

Food Service
A variety of options are available for luncheon in Hogan Center on Saturday and Sunday. A special section will be designated as the dining area for meeting participants, where meal service is cafeteria-style. The most efficient avenue for getting a suitable lunch is a large Burger King adjacent to the Howard Johnson's across from the campus. Information on other campus food service options and restaurants in the Worcester area will be available at the meeting registration desk.

Travel
The Worcester airport is located about five miles from the campus. Airline service to Worcester is provided by Northwest Airlines, Piedmont, Continental Express, and United Express, with direct flights from Baltimore, Washington, Pittsburgh, Newark and New York City. There is an extensive array of connecting airlines directly into the Worcester Airport. Since travel time from Logan International Airport in Boston can involve more than two hours, flying directly into Worcester is recommended if possible.
CAMPUS OF HOLY CROSS COLLEGE

Enter here, gate 7, for field house, Campus Center, Hart Center, Visitors' Parking Area.

Enter here, gate 2, for Administrative and Admissions offices, Visitors' Parking Area.

1. SWORDS HALL
2. HABERLIN HALL
3. VISITORS' PARKING AREA
Meetings

Those participants electing Logan International should make use of the Worcester Limousine Service, which will transport passengers directly to the campus or elsewhere in Worcester. Reservations are necessary and may be obtained by calling (508) 756-4834; at the same time information will be provided concerning passenger pickup at Logan.

Worcester is also served by Peter Pan Bus Lines and AMTRAK rail service. The bus station is about one mile from the campus. Taxi service is available from the bus station to the campus for approximately $5.00.

Participants driving to the meeting should use Auburn Exit No. 10 from the Massachusetts Turnpike, then take Route 290 East to Worcester. The College Square Exit from Route 290 is a block from the campus.

Special Needs

Participants attending the meeting who may have special needs with regard to their talks in terms of audiovisual aids, etc., should contact Leonard Sulski in the Department of Mathematics at College of the Holy Cross either by mail or telephone and be quite specific. Every attempt will be made to meet such requests.

Parking

Free parking is available at several lots located on the College of the Holy Cross Campus. Hogan Lot is the best option.
Program of the Sessions

The time limit for each contributed paper in the sessions is ten minutes. In the special sessions, the time limit varies from session to session and within sessions. To maintain the schedule, time limits will be strictly enforced.

Abstracts of papers presented in the sessions at this meeting will be found in the March 1989 issue of Abstracts of papers presented to the American Mathematical Society, ordered according to the numbers in parentheses following the listings below.

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

---

Saturday, April 15

AMS Session on Graphs, Trees and Groups

8:55 a.m.–10:50 a.m. Room 19, Haberlin Hall

8:55 a.m. On the structure of the strong orientations of a graph.
(1) John Donald and John Elwin*, San Diego State University (848-05-31) (Sponsored by Edgar J. Howard)

9:10 a.m. Construction of self-dual graphs.
(2) Peter R. Christopher* and Brigitte Servatius, Worcester Polytechnic Institute (848-05-73)

9:25 a.m. Three and four-dimensional Catalan numbers.
(3) Stephen Snover* and Stephanie Troyer, University of Hartford (848-05-95)

9:40 a.m. m-Dimensional Catalan numbers.
(4) Stephen Snover and Stephanie Troyer*, University of Hartford (848-05-94)

9:55 a.m. Rigidity trees.
(5) Brigitte Servatius, Worcester Polytechnic Institute (848-05-46)

10:10 a.m. Completely normal lattices. Preliminary report.
(6) Constantine Tsinakis, Vanderbilt University (848-06-75)

10:25 a.m. The Tits conjecture and the five-string braid group.
(7) Carl Droms*, James Madison University, Jacques Lewin, Syracuse University, and Hermann Servatius, College of the Holy Cross (848-20-32)

10:40 a.m. Surface subgroups of infinite Coxeter groups.
(8) Preliminary report.
Carl Droms, James Madison University, Brigitte Servatius, Worcester Polytechnic Institute, and Hermann Servatius*, College of the Holy Cross (848-20-52)

---

AMS Special Session on Infinite-dimensional Symmetries in Mathematics and Physics, I

9:00 a.m.–10:50 a.m. Room 236, Haberlin Hall

9:00 a.m. Multiplicities in the discrete series of the Virasoro algebra.
Alvany Rocha, Bernard M. Baruch College, City University of New York (848-17-53)

9:30 a.m. The KP deformations of vector bundles over an elliptic curve. Preliminary report.
Emma Previalo*, Boston University, and George Wilson, Imperial College, London (848-14-38)

10:00 a.m. A correspondence between an infinite Grassmannian and arbitrary vector bundles on algebraic curves.
Motohico Mulase, Temple University and Institute for Advanced Study (848-58-10)

10:30 a.m. Catastrophes, conformal theories and Calabi-Yau manifolds.
Cumrun Vafa, Harvard University (848-81-84)
(Sponsored by James I. Lepowsky)

---

AMS Special Session on Gauge Theory and Differential Geometry, I

9:00 a.m.–10:50 a.m. Room 328, Swords Hall

9:00 a.m. Constructing the Floer cycles.
(13) Cliff Taubes, Harvard University (848-53-67)
(Sponsored by Thomas H. Parker)

9:30 a.m. Vortices on Kähler manifolds.
(14) Steven Bradlow, Stanford University (848-53-17)

10:00 a.m. Instantons and the geometry of the nilpotent variety.
(15) Peter Kronheimer, Institute for Advanced Study (848-53-20)

10:30 a.m. Converging Ricci flow for metrics with indefinite curvature in arbitrary dimensions.
James Isenberg, University of California at San Diego, La Jolla, and University of Oregon (848-53-15)
### Saturday, April 15 (cont'd)

#### AMS Special Session on L-functions and Arithmetic, I

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker(s)</th>
<th>Institution(s)</th>
<th>Phone(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 a.m.</td>
<td>A formal Mellin transformation in the arithmetic of function fields.</td>
<td>David Goss</td>
<td>University of Maryland, Baltimore County (848-14-23)</td>
<td></td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>Representations of the Weil group.</td>
<td>George Zettler&lt;sup&gt;*&lt;/sup&gt;, Don M. Blasius</td>
<td>Columbia University, Los Angeles University of California, Los Angeles (848-11-96) (Sponsored by Karl Rubin)</td>
<td></td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>Arithmetic ampleness.</td>
<td>Christophe Soulé</td>
<td>Centre National de la Recherche Scientifique and Harvard University (848-11-65) (Sponsored by Glenn Howard Stevens)</td>
<td></td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Modular caps, totally real fields, and periods of Eisenstein series</td>
<td>Glenn Stevens</td>
<td>Boston University                     (848-11-66)</td>
<td></td>
</tr>
</tbody>
</table>

#### AMS Special Session on Operator Algebras, Galois Theory and Representations, I

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker(s)</th>
<th>Institution(s)</th>
<th>Phone(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:30 a.m.</td>
<td>Noncommutative toroidal orbifolds.</td>
<td>Ola Bratteli, George A. Elliott&lt;sup&gt;*&lt;/sup&gt;, David E. Evans, Akitaka Kishimoto</td>
<td>University of Trondheim, Norway, University of Toronto, University College of Swansea, Tōhoku University, Japan (848-46-49)</td>
<td></td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>Representations of projections.</td>
<td>Man-Duen Choi</td>
<td>University of Toronto                (848-47-50)</td>
<td></td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Symmetries of the CAR algebra.</td>
<td>Bruce Blackadar</td>
<td>University of Nevada, Reno             (848-46-87)</td>
<td></td>
</tr>
</tbody>
</table>

#### AMS Special Session on Knot Theory and Algebraic Geometry in the Large, I

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker(s)</th>
<th>Institution(s)</th>
<th>Phone(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00 a.m.</td>
<td>The equisymmetric stratification of the moduli space.</td>
<td>S. Allen Broughton</td>
<td>Cleveland State University             (848-14-54)</td>
<td></td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Homology of Abelian covers.</td>
<td>A. Libgober</td>
<td>University of Illinois, Chicago        (848-99-98)</td>
<td></td>
</tr>
</tbody>
</table>

### AMS Invited Address

- **11:00 a.m.-12:00 noon**
  - Room 103, Haberlin Hall
  - The structures of symmetries of quantum space.
  - Adrian Ocneanu, Pennsylvania State University, University Park (848-99-92)

#### AMS Special Session on Infinite-dimensional Symmetries in Mathematics and Physics, II

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker(s)</th>
<th>Institution(s)</th>
<th>Phone(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:45 p.m.</td>
<td>Representation theory and the Schubert calculus.</td>
<td>Dale H. Peterson</td>
<td>University of British Columbia (848-22-88)</td>
<td></td>
</tr>
<tr>
<td>3:15 p.m.</td>
<td>Vertex operators and integral bases of affine Lie algebras.</td>
<td>Shari Prevost</td>
<td>Rutgers University, New Brunswick (848-17-32)</td>
<td></td>
</tr>
<tr>
<td>4:15 p.m.</td>
<td>Vertex operator relations for affine Lie algebras.</td>
<td>Stefano Capparelli</td>
<td>Yale University (848-17-57)</td>
<td></td>
</tr>
</tbody>
</table>

#### AMS Special Session on Gauge Theory and Differential Geometry, II

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker(s)</th>
<th>Institution(s)</th>
<th>Phone(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:45 p.m.</td>
<td>On the existence of hyperbolic monopoles.</td>
<td>L. M. Sibner&lt;sup&gt;*&lt;/sup&gt;, Karen Uhlenbeck</td>
<td>Brooklyn College, City University of New York, University of Texas (848-53-79)</td>
<td></td>
</tr>
<tr>
<td>3:15 p.m.</td>
<td>The geometry of magnetic monopoles.</td>
<td>Peter J. Braam</td>
<td>University of Utah and Merton College, England (848-53-22)</td>
<td></td>
</tr>
<tr>
<td>3:45 p.m.</td>
<td>Torsion constraints in supergeometry.</td>
<td>John Lott</td>
<td>University of Michigan, Ann Arbor      (848-53-19)</td>
<td></td>
</tr>
</tbody>
</table>
Program of the Sessions

AMS Session on Geometry, Topology and Applied Mathematics

2:45 p.m.–5:10 p.m. Room 19, Haberlin Hall

2:45 p.m. A note on \( \kappa \)-uniform rotundity.
(47) Srinivasa Swaminathan, Dalhousie University (848-46-43)

3:00 p.m. Interior hull inequalities for lattice polygons.
(48) Stanley Rabinowitz, Westford, Massachusetts (848-52-74)

3:15 p.m. Invariant affine connections on symmetric spaces.
(49) H. Turner Laquer, Case Western Reserve University (848-53-53)

3:30 p.m. Complete stable minimal surfaces in \( \mathbb{R}^3 \).
(50) Marty Ross, Stanford University (848-53-09)

3:45 p.m. Comparison of the handle and tunnel numbers of classical knots. Preliminary report.
(51) John Erbland, University of Hartford (848-57-45)

4:00 p.m. The interbubble medium: Inflationary IBM. Preliminary report.
(52) Stephen L. Weinberg, Berkeley Academy of Artscience, Berkeley, California (848-85-06)

4:15 p.m. The force field holor.
(53) Shama Y. Uma, Bridgewater State College, and Domina Eberle Spencer*, University of Connecticut, Storrs (848-78-13)

4:30 p.m. Electromagnetic field holors.
(54) Shama Y. Uma*, Bridgewater State College, and Domina Eberle Spencer, University of Connecticut, Storrs (848-78-12)

4:45 p.m. A theory of duality in mathematical programming.
(55) Andrzej Wieczorek, Polish Academy of Sciences, Warsaw (848-50-07)

5:00 p.m. Computing characteristic classes of continuous lattice gauge fields.
A. V. Phillips, State University of New York, Stony Brook, and David A. Stone*, City College, City University of New York (848-81-44)

AMS Special Session on Operator Algebras, Galois Theory and Representations, II

3:15 p.m.–4:35 p.m. Room 238, Haberlin Hall

3:15 p.m. Continuous semigroups of *-endomorphisms of \( B(H) \).
(57) Robert Powers, University of Pennsylvania (848-46-28)

3:45 p.m. The \( C^* \)-algebras generated by pairs of semigroups of isometries satisfying certain commutation relations.
(58) Geoffrey Price, United States Naval Academy (848-46-81)

4:15 p.m. Index theory for pairs of factors of infinite index.
(59) Richard Herman* and Adrian Ocneanu, Pennsylvania State University, University Park (848-46-85)

AMS Special Session on Knot Theory and Algebraic Geometry in the Large, II

2:45 p.m.–5:05 p.m. Room 359, Swords Hall

2:45 p.m. Higher codimensional algebraic knots. Preliminary report.
(43) Alan H. Durfee, Mount Holyoke College (848-57-26)

3:15 p.m. Complex algebraic plane curves via their links at infinity.
(44) Walter D. Neumann, Ohio State University, Columbus (848-57-34)

3:45 p.m. A congruence between link polynomials.
(45) Lee Rudolph, Clark University (848-57-30)

4:15 p.m. The fundamental group of the complement of an algebraic curve.
(46) Stepan Yu Orevkov, Moscow, USSR (848-14-51) (Sponsored by Lee N. Rudolph)

4:45 p.m. Discussion

AMS Special Session on L-functions and Arithmetic, II

2:45 p.m.–5:05 p.m. Room 414, Haberlin Hall

2:45 p.m. L-functions of universal elliptic curves over Igusa curves.
(38) Douglas L. Ulmer, Massachusetts Institute of Technology (848-11-24)

3:15 p.m. Trilinear forms and local \( \epsilon \)-factors for \( GL_2 \).
(39) Dipendra Prasad, Harvard University (848-11-42)

3:45 p.m. Averages of L-functions and their derivatives.
(40) V. Kumar Murty*, McGill University (848-11-72) (Sponsored by Glenn Howard Stevens)

4:15 p.m. The formal group of the Jacobian of an algebraic curve.
(41) Margaret N. Freije, College of the Holy Cross (848-11-70)

4:45 p.m. Modular quaternionic L-value congruences.
(42) Ted Chinburg, Columbia University (848-11-08)

AMS Special Session on Geometry, Topology and Applied Mathematics

2:45 p.m.–5:10 p.m. Room 19, Haberlin Hall

2:45 p.m. A note on \( \kappa \)-uniform rotundity.
(47) Srinivasa Swaminathan, Dalhousie University (848-46-43)

3:00 p.m. Interior hull inequalities for lattice polygons.
(48) Stanley Rabinowitz, Westford, Massachusetts (848-52-74)

3:15 p.m. Invariant affine connections on symmetric spaces.
(49) H. Turner Laquer, Case Western Reserve University (848-53-53)

3:30 p.m. Complete stable minimal surfaces in \( \mathbb{R}^3 \).
(50) Marty Ross, Stanford University (848-53-09)

3:45 p.m. Comparison of the handle and tunnel numbers of classical knots. Preliminary report.
(51) John Erbland, University of Hartford (848-57-45)

4:00 p.m. The interbubble medium: Inflationary IBM. Preliminary report.
(52) Stephen L. Weinberg, Berkeley Academy of Artscience, Berkeley, California (848-85-06)

4:15 p.m. The force field holor.
(53) Shama Y. Uma, Bridgewater State College, and Domina Eberle Spencer*, University of Connecticut, Storrs (848-78-13)

4:30 p.m. Electromagnetic field holors.
(54) Shama Y. Uma*, Bridgewater State College, and Domina Eberle Spencer, University of Connecticut, Storrs (848-78-12)

4:45 p.m. A theory of duality in mathematical programming.
(55) Andrzej Wieczorek, Polish Academy of Sciences, Warsaw (848-50-07)

5:00 p.m. Computing characteristic classes of continuous lattice gauge fields.
A. V. Phillips, State University of New York, Stony Brook, and David A. Stone*, City College, City University of New York (848-81-44)
Program of the Sessions

Saturday, April 15  (cont’d)

AMS Council

7:00 p.m.–10:00 p.m.  Sturbridge A & B, Howard Johnson’s Motor Lodge

AMS Special Session on Operator Algebras, Galois Theory and Representations, III

8:30 a.m.–10:50 a.m.  Room 238, Haberlin Hall

8:30 a.m.  Applications of equivariant Kasparov theory.
           Preliminary report.
           Peter Haskell, Virginia Polytechnic Institute and State University (848-46-41)

9:00 a.m.  de Rham cohomology for discrete groups.
           Paul Baum*, Pennsylvania State University, University Park, and Alain Connes, College of France, Paris (848-46-88)

9:30 a.m.  Comparison of (negative) algebraic and topological K-theory for C* algebras.
           Ronald Douglas, State University of New York, Stony Brook (848-58-56)

10:00 a.m. Transverse cyclic cocycles via elliptic renormalization.
           Jerry Kaminker, Indiana University-Purdue University, Indianapolis (848-46-86)

AMS Special Session on Infinite-dimensional Symmetries in Mathematics and Physics, III

8:30 a.m.–10:50 a.m.  Room 236, Haberlin Hall

8:30 a.m.  Higher-order Sugawara operators for affine Lie algebras.
           Roe Goodman* and Nolan R. Wallach, Rutgers University, New Brunswick (848-22-48)

9:00 a.m.  Bernstein-Gelfand-Gelfand resolution for arbitrary Kac-Moody algebras.
           Shrawan Kumar, Institute for Advanced Study (848-22-61) (Sponsored by James I. Lepowsky)

9:30 a.m.  Vertex operators, symmetric polynomials and symmetric groups.
           Naihuan Jing, Yale University (848-17-37)

10:00 a.m. Z2-orbifold theory.
           Yi-Zhi Huang, Rutgers University, New Brunswick (848-17-59)

10:30 a.m. Duality, crossing and Mac Lane’s coherence.
           Ram Brustein, Yuval Neeman, Tel Aviv University, Israel, and Shlomo Sternberg*, Tel Aviv University, Israel and Harvard University (848-18-64)
           (Sponsored by James I. Lepowsky)

AMS Special Session on L-functions and Arithmetic, III

8:30 a.m.–10:50 a.m.  Room 414, Haberlin Hall

8:30 a.m.  Cohomology of GL(n, Z). Preliminary report.
           Avner Ash, Ohio State University, Columbus (848-11-05)

9:00 a.m.  Relations among L-functions attached to algebraic varieties. Preliminary report.
           Michael Rosen, Brown University (848-11-71)

9:30 a.m.  The Markov equation X^2 + Y^2 + Z^2 = 3XYZ over quadratic imaginary fields. Preliminary report.
           Joseph H. Silverman, Brown University (848-11-04)

10:00 a.m. Vanishing and nonvanishing of certain L-functions.
           Preliminary report.
           David Rohrlich, Rutgers University, New Brunswick (848-11-55)

10:30 a.m. Mock Heegner points and congruent numbers.
           Paul Monsky, Brandeis University (848-11-25)

AMS Session on Analysis

8:40 a.m.–10:50 a.m.  Room 19, Haberlin Hall

8:40 a.m.  On B2 sequences.
           John C. M. Nash, Marshall University (848-11-58)

8:55 a.m.  L-functions and differential equations. Preliminary report.
           Peter F. Stiller, Institute for Advanced Study (848-14-33)

9:10 a.m.  Compact subgroups and compactly generated subgroups of topological groups.
           R. W. Bagley*, T. S. Wu and J. S. Yang, University of Miami (848-22-02)

9:25 a.m.  Properties of power-series coefficients of H^2[I_1] functions.
           Charles Slavin, University of Maine, Orono (848-30-11)

9:40 a.m.  Positive almost periodic solutions of some delay integral equations.
           A. M. Fink* and J. A. Gatica, University of Iowa (848-34-03)

9:55 a.m.  On some inequalities for polynomials.
           Narendra K. Govil, Auburn University, Auburn (848-41-36)

10:10 a.m. On equations in Banach spaces involving composition products of set-valued mappings.
           Frank U. Williamson, Jr., Vitry sur Seine, France (848-93-01)
### Program of the Sessions

#### AMS Invited Address

**1:30 p.m.–2:30 p.m.**

Room 103, Haberlin Hall

(92) The arithmetic of elliptic curves.

Karl Rubin, Columbia University (848-11-90)

### AMS Special Session on Infinite-dimensional Symmetries in Mathematics and Physics, IV

**2:45 p.m.–4:35 p.m.**

Room 236, Haberlin Hall

2:45 p.m. Einstein's equations and representation theory.

(93) Bertram Kostant, Massachusetts Institute of Technology (848-22-83)

3:15 p.m. A Jacobi identity for relative twisted vertex operators.

(94) Chongying Dong* and James Lepowsky, Rutgers University, New Brunswick (848-17-58)

3:45 p.m. Relative $\mathbb{Z}_2$-twisted vertex operators and standard $sl(2)$-modules.

Cristiano Husu, Rutgers University, New Brunswick (848-17-60)

4:15 p.m. String path integral realization of vertex operator algebras.

Haruo Tsukada, University of California at San Diego, La Jolla (848-22-97)

### AMS Special Session on Knot Theory and Algebraic Geometry in the Large, III

**2:45 p.m.–4:05 p.m.**

2:45 p.m. Discussion

Room 414, Haberlin Hall

W. Wistar Comfort

Associate Secretary

Middletown, Connecticut

### AMS Special Session on Gauge Theory and Differential Geometry, IV

**2:45 p.m.–4:05 p.m.**

Room 328, Swords Hall

2:45 p.m. Smooth 2-spheres in indefinite 4-manifolds.

(97) Daniel Ruberman, Brandeis University (848-57-78)

3:10 p.m. Applications of fixed point varieties of unipotent transformations to the space of SU(n)-instantons on the four-sphere. Preliminary report.

Martin A. Guest, University of Rochester (848-81-35)

3:45 p.m. Discussion

### AMS Invited Address

**11:00 a.m.–12:00 noon**

Room 103, Haberlin Hall

(91) Vertex operator algebras and quantum groups.

Igor B. Frenkel, Yale University (848-99-93)
Presenters of Papers

Numbers following the names indicate the speakers' positions on the program.

- AMS Invited Lecturer
- AMS Special Session Speaker

<table>
<thead>
<tr>
<th>Names</th>
<th>Positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash, A., Bagley, R. W.,</td>
<td>70, 77</td>
</tr>
<tr>
<td>Baum, P., Blackadar, B.</td>
<td>61, 23</td>
</tr>
<tr>
<td>Braam, P. J., Bradlow, S.</td>
<td>34, 14</td>
</tr>
<tr>
<td>Broughton, S. A., Buchdahl, N.</td>
<td>42, 37</td>
</tr>
<tr>
<td>Capparelli, S., Chiriburt, T.</td>
<td>32, 42</td>
</tr>
<tr>
<td>Blackadar, B., Braam, P. J.,</td>
<td>23, 34</td>
</tr>
<tr>
<td>Bradlow, S., Bragg, S. A.</td>
<td>14, 24</td>
</tr>
<tr>
<td>Buchdahl, N., Capparelli, S.</td>
<td>37, 32</td>
</tr>
<tr>
<td>Blackadar, B., Braam, P. J.,</td>
<td>23, 34</td>
</tr>
<tr>
<td>Bradlow, S., Broughton, S. A.</td>
<td>14, 24</td>
</tr>
<tr>
<td>Buchdahl, N., Capparelli, S.</td>
<td>37, 32</td>
</tr>
<tr>
<td>Blackadar, B., Braam, P. J.,</td>
<td>23, 34</td>
</tr>
<tr>
<td>Bradlow, S., Broughton, S. A.</td>
<td>14, 24</td>
</tr>
<tr>
<td>Buchdahl, N., Capparelli, S.</td>
<td>37, 32</td>
</tr>
<tr>
<td>Blackadar, B., Braam, P. J.,</td>
<td>23, 34</td>
</tr>
<tr>
<td>Bradlow, S., Broughton, S. A.</td>
<td>14, 24</td>
</tr>
<tr>
<td>Buchdahl, N., Capparelli, S.</td>
<td>37, 32</td>
</tr>
</tbody>
</table>
The eight-hundred-and-forty-ninth meeting of the American Mathematical Society will be held on the Lake Shore Campus of Loyola University of Chicago on Friday, May 19, and Saturday, May 20, 1989. All special sessions and sessions for contributed papers will be held in Damen Hall and all invited addresses in the auditorium of Flanner Hall.

**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 the titles of their talks are:

- **HENRI GILLET**, University of Illinois at Chicago, *Analogies between number fields and function fields*
- **NICHOLAS LERNER**, Purdue University, *Microlocal analysis and applications*
- **RICHARD ROCHEBERG**, Washington University, *Estimates for singular numbers of integral operators*
- **SHMUEL WEINBERGER**, University of Chicago, *Flexibility and rigidity of stratified spaces*

**Special Sessions**

By invitation of the same committee, there will be thirteen special sessions of selected twenty-minute papers. The topics, names and affiliations of the organizers, are as follows:

- **Noncommutative ring theory**, JEFFREY BERGEN, DePaul University
- **Sequence spaces and summability**, MARTIN BUNTINAS, Loyola University and BILLY RHOADES, Indiana University
- **Geometric topology**, TIM D. COCHRAN, Northwestern University
- **Numerical methods in harmonic analysis**, JONATHAN COHEN, DePaul University
- **Kazhdan-Lusztig theory and related topics**, VINAY DEODHAR, Indiana University
- **Algebraic groups and related topics**, STEPHEN DOTY, Loyola University of Chicago
- **Arithmetic geometry and intersection theory**, HENRI GILLET
- **Recursion theory**, CHRISTINE HAUGHT, University of Chicago
- **Codes and designs**, NEAL BRAND, North Texas State University, and CARY HUFFMAN, Loyola University of Chicago
- **Algebraic topology and varieties**, RONNIE LEE, Yale University, and STEVEN WEINTRAUB, Louisiana State University
- **Partial differential equations**, NICHOLAS LERNER
- **Quadratic forms and real algebraic geometry**, COLM MULCAHY, Spelman College, VICTORIA POWERS, Emory University
- **Nonlinear analysis and its applications**, S. P. SINGH, Memorial University of Newfoundland

**Contributed Papers**

There will also be sessions for contributed ten-minute papers. Late papers will not be accommodated.

**Registration**

The meeting registration desk will be located in room 147 of Damen Hall and will be open from 8:00 a.m. to 5:00 p.m. on Friday, May 19, and 8:00 a.m. to noon on Saturday, May 20. 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 Phoenix meeting announcement on page 1502 of the December 1988 issue of Notices.

**Accommodations**

Blocks of rooms are being held in Mertz Hall on the Lake Shore Campus. This air conditioned facility is adjacent...
to a campus parking lot, cafeteria, and athletic facilities. It is a three-minute walk to Damen and Flanders Halls. Participants should make reservations by calling 312-508-3300, and should indicate that they are attending the AMS meeting. After May 1, 1989, reservations will be accepted on a space available basis. Families are welcome in Mertz Hall, and arrangements can be made to stay longer than the time of the conference. The rates are $32 for single occupancy and $22 per person double occupancy.

For participants staying on campus, housing registration and check-in will be in the Front Desk Lobby on the second floor of Mertz Hall. The Front Desk is open daily from 7:00 a.m. until midnight. If the Front Desk is not open, please refer to the Conference Staff Duty Roster that is posted at the Front Desk for the extension of the staff member on duty. Dial the four digit extension on the beige house phone located around the corner from the Front Desk and the person on duty will come to the Front Desk.

Although rooms have not been blocked at either of the following locations, they are included for information. Rates are subject to change. Both are approximately 20 minutes by car and 30 minutes by public transportation from Loyola.

**Holiday Inn, Evanston**
1501 Sherman Ave.
Evanston, IL 60201
Telephone: (312) 491-6400

- Single $70  
- Double $78

**Orrington Hotel**
1710 Orrington Ave.
Evanston, IL 60202
Telephone: (312) 866-8700

- Single $90  
- Double $100

**Food Service**
The campus food service is located on the second floor of Centennial Forum, across the patio from Mertz Hall. A daily meal pass costing $10 can be purchased at the housing registration desk (second floor, Mertz Hall). Present this pass or pay the appropriate price to gain entry into any meal. Among the features offered by the food service are a variety of cereals, a salad bar with a multitude of fresh fixings, a daily soup bar, menu variety for both meat eaters and vegetarians, a selection of ice cream, a large array of beverages, and unlimited seconds.

There are several restaurants and fast food establishments within walking distance or a short drive. A list of these will be available at the meeting registration desk in Damen Hall 147.

**Travel**
To reach Loyola University's Lake Shore Campus at 6525 North Sheridan Road, corner of Sheridan Road on Loyola Avenue:

**FROM MIDWAY AIRPORT:** Take the Continental Airport bus to the Park Hyatt Hotel on Chicago Avenue. Walk two blocks west on Chicago Avenue to the State Street subway and take the Howard line north to Loyola Avenue. Or, take the Outer Drive Express bus (CTA #147), or the Sheridan Howard Terminal bus (CTA #151), north to Sheridan and Devon (catch this bus on the north-east corner of Water Tower Place). By taxi it is fifty-six blocks north.

**FROM O'HARE FIELD:** Take the Continental Airport bus to the Park Hyatt Hotel on Chicago Avenue. Walk two blocks west on Chicago Avenue to the State Street subway and take the Howard line north to Loyola Avenue. Or, take the Outer Drive Express bus (CTA #147), or the Sheridan Howard Terminal bus (CTA #151), north to Sheridan and Devon (catch this bus on the north-east corner of Water Tower Place). By taxi it is fifty-six blocks north.

Alternately, take the airport bus to the Holiday Inn in Evanston and a taxi to Loyola. This would be a shorter ride. Or, take the O'Hare/Congress or O'Hare/Douglas subway (located under the O'Hare Hilton) downtown to Washington Street. Get off at Washington and take the stairs down to the tunnel and walk across to the State Street subway and take the Howard Line north (A or B train) to Loyola Avenue.

**FROM THE GREYHOUND OR TRAILWAYS BUS STATION:** From the Greyhound Station walk east on Randolph to State Street (two blocks) and take the Howard Line subway north to Loyola Avenue Station.

From the Trailways Station walk west on Randolph to State Street and take the Howard Line subway north to Loyola Avenue Station.

**FROM UNION STATION (AMTRAK):** Take the Sheridan/Devon (CTA #151) to State Street, then take the Howard Line subway north to Loyola Avenue Station.

**FROM THE ILLINOIS CENTRAL STATION (SOUTH SHORE):** Take the Outer Drive Express bus (CTA #147) at Michigan Avenue north to Loyola Avenue, or walk west to State Street and take the Howard Line subway north to Loyola Avenue Station.

**BY AUTOMOBILE:** If arriving from the south, east, or west by Interstates 55, 57, 90, or 94, take an exit to Lake Shore Drive north to its limit. Turn north on Sheridan Road and take it to Loyola.

If arriving on Interstate 94 from the north, take Touhy Avenue eastbound to its limit at Sheridan Road South. Take a right on to Sheridan Road. Loyola is on the left approximately 8 or 9 blocks south.
Meetings

If arriving on Interstate 194 or 294 from the north or northwest, take Foster Avenue east to Broadway or Sheridan, then north to Loyola.

Parking

Parking is available in the parking lot south of Mertz Hall. The fee is 50 cents. To park in the lot overnight, please obtain a parking sticker at the housing desk.

Athletic Facilities

All meeting participants will be given complimentary access to the new George Halas Jr., Sports Center on Loyola’s campus. This facility has an olympic-size swimming pool, six racketball/handball courts, weight rooms with free-weight and Nautilus equipment, two aerobic dance rooms, three full length basketball courts, and an indoor track (an outdoor track is also available).

Weather

The average high temperature in Chicago in May is 70° F and the average low is 48° F. Because the university is located on the shore of Lake Michigan, it may be slightly cooler during the daytime. The average rainfall for the month is 3.15 inches.

Andy Roy Magid
Associate Secretary
Norman, Oklahoma

A Century of Mathematics in America — Part I

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.

1980 Mathematics Subject Classification: 01
ISBN 0-8218-0124-4, LC 88-22155
ISSN 0899-2428
486 pages (hardcover), August 1988
List price $57, Institutional member $46,
Individual member $34
To order, please specify HMATH/1NA

Shipping/Handling: 1st book $2, each add $1, $25 max. By air, 1st book $5, each add $3, $100 max. Prepayment required. Order from AMS, P. O. Box 1571, Annex Station, Providence, RI 02901-1571, or call 800-556-7774 to use VISA or MasterCard.

MARCH 1989, VOLUME 36, NUMBER 3

293
# 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.

### Chicago, May 1989
- Henri Gillet
- Richard Rochberg
- Shmuel Weinberger

### Boulder, August 1989
- Maury D. Bramson
  - (Progress in Mathematics Lecture)
- Haim Brezis
  - (Progress in Mathematics Lecture)
- John Conway (AMS-MAA)
- Persi Diaconis
  - (Hedrick Lecture)
- Joseph A. Gallian
  - (AMS-MAA-PME)
- Shizuo Kakutani
  - (AMS-MAA)
- Serge Lang (AMS-MAA)
- Howard A. Masur
- Dusa McDuff
- Jean Taylor (AMS-MAA)
- William Thurston
  - (Colloquium Lecture)

### Hoboken, October 1989
- Russel Caflisch
- Fang Hua Lin
  - (Sequence spaces and summability)

### Muncie, October 1989
- Laszlo Lempert
- Kenneth Meyer

### Louisville, January 1990
- Sun-Yung Alice Chang
- George B. Dantzig
  - (Gibbs Lecture)
- Shlomo Sternberg
  - (Colloquium Lecture)

## 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.

### May 1989 Meeting in Chicago
- Central Section
  - Associate Secretary: Andy Roy Magid
  - Deadline for organizers: Expired
  - Deadline for consideration: Expired
- Jeffrey Bergen, *Noncommutative ring theory*
- Martin Buntinas and Billy Rhoades, *Sequence spaces and summability*
- Tim D. Cochran, *Geometric topology*
- Jonathan Cohen, *Numerical methods in harmonic analysis*
- Vinay Deodhar, *Kazhdan-Lusztig theory and related topics*
- Stephen Doty, *Algebraic groups and related topics*
- Henri Gillett, *Arithmetic geometry and intersection theory*
- Christine Haught, *Recursion theory*
- Cary Huffman and Neal Brand, *Codes and designs*
- Ronnie Lee and Steven Weintraub, *Algebraic topology of varieties*
- Nicholas Lerner, *Partial differential equations*
- Colm Mulcahy and Victoria Powers, *Quadratic forms and real algebraic geometry*
- S. P. Singh, *Nonlinear analysis and its applications*

### August 1989 Meeting in Boulder
- Associate Secretary: Andy Roy Magid
  - Deadline for organizers: Expired
  - Deadline for consideration: April 25, 1989
- Richard A. Askey, *History of orthogonal polynomials*
- Maury D. Bramson and David S. Griffeath, *Complex random phenomena*
- George J. Fix and Rangabhary Kannan, *Mathematical questions in computational geometry*
- Kirk E. Lancaster and Edward W. Stredulinsky, *Free boundary problems and partial differential equations*
Invited Speakers and Special Sessions

Howard A. Masur and John Smillie, Dynamics and moduli space
Kevin S. McCurley, Computational number theory and applications

October 1989 Meeting in Hoboken
Eastern Section
Associate Secretary: W. Wistar Comfort
Deadline for organizers: Expired
Deadline for consideration: July 26, 1989
Prabir Bhattacharya and Robert A. Melter, Geometry related to computer vision
Stephen Bloom, Algebraic semantics
Mark Feighn, Lee Mosher and Ulrich Oertel, Low-dimensional topology
Bruce P. Kitchens and Sheldon Newhouse, TBA
Richard Lyons and Richard O'Nan, Finite groups
Charles Sims, Computational algebra
Marvin D. Tretkoff, Algebraic geometry, p-adic aspects

October 1989 Meeting in Muncie
Central Section
Associate Secretary: Andy Roy Magid
Deadline for organizers: Expired
Deadline for consideration: July 26, 1989
Alan Adolphson and Steven Sperber, Number theory and algebraic geometry
David Bennett and Laszlo Lempert, Complex analysis
Ananda Gubbi, Extremally disconnected spaces and their applications
David Larson, Triangular operator algebras
Kathryn Porter, Functions spaces and topology
T. K. Puttaswamy, Differential equations

November 1989 Meeting in Los Angeles
Far Western Section
Associate Secretary: Lance W. Small
Deadline for organizers: Expired
Deadline for consideration: July 26, 1989

January 1990 Meeting in Louisville
Associate Secretary: Joseph A. Cima
Deadline for organizers: March 22, 1989
Deadline for consideration: September 28, 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 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 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
Joseph A. Cima, Associate Secretary
Department of Mathematics
University of North Carolina, Chapel Hill
Chapel Hill, NC 27599 – 3902
(Telephone 919 – 962 – 1050)

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.

Number of Papers Presented
Joint Authorship
Although an individual may present only one ten-minute contributed paper at a meeting, any combination of joint authorship may be accepted, provided no individual speaks more than once. An author can speak by invitation in more than one Special Session at the same meeting.

An individual may contribute only one abstract by title in any one issue of Abstracts, but joint authors are treated as a separate category. Thus, in addition to abstracts from two individual authors, one joint abstract by them may also be accepted for an issue.
Symposium on Complex Geometry and Lie Theory
Sundance, Utah
May 26–May 29, 1989

With the support from the National Science Foundation, Duke University, and the University of Utah, a symposium on Complex Geometry and Lie Theory will take place Friday through Monday, May 26-29, 1989 at the Sundance Center, Sundance, Utah.

The topic was selected by the AMS Committee on Summer Institutes and Special Symposia whose members at the time of selection were: Eric M. Friedlander, Steven L. Kleiman, Paul H. Rabinowitz, Thomas C. Spencer, Robert B. Warfield, Jr., and John Wermer.

Proceedings will be published by the American Mathematical Society.

The Organizing Committee for the symposium includes James A. Carlson, University of Utah (co-chair); C. Herbert Clemens, University of Utah (co-chair); and David Morrison, Duke University.

This symposium will review the interaction of the two fields of complex geometry and Lie theory, with concentration on the interaction related to Hodge theory. Speakers will also present current work and discuss possible future directions.

The list of invited speakers includes Enrico Arbarello, University of Rome, Italy; Robert Bryant, Duke University; James Carlson, University of Utah; Eduardo Cattani, University of Massachusetts, Amherst; C. Herbert Clemens, University of Utah; Maurizio Cornalba, University di Pavia, Italy; Robert Friedman, Columbia University; Phillip Griffiths, Duke University; Mark Green, University of California, Los Angeles; Richard Hain, University of Washington; Joseph Harris, Harvard University; Aroldo Kaplan, University of Massachusetts, Amherst; Janos Kollar, University of Utah; Robert MacPherson, Massachusetts Institute of Technology; John Morgan, Columbia University; David Morrison, Duke University; Chris Peters, University of Leiden, The Netherlands; Morihiko Saito, RIMS Kyoto; Wilfried Schmid, Harvard University; Carlos Simpson, Princeton University; Andrew Sommese, Notre Dame University; Joseph Steenbrink, University of Nijmegen, The Netherlands; Stephen Zucker, Johns Hopkins University.

Registration

The symposium registration desk will be located in the Cottage Reception Center. The desk will be staffed from 2:00 p.m. until 7:00 p.m. on Thursday, from 7:00 a.m. until 4:30 p.m. Friday through Sunday, and from 7:00 a.m until 11:00 a.m. on Monday. Participants opting for the meal plan should check in at the symposium desk in order to obtain a meal card. There is a restaurant to serve participants not on the meal plan.

Registration Fees

All participants including speakers and committee members are required to pay a $25 social fee and a $15 registration fee. The social fee will cover the cost of refreshments served at breaks and evening refreshments. These fees cannot be prorated for those participants choosing not to attend the full period of the symposium. Cash, travelers' checks, and personal checks will be accepted; credit cards cannot be accepted.

Accommodations

The accommodations are a collection of privately owned homes scattered among the aspen and pine. They range from the rustic charm of log homes to contemporary architecture. Individual needs can be met with single accommodations to large Inns holding up to twelve people. All units are equipped with kitchen and bathroom units. Many units also have fireplaces and jacuzzi spas.

Two types of accommodations are available. The first, referred to as cottages, are units consisting of two-bedroom and three-bedroom complexes, all with kitchensettes, living rooms, and private bathrooms. The bedding configuration varies greatly from one twin bed to two queen-sized beds per room.

The second type of accommodations are private homes, referred to as cabins, along the mountainside of Mt. Timpanagos. These cabins range in size from two-bedroom to seven-bedroom homes. All cabins
have at least two full baths, several parlors, full kitchens, and many have at least one jacuzzi spa. The bedding configuration in these cabins is more varied than the cottages, with one king or queen-sized bed to four assorted sized beds per room.

Participants with special dietary needs are encouraged to bring any special foods required and are free to make use of the kitchen facilities in any of the accommodations. Utensils are supplied in kitchen areas.

Participants desiring accommodations at the resort cannot be guaranteed the preferred type of housing due to the unique configurations of the bedroom areas offered. Final housing assignments are responsibility of the Organizing Committee.

A housing form for participants to use to reserve accommodations can be found at the back of this issue. **Deadline for receipt of this form is April 7, 1989.**

**Check-In Locations and Times**
The residence check-in desk will be located at the Cottage Reception Center. The desk is open on a 24-hour basis. Participants opting for the meal plan should refer to the schedule listed in the Registration section of this announcement.

**Room and Board Rates**
Due to the limited nature of dining facilities and the isolated location of the Sundance Resort a complete meal plan is being offered to participants beginning with dinner on Thursday evening, May 25 from 7:00-9:00 p.m., and ending with a continental breakfast on Tuesday morning, May 30. The cost for the meal plan is $225.00.

- Single occupancy: $60.00
- Double occupancy: $30.00

**Travel**
The Salt Lake City International Airport has service from all parts of the country, and the major carrier is Delta Airlines. The distance to the Sundance Resort is 50 miles and approximately a one-hour drive by car.

Limousine service directly to the resort is provided by Key Limo Transportation at a cost of approximately $40 round trip. A shuttle service will also be available to participants for travel to and from the Salt Lake City area and the resort. A schedule for this service will appear in the April issue of Notices.

**Social Event**
A professionally organized two day river trip on the Colorado River is planned following the symposium. The trip does not require river skills, and the total cost including all food, and transportation to and from Sundance and the Salt Lake City airport is $235. Individuals who do not have the necessary camping gear such as sleeping bags and parkas will be charged an additional $30 rental fee.

The bus taking participants to the embarkation point on the Colorado River will leave Sundance at 6:00 a.m. on Tuesday morning, May 30, arriving at the starting point by 2:00 p.m. that afternoon. Return service is on Wednesday afternoon at approximately 2:00 p.m., at which time participants will be bussed back to Salt Lake City by early evening. At present there are only 35 openings and reservations can be made by contacting Herb Clemens, Mathematics Department, University of Utah, Salt Lake City, UT 84112. The telephone number is 801-581-5275. Reservations can also be made by contacting Barbara Smoot at 801-581-7710. **The deadline for making reservations is April 7, 1989.**
The thirty-seventh Summer Research Institute sponsored by the American Mathematical Society will be devoted to **Several complex variables and complex geometry** and will take place at the University of California, Santa Cruz. Members of the Organizing Committee are: **Eric Bedford**, Indiana University at Bloomington; **John D'Angelo**, University of Illinois at Urbana-Champaign, **Robert E. Greene**, University of California, Los Angeles; and **Steven G. Krantz**, Washington University (chair). It is anticipated that the institute will be partially supported by a grant from the National Science Foundation. Proceedings of the institute will be published in the AMS series *Proceedings of Symposia in Pure Mathematics*.

This topic was selected by the 1987 Committee on Summer Institutes and Special Symposia whose members were **Eric Friedlander**, **Steven L. Kleiman**, **Paul H. Rabinowitz**, **Thomas C. Spencer**, **Robert B. Warfield, Jr.**, and **John Wermer** (chair).

In 1975, a summer institute was held on several complex variables; prior to that an institute was held in 1953 (to celebrate the solution of the Levi problem). The institute for 1989 marks a substantial lapse of time and at least as great an increment of growth in the subject. There follows a discussion of some of the new developments which will be treated during this institute.

The partial differential equations that define holomorphic functions are called the Cauchy-Riemann equations (or the $\partial$ equation). Theorems about these equations go hand in hand with the solution of function-theoretic problems, because one can perform real variable constructions with smooth functions and correct them with the $\partial$ equation. In these constructions, regularity at the boundary is of crucial importance. However the $\partial$-Neumann problem is not elliptic at the boundary and new techniques had to be developed by Kohn to obtain so-called subelliptic estimates on strongly pseudoconvex domains; local boundary regularity follows. More recently, Catlin has found necessary and sufficient conditions for subellipticity. The conditions are in terms of order of contact of complex varieties with the boundary and reveal surprising connections between partial differential equations and algebraic geometry—especially the intersection of theory of complex varieties.

A second partial differential equation arising in several complex variables is the complex Monge-Ampère equation. This equation is a nonlinear generalization of the Laplacian. This equation is important in plurisubharmonic function theory, the construction of Kähler metrics, and in the potential theory of several complex variables. The existence and regularity theory for this equation does not fit any standard mold and has brought many surprises.

Biholomorphic and proper maps have been intensely studied in recent years. In 1974, C. Fefferman proved that biholomorphic mappings of strongly pseudoconvex domains continue smoothly to the boundary. More recently, new methods have been found which apply to broader classes of domains and to proper mappings and correspondences as well. At the same time, proper mappings of domains in different dimensions are revealing surprising pathologies. These pathologies, and the methods used to construct them, are related to the inner functions of Aleksandrov and Lew. Inner functions have aided in the resolution of a number of problems in constructive function theory.

Yet another method in holomorphic mapping theory is complex analytic dynamics. Fifty years ago H. Cartan used this method to study automorphisms of domains in $\mathbb{C}^n$. More recently, these methods have been used to obtain new constructions of Fatou-Bieberbach mappings (entire mappings with “small range”) and to prove new characterizations of automorphisms.

The intersection theory of complex analytic varieties has been used by D'Angelo to describe the geometry of real hypersurfaces in $\mathbb{C}^n$. When the hypersurface bounds a domain, then the boundary geometry influences the function theory on the interior. The invariant metrics of Bergman, Carathéodory, Kobayashi/Royden are a useful device for mediating between boundary geometry and interior function theory. The theories of Hardy spaces, Bloch functions, the Lindelöf Principle, and so forth, are being increasingly treated with this metric language. In addition, the work of Lempert on extremal discs for
the Kobayashi/Royden metric has tied invariant metrics to the Monge-Ampère equation and to mapping problems.

The function theory of complex manifolds is also predominantly geometric. Even for topologically trivial complex manifolds, many different function theories can arise: the curvatures of complex geometries specify the possibilities. If one specializes to Hermitian symmetric spaces, Kähler manifolds, parabolic manifolds, inbedded CR manifolds, or other contexts with structure, then a subject rich in texture emerges. In the last decade powerful machines such as nonlinear partial differential equations, positive and negative vector bundles, Hodge theories and vanishing theorems have been exploited to further the subject.

Complex analysis in several variables has grown considerably since 1975. A significant component of this growth has stemmed from the interaction with other parts of mathematics. The 1989 institute will make explicit many of these connections and review several of the major achievements stemming from them. One principal purpose of the institute is to foster and encourage further interaction among complex analysts with diverse interests.

The list of principal speakers for week one includes David Barrett, University of Michigan; Steven Bell, Purdue University; Bo Berndtsson, Chalmers Institute of Technology, Sweden; Franc Forstneric, University of Ljubljiana; Laszlo Lempert, Purdue University; Jean Martinet, University de Strasbourg, France; Sergei Pinchuk, Ufa State University, USSR; Jean Pierre Rosay, University of Wisconsin, Madison; Nessim Sibony, University de Paris-Sud, France; Bert Stensones, Rutgers University; A. G. Vitushkin, Steklov Mathematical Institute, USSR.

The list of principal speakers for week two includes Edward Bierstone, University of Toronto, Canada; James Carlson, University of Utah; Pierre Demailly, Universite de Grenoble, France; Akito Futaki, Chiba University, Japan; Ngaiming Mok, Columbia University; Takeo Ohsawa, Kyoto University, Japan; Yum Tong Siu, Harvard University; Gang Tian, Princeton University; Shing Tung Yau, Harvard University.

The list of principal speakers for week three includes M. Salah Baouendi, University of California, San Diego; David Catlin, Purdue University; Michael Christ, University of California, Los Angeles; Yakov Eliashberg, University of California, Berkeley; John Fornaess, Princeton University; Gennadi M. Henkin, Mathematical Institute AN, USSR; Joseph T. Kohn, Princeton University; Linda Parnsoon, University of Minnesota, Minneapolis; Preiss Rothschild, University of California, San Diego; Elias M. Stein, Princeton University; Francois Treves, Rutgers University; Sidney Webster, University of Minnesota, Minneapolis.

A tentative list of the topics to be addressed follows. Please note, however, that the program is subject to change.

**Week One: Complex Function Theory**
Biholomorphic and proper maps, complex potential theory, plurisubharmonic functions, approximation theory, complex analytic dynamics, convolution equations, analytic multifunctions, inner functions.

**Week Two: Complex Manifolds and Complex Geometry**
Hermitian and Kähler geometry, curvature, holomorphic mappings, invariant metrics, deformations, parabolic manifolds, finite type conditions, positive and negative vector bundles, vanishing theorems, Hodge theory.

**Week Three: Analysis and Partial Differential Equations**
Cauchy-Riemann equations, CR geometry of hypersurfaces, CR functions, complex Monge-Ampère equation, integral kernels and asymptotics, pseudoconvexity, hyperfunctions.

Accommodations will be available in the campus residence halls for participants; cafeteria style meals will be available. All facilities will be accessible to the handicapped.

Information on housing, dining, travel and the local area will be sent to invited participants in the spring. Each participant will pay a registration fee and a social fee to cover the costs of social events scheduled during the institute.

Those interested in receiving an invitation to participate in the institute should send the following information to Wayne S. Drady, Summer Institute Conference Coordinator, American Mathematical Society, Post Office Box 6248, Providence, RI 02940, prior to April 1, 1989, or through electronic mail WSD@MATH.AMS.COM.

Please type or print the following:
1. Full name;
2. Mailing address;
3. Telephone number and area code for office and home;
4. Which week or weeks you wish to attend;
5. Your scientific background relevant to the institute topic;
6. Financial assistance requested;
7. Indicate if support is not required, and if interested in attending even if support is not offered. Requests for invitations will be forwarded to the Organizing Committee for consideration. Requests will be considered after April 1, 1989, and applicants selected will receive formal invitations and notification of financial assistance beginning in mid-May.

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:
Volume 1: Global analysis, analysis on manifolds; General theory of differentiable manifolds; Infinite-dimensional manifolds; Calculus on manifolds; nonlinear operators; Spaces and manifolds of mappings;
Volume 2: Variational problems in infinite-dimensional spaces; Ordinary differential equations on manifolds; dynamical systems;
Volume 3: Ordinary differential equations on manifolds; dynamical systems;
Volume 4: Partial differential equations on manifolds; differential operators; Pseudogroups and general structures on manifolds;
Volume 5: Series contents; Author index; Key index.

1980 Mathematics Subject Classification: 58
5 volumes, 4060 pages (softcover), August 1988
List price $295, Institutional member $236, Individual member $177, Reviewer $148
To order, please specify REVGL0/86PNA

List $472, Institutional member $378, Individual member $283, Reviewer $236.
To order, Please specify REVPGL/86PNA

Prepayment required. Order from AMS, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, or call 800-556-7774 to use VISA or MasterCard.
A New Way to View Mathematics

AMS-MAA Invited Addresses
and ICM-86 Plenary Addresses
—now on videotape!

Today's eminent mathematicians...
The AMS is now offering a selection of important mathematics lectures on videotape: Joint AMS-MAA Invited Addresses, presented at the January Joint Mathematics meetings, and Plenary Addresses presented at the International Congress of Mathematicians in August, 1986. The lecturers in these two series are among the world's most distinguished mathematicians.

...bring the subject to life
Because these lectures are intended to be expository and to appeal to a wide audience, the videotapes make excellent teaching tools. This medium communicates the excitement and enthusiasm for mathematics in a way that written material cannot. Students, teachers, and researchers will all appreciate these videotapes not only for their important mathematical content, but also for the historical perspective and personal touches the speakers bring to them.

Joint AMS-MAA Invited Addresses
VHS Format, approx. one hour,
Price $59 each

- The European Mathematicians' Migration to America, by Lipman Bers, Code VIDBERS/NA
- Zoll Surfaces, by Victor Guillemin, Code VIDGUilleMIN/NA
- Matrices I Have Met, by Paul R. Halmos, Code VIDHALMOS/NA
- How Computers Have Changed the Way I Teach, by John G. Kemeny, Code VIDKEMENY/NA
- The Flowering of Applied Mathematics in America, by Peter D. Lax, Code VIDLAX/NA
- Oscar Zariski and His Work, by David Mumford, Code VIDMUMFORD/NA

ICM-86 Plenary Addresses
VHS Format, approx. one hour,
Price $49 each

- Geometry of four-manifolds, by Simon K. Donaldson, Code VIDDONALDSON/NA
- Underlying concepts in the proof of the Bieberbach conjecture, by Louis de Branges, Code VIDDEBRANGES/NA
- Recent progress in arithmetic algebraic geometry, by Gerd Faltings, Code VIDFALTINGS/NA
- Soft and hard symplectic geometry by Mikhael Gromov, Code VIDGROMOV/NA
- Efficient algorithms in number theory, by Hendrik W. Lenstra, Code VIDLENSTRA/NA
- Classifying general classes, by Saharon Shelah, Code VIDSHELAH/NA
- Complexity aspects of numerical analysis, by Stephen Smale, Code VIDSMALE/NA
- Problems in harmonic analysis related to oscillatory integrals and curvature, by Elias M. Stein, Code VIDSTEIN/NA
- Representations of reductive Lie groups, by David A. Vogan, Jr., Code VIDVOGAN/NA
- String theory and geometry, by Edward Witten, Code VIDWITTEN/NA

- Also available from ICM-86: Addresses on the Work of the 1986 Fields Medalists and Nevanlinna Prize Winner (These four talks are on one tape.) Code VIDMEDAL/NA
  - On the work of Michael Freedman, Fields Medalist, by Barry Mazur; On the work of Leslie G. Valiant, Nevanlinna Prize Winner, by Volker Strassen

PREPAYMENT REQUIRED. Order from American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571 USA or call (800) 556-7774 in the continental U.S. to charge on VISA or MasterCard. All prices are subject to change without notice. Please add shipping & handling: 1st video $2, each add'l $1, max. $25; by air, 1st video $5, each add'l $3, max. $100.


1989. 40th Anniversary of Kansas Gamma of Pi Mu Epsilon, Wichita State University, Wichita, Kansas. (January 1989, p. 63)


**March 1989**


Program: Survey talks on Novikov's conjectures will be given on March 19, coinciding with one of the regular quarterly Midwest Topology Seminars. Technical talks and working sessions will be held on the following days.

Invited Speakers: M. Bogstedt; D. Burghera; S. Cappell; G. Carlsson; R. Cohen; T. Goodwillie; T. Farrell; S. Ferry; W.-C. Hsiang; B. Hughes; J. Jones; L. Jones; I. Madsen; H. Moscovici; A. Nica; F. Quinn; A. Ranicki; J. Rosenberg; J. Shaneson.

Information: M. Rothenberg (312-702-7100), S. Weinberger (312-702-7345), or B. Williams (312-702-7349), Department of Mathematics, the University of Chicago, Chicago, Illinois 60637.

27-30. Twentieth Annual Iranian Mathematical Conference, University of Tehran, Tehran, Iran. (October 1988, p. 1242)


30-April 1. Conference Honoring Richard S. Varga, Kent, Ohio. (October 1988, p. 1242)

31-April 1. Spring Conference on the First Two Years: Teaching the Mathematical Core, University of Hartford, West Hartford, Connecticut. (January 1989, p. 64)

**April 1989**


Meetings and Conferences

3–5. Third SIAM Conference on Optimization, Boston, Massachusetts. (October 1988, p. 1242)


3–7. Forty-first British Mathematical Colloquium, University of Nottingham, Nottingham. (December 1988, p. 1586)


7–8. Spring Meeting of the Missouri Section of the MAA, University of Missouri-Columbia, Columbia, Missouri. (December 1988, p. 1586)

7–8. Sixth Annual Auburn MiniConference on Real Analysis, Auburn University, Alabama. (December 1988, p. 1586)

8–9. Fifth Annual Geometry Festival, State University of New York at Stony Brook, Stony Brook, New York. (January 1989, p. 65)

8–9. Twelfth Annual Texas PDE Seminar, University of Houston, Houston, Texas.

9–13. Fourth Copper Mountain Conference on Multigrid Methods, Copper Mountain, Colorado. (October 1988, p. 1242)


*7–8. Spring Meeting of the Missouri Section of the MAA, University of Missouri-Columbia, Columbia, Missouri.

*7–8. Sixth Annual Auburn MiniConference on Real Analysis, Auburn University, Alabama. (December 1988, p. 1586)


Sponsors: Carleton University and the University of Ottawa.

Invited Speakers: V. Deodhar, Indiana University; M. P. Malliavin, Université de Paris; M. Schacher, University of California, Los Angeles.

Information: M. Racine, Department of Mathematics, University of Ottawa, Ottawa, Ontario, Canada K1N 6N5.


27–29. Third Annual Conference on Undergraduate Research, Trinity University, San Antonio, Texas. (October 1988, p. 1243)


Invited Speakers: A. Chang, University of California, Berkeley, and University of California, Los Angeles; M. Crandall, University of California, Santa Barbara; L. Lempert, Purdue University; L. Nirenberg, New York University, Courant Institute

Information: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


17–21. Minisymposium on Front Tracking in a Supercomputer Environment, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (October 1988, p. 1243)

17–28. Topical Meeting on Hyperbolic Geometry and Ergodic Theory, Trieste, Italy. (October 1988, p. 1243)


Information: K. Dundas, Program Chair 1989 Conference, Hutchinson Community College, 1300 North Plum, Hutchinson, Kansas 67501.
of Mathematical Sciences; L. Simon, Stanford University.
INFORMATION: S. Baouendi or L. Rothschild, Department of Mathematics, University of California, San Diego, La Jolla, California 92037.

May 1989

* NSF-CBMS Conference on Discrete Groups, Expanding Graphs, and Invariant Measures, University of Oklahoma, Norman, Oklahoma.

INFORMATION: A. Lubotsky.
INFORMATION: A. Magid, Department of Mathematics, University of Oklahoma, Norman, Oklahoma 73019, 405-325-2052.


4-5. Twentieth Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania. (September 1988, p. 1058)

4-7. Mathematicians and Education Reform Network, University of California, Berkeley, Berkeley, California. (January 1989, p. 66)


INVITED SPEAKERS: C. Peskin, Courant Institute of Mathematical Sciences; C. DeLisi, Mount Sinai School of Medicine.
INFORMATION: E. Beltrami, Department of Applied Mathematics and Statistics, State University of New York at Stony Brook, Stony Brook, New York 11794, 516-632-8367.


8-12. Algorithmique Et Programmation Pascal, Marseille, France. (February 1989, p. 176)


CONFERENCE TOPICS: Infinite-Dimensional Diffusions; Measure-Valued and Distribution-Valued Processes; Stochastic Partial Differential Equations.
INVITED SPEAKERS: D. Dawson; E. B. Dynkin; I. Gyöngy; T. Kurtz; E. Perkins; T. Shiga, J. Walsh.
INFORMATION: Mathematical Sciences Institute, 201 Caldwell Hall, Cornell University, Ithaca, New York 14853, 607-255-7740, 8005 or 7763.


15-19. Moments de Geometrie Symplectique, Marseille, France. (February 1989, p. 176)


17-19. SIAM Conference on Control and Systems Theory, San Francisco, California. (December 1988, p. 1586)

19-20. Central Section Meeting of the AMS, Loyola University, Chicago, Illinois.

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


22-24. Workshop on Vortex Methods, Mathematical Sciences Research Institute, Berkeley, California. (September 1988, p. 1059)


22-26. Cohomologie des Groupes Arithmetiques, Marseille, France. (February 1989, p. 176)


22-26. Meeting on Rational Mechanics and Analysis in Honor of Clifford Truesdell on His 70th Birthday, Pisa, Italy. (December 1988, p. 1587)

22-June 3. NATO Advanced Study Institute on Orthogonal Polynomials and Their Applications, The Ohio State University, Columbus, Ohio. (September 1988, p. 1059)


INFORMATION: L. Cabrera, IBM Almaden Research Center, Mail Code KS2/803, San Jose, California 95120-6099.


26-30. AMS Pure Mathematics Symposium on Complex Geometry and Lie Theory, Sundance, Utah.

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


29-June 1. Third International Conference in Mathematics: Fractional Calculus and Its Applications, Nihon University, Tokyo, Japan. (May/June 1988, p. 731)

29-June 2. NSF-CBMS Regional Conference on Discrete Groups, Expanding Graphs, and Invariant Measures, University of Oklahoma, Norman, Oklahoma. (February 1989, p. 177)

29–June 2. **Ondelettes**, Marseille, France. (February 1989, p. 177)


**Purpose:** This conference aims to give a status report on wavelets by describing specific examples where some important problems were solved using wavelet techniques.

**Invited Speakers:** A. Arneodo, Centre de Recherche Paul Pascal; M. Farge, ENS Paris; M. Holschneider, CPT Marseille; M. Basseville, IRISA, Rennes; P. Flandrin, ICPI, Lyon; R. Coifman, Yale; M. Duval-Destin; S. Mallat, Courant Institute of Mathematical Sciences; R. Kronland-Martinet, LMA, Marseille.

**Conference Topics:** Wavelets, Dynamical Systems and Richardson Cascades in Turbulence; Wavelets and Non-stationary Signal Processing; Wavelets and Numerical Analysis; Wavelets and Image Processing; Wavelets and Acoustics.

**Information:** Y. Meyer, Ceremade, Université Paris Dauphine, 75775-Paris Cedex 16, France. Telephone: (33)-1-47277503.

29–June 3. **Meeting on Computer and Commutative Algebra (COCOA II)**, Dipartimento di Matematica, Università, Genova, Italy. (February 1989, p. 177)


**Information:** B. Verducci, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


31–June 2. **Workshop on Blow-up and Extinction for Parabolic and Other Systems**, Heriot-Watt University, Edinburgh. (January 1989, p. 66)


June 1989

*IMACS International School on Lyapunov Functions*, Irkutsk, Union of Soviet Socialist Republics.

**Information:** V. M. Matrosov, Director of the Irkutsk Computing Centre, Siberian Branch, Union of Soviet Socialist Republics Academy of Sciences, Lermontov Str. 134, 664033 Irkutsk, Union of Soviet Socialist Republics.

**Lecturer:** M. Rosenblatt.

**Information:** G. Roussas, Department of Statistics, University of California, Davis, California 95616, 916-752-8142.

*1–3. Annual Summer Meeting of the Canadian Mathematical Society*, University of Windsor, Windsor, Ontario.

**Program:** The meeting will include four special sessions, each featuring a plenary speaker. There will be a session for 15-minute contributed papers.

**Invited Speakers:** F. Atkinson, Differential Equations; D. Passman, Group Algebras; B. Kostant, Lie and Nonassociative Algebras; D. Friedan, Mathematical Physics.

**Call for Papers:** Two copies of each abstract should be submitted to the organizing committee by March 15.

**Information:** F. Lemire, Chairman, Organizing Committee, Department of Mathematics and Statistics, University of Windsor, Windsor, Ontario, Canada N9B 3P4.


2–5. **Seminar on Fractional Calculus**, Nihon University, Koriyama, Japan. (February 1989, p. 177)

3–August 5. **Joint AMS-IMS-SIAM Summer Research Conferences in the Mathematical Sciences**, Humboldt State University, Arcata, California.

**Information:** C. Kohanski, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


4–9. **Geometrical and Algebraical Aspects in Several Complex Variables**, Cetraro (CS), Italy. (November 1988, p. 1385)

4–30. **1989 Complex Systems Summer School, Santa Fe, New Mexico.** (January 1989, p. 67)


5–8. **International Colloquium on Complex Analysis and Sixth Romanian-Finnish Seminar**, University of Bucharest, Romania. (December 1988, p. 1588)

5–8. **Fourth Annual Symposium on Logic in Computer Science (LICS)**, Asilomar, California. (October 1988, p. 1244)


5–9. **Chaos and the Microcomputer**, Salisbury State University, Salisbury, Maryland. (January 1989, p. 67)

5–9. **Conference in Mathematical Analysis in Honor of the Memory of Jose Luis Rubio de Francia**, El Escorial, Spain. (February 1989, p. 178)

5–10. **Analytic Number Theory**, Centre de recherches mathématiques, Université de Montréal. (Please note date change from September 1988, p. 1059)


**Sponsors:** Washington University and the National Science Foundation.

**Purpose:** The conference will bring together specialists in various branches of algebraic geometry to discuss recent developments, results, and problems in their fields.

**Main Speaker:** W. Fulton, University of Chicago, will deliver five 90-minute talks on Toric Varieties.

**Other Invited Speakers:** H. Clemens, University of Utah; S. Bloch, University of Chicago; R. Lazarsfeld,
Meetings and Conferences

University of California, Los Angeles; L. Ein, University of Illinois at Chicago; T.-t Moh, Purdue University; D. Morrison, Duke University; Z. Ran, University of California at Riverside; D. Harbater, University of Pennsylvania; M. P. Murthy, University of Chicago; R. Donagi, University of Pennsylvania.

Information: D. Wright or D. Webb, Department of Mathematics, Washington University, Saint Louis, Missouri, 314-889-6781.

5–10. Theorie du Point Fixe et Applications, Marseille, France. (February 1989, p. 178)


12–16. NSF-CBMS Conference on Harmonic Analysis, Real Function Spaces and Related Areas, Auburn University-Auburn, Auburn University, Alabama.

Lecturer: G. Weiss.

Information: G. DeSouza, Department of Mathematics, Auburn University-Auburn, Auburn University, Alabama 36849, 205-826-4290.


Lecturer: J. Friedman.


12–16. Greco Calcul Formel, Marseille, France. (February 1989, p. 178)


12–July 8. Summer Conference on Complex Analysis, Bordeaux, France. (February 1989, p. 178)

13–15. Third Chico State Western States Topology Conference, California State University, Chico, Chico, California. (February 1989, p. 178)


Sponsor: Illinois Section of the Mathematical Association of America.

Purpose: This conference is designed to give teachers insight and techniques useful for a course in modeling.

Principal Speakers: F. R. Giordano, United States Military Academy; M. D. Weir, Naval Postgraduate School.

Information: R. F. Wheeler, Department of Mathematical Sciences, Northern Illinois University, DeKalb, Illinois 60115, 815-753-6738.

14–17. International Conference on Dynamical Systems, Control Theory, and Applications, Wright State University, Dayton, Ohio. (October 1988, p. 1244)


Purpose: This workshop will bring together researchers working in the geometry and rigidity of regular and random packing of spheres, the numerical simulation of arrays of hard or elastic spheres, and the modeling of the mechanical behavior of idealized granular materials.

Invited Speakers: A. Bezdek; K. Bezdek; C. S. Chang; R. Connelly; H. Frost; Z. Gaspar; J. T. Jenkins; J. Papadopoulos; E. Petrakis; T. Rosato; M. Satake; T. Tarnai; W. Whiteley.

Information: For further information on the scientific program, contact J. Jenkins, Department of Theoretical and Applied Mechanics, Cornell University, Ithaca, New York 14853, 607-255-7185 or 5062. To attend the workshop, contact the Mathematical Sciences Institute, 201 Caldwell Hall, Cornell University, Ithaca, New York 14853, 607-255-7740, 8005 or 7763. (Note: Limited funding is available for partial support of predoctoral and young postdoctoral attendees.)

15–23. CIME Course on Methods of Nonconvex Analysis, Villa Monastero, Varenna Lake (Lake of Como), Italy. (January 1989, p. 67)


19–24. Harmonizable Fields and Related Topics, Marseille, France. (February 1989, p. 179)


**Purpose:** The main purpose of the symposium is to assemble as strong a group of algebraic geometers as possible from each of the two countries and to do all that is possible to allow them to work together for a substantial amount of time.

**Conference Topics:** Different broad areas of algebraic geometry will be emphasized during different phases of the symposium. The main emphasis of the first week will be arithmetic algebraic geometry. The second week is tentatively scheduled to emphasize applications to physics, K-theory, and representation theory.

**Information:** J. P. May, The University of Chicago Mathematical Disciplines Center, 5734 University Avenue, Chicago, Illinois 60637.


**Lecturer:** M. Sipser.

**Information:** J. Simon, Department of Computer Science, University of Chicago, Chicago, Illinois 60637, 312-702-3488.


**Purpose:** This workshop will gather together researchers from various disciplines to discuss the state of the art in this area.

**Conference Topics:** Possible topics include polynomial-time logics, bounded versions of arithmetic and lambda calculus, proof theory of feasible systems, feasible polymorphic languages, and polynomial time versions of algebra and analysis.

**Invited Speakers:** M. Ajtai; L. Blum; S. Buss; P. Clote; J. Crossley; S. Cook; J-Y. Girard; Y. Gurevich; K-I. Ko; D. Leivant; A. Nerode; J. Remmel; A. Scedrov; P. Scott; G. Takeuti; A. Urquhart.

**Information:** For more information on the scientific program, contact S. Buss, Department of Mathematics, University of California at San Diego, La Jolla, California 92039, 619-534-6455 or P. Scott, Department of Mathematics, University of Ottawa, Ontario, Canada K1N 6N5, 613-564-5884. To attend the workshop, contact the Mathematical Sciences Research Institute, 201 Caldwell Hall, Cornell University, Ithaca, New York 14853, 607-255-7740, 8005, or 7763. (Note: Limited funding is available for partial support of predoctoral and young postdoctoral attendees.)

26–29. IFAC/IMACS/IFIP Symposium on Control of Distributed Parameter Systems, Perpignan, France.

**Information:** A. El Jai, Lab. d' Automatique IMP du CNRS, Université de Perpignan, 50 Avenue de Villeneuve, F-66000 Perpignan, France.

26–29. ICOSAHOM '89: International Conference on Spectral and High Order Methods for Partial Differential Equations, Como, Italy. (February 1989, p. 179)


**Lecturer:** R. S. Varga.

**Information:** A. Carpenter, Department of Mathematics, Butler University, Indianapolis, Indiana 46208, 317-283-9436.


**Sponsor:** North Central Section of the Mathematical Association of America.

**Principal Lecturer:** J. Goldfeather.

**Program:** There will be a short course on computer graphics together with several invited lectures and contributed papers.

**Information:** S. Galovich, Department of Mathematics and Computer Science, Carleton College, Northfield, Minnesota 55057.

*26–30. AAECC-7 International Conference, P. Sabatier University, Toulouse.

**Conference Topics:** Error Correcting Codes (theory and applications) and Computational Algebra and Geometry.

**Information:** A. Poli, Lab. AAECC/LSI, P. Sabatier University, 118 route de Narbonne, 31062 Toulouse cedex (F).

26–30. Centenaire Halpen, Marseille, France. (February 1989, p. 179)

26–30. Workshop on Symbol Manipulation, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (February 1989, p. 179)

27–30. Second Conference of the International Federation of Classification Societies (IFCS), Charlottesville, Virginia. (October 1988, p. 1244)

July 1989


**Information:** Logic at Botik '89, Post Office Box 11, Program Systems Institute of the Union of Soviet Socialist Republics Academy of Sciences, 152140 Pereslavl-Zalessky, Union of Soviet Socialist Republics.

2–7. Fourth Gregynog Symposium on Differential Equations, Gregynog Conference Center, University of Wales, United Kingdom. (December 1988, p. 1588)

Meetings and Conferences


INFORMATION: CRAN-IFAC Congress Secretary, Faculte des Sciences - B.P. 239, 54506 Vandoeuvre Cedex, France.

3–7. NSF-CBMS Regional Research Conference in the Mathematical Sciences: Harmonic Analysis and Real Function Spaces, Auburn University, Auburn University, Alabama. (February 1989, p. 179)

3–7. Annual General Meeting of the Australian Mathematical Society, Macquarie University, Sydney, New South Wales, Australia. (December 1988, p. 1589)


3–11. CIME Course on Microlocal Analysis and Applications, Villa "La Querceta," Montecatini Terme (Pistoia), Italy. (January 1989, p. 68)

* 3–13. Surfaces Minimales, Marseille, France.


INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

3–21. SMS-NATO ASI: Fractal Geometry and Analysis, Universite de Montreal, Montreal, Canada. (January 1989, p. 68)


PURPOSE: This workshop will present current research into formal methods for hardware design. The goal of research into formal methods for hardware design is to develop methods for improving the design process and the quality of the resulting designs.

INVITED SPEAKERS: D. Basin; G. Bristwistle; R. Bryant; R. Campesano; S-K. Chin, E. Clarke; W. Hunt; S. Johnson; J. Joyce; C. Lengauer; P. Lowenstein; A. Martin; G. Milne; M. Sheeran; M. K. Srivas; P. A. Subramanyam; D. Weise.

INFORMATION: For more information on the scientific program, contact G. Brown, 406 Phillips Hall, Cornell University, Ithaca, New York 14853, 607-255-8804. To attend the workshop, contact the Mathematical Sciences Institute, 201 Caldwell Hall, Cornell University, Ithaca, New York 14853, 607-255-7740, 8005, or 7763. (Note: Limited funding is available for partial support of predoctoral and young postdoctoral attendees.)


* 6–9. Third Mathematicians and Education Reform Network Workshop, University of Minnesota, Minneapolis.

ORGANIZERS: The MER Network, supported by a grant from the National Science Foundation, is directed by P. Wagreich, University of Illinois at Chicago, and H. B. Keynes, University of Minnesota.

PURPOSE: The aim of the network is to strengthen ties among mathematicians involved in precollege educational activities and to encourage more mathematicians to become active in educational projects at the precollege level.

INFORMATION: N. Fisher, Associate Director, MER Network, University of Illinois at Chicago, Office of Mathematics and Computer Education (M/C 249), Box 4348, Chicago, Illinois 60680, 312-996-2439.

10. Tutorial Short Courses, Trinity College, Dublin, Ireland. (November 1988, p. 1386)


10–21. NATO Advanced Study Institute: Computation of Curves and Surfaces, Puerto de la Cruz, Canary Islands, Spain. (February 1989, p. 180)


10–30. AMS Summer Research Institute on Several Complex Variables and Complex Geometry, University of California, Santa Cruz, California.

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


LECTURER: K. Schmidt.

INFORMATION: D. Lind, Department of Mathematics, University of Washington, Seattle, Washington 98195, 206-543-1723.

Meetings and Conferences

* 17–22. Journées Arithmétiques, Marseille, France.

CHAIRMAN: G. Lachaud, Marseille.
INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.


PURPOSE: This workshop will focus on how mathematical research has contributed to the understanding of financial markets. The approach will be theoretical and, therefore, of interest primarily to researchers involved in probability and financial theory.

TOPICS: Optimal consumption; portfolio management; mathematical models of financial markets, including arbitrage and martingale measures.

INVITED SPEAKERS: P. Artzner; K. Back; T. Cover; F. Delbaen; D. Duffie; P. Dybvig; H. Föllmer; T. Ho; C.-F. Huang; R. Jarrow; I. Karatzas; T. Kurtz; J. Lehoczky; A. Morton; S. Pliska; P. Protter; S. Richard; S. Shreve; C. Stricker; W. Willinger.

INFORMATION: For more information on the scientific program, contact D. Heath, 318 Upson, Cornell University, Ithaca, New York 14853, 607-255-9125. To attend the workshop, contact the Mathematical Sciences Institute, 201 Caldwell Hall, Cornell University, Ithaca, New York 14853, 607-255-7740, 800-5, or 7763. (Note: Limited funding is available for partial support of predoctoral and young postdoctoral attendees.)


PURPOSE: The conference, held in conjunction with the LSA/MLA Linguistic Institute, will focus on theoretical interactions of linguistics and logic.

PROGRAM COMMITTEE: D. T. Langendoen; V. McGee; R. T. Oehrle; J. L. Pollock.

CALL FOR PAPERS: The deadline for submission of one-page abstracts of contributed papers is April 1, 1989.

INFORMATION: R. T. Oehrle, Department of Linguistics, Douglass 200E, University of Arizona, Tucson, Arizona 85721.

24–27. Gauss Symposium on Mathematics and Theoretical Physics, Guarujá, SP, Brazil. (November 1988, p. 1387)


LECTURER: R. S. Hamilton.

INFORMATION: J. Weiner, Department of Mathematics, University of Hawaii, Honolulu, Hawaii 96822, 808-948-8959.


CHAIRMEN: M. Cathelineau, Nice; P. Cartier, Palaiseau; J. Dupont, Aarhus; M. Sah, Stony Brook.

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.


August 1989


CALL FOR PAPERS: Send two copies of abstracts (300 words for full-length papers, 100 words for short reports) to the address given below.

INFORMATION: Xavier J. R. Avula, Department of Mechanical and Aerospace Engineering, University of Missouri-Rolla, Rolla, Missouri 65401, 314-341-4661.

6–7. AMS Short Course on Cryptology and Computational Number Theory, Boulder, Colorado.

INFORMATION: M. Foulkes, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


7. AMS-SIAM-SMB Symposium on Some Mathematical Questions in Biology: Sex Allocation and Sex Change, Experiments and Models, University of Toronto, Toronto, Ontario, Canada. (February 1989, p. 181)

* 7–11. Thirteenth Johns Hopkins Mathematical Sciences Summer Lecture Series, Johns Hopkins University, Baltimore, Maryland.

PRINCIPAL SPEAKER: A. F. Veinott, Jr., Lattice Programming.

INFORMATION: J. Pang, Department of Mathematical Sciences, Maryland Hall, Johns Hopkins University, Baltimore, Maryland 21218, 301-338-7216.

Meetings and Conferences

Science, Poznan, Poland. (November 1988, p. 1387)
10–12. International Conference on Computational Techniques and Applications, Brisbane, Australia. (February 1989, p. 181)
*13–18. Fifth International Conference on Stochastic Programming, University of Michigan, Ann Arbor, Michigan.

PROGRAM: This conference will focus on stochastic programming theory and applications with particular emphasis on computation. A tutorial session will introduce new investigators and users to the field.

CALL FOR PAPERS: Anyone wishing to submit a paper should send a title and abstract by March 31, 1989, to the address below.

INFORMATION: J. R. Birge, Department of Industrial and Operations Engineering, 1205 Beal, the University of Michigan, Ann Arbor, Michigan 48109-2117, 313-764-9422.


CHAIRMEN: E. Becker, Dortmund; A. Dress, Bielefeld; J. Wills, Siegen.


*16–September 2. Nineteenth Summer Session on Probability Theory, Saint-Flour (Cantal), France.

INVITED SPEAKERS: D. L. Burkholder, University of Illinois at Urbana-Champaign; E. Pardoux, Université de Provence (Aix-Marseille 1); A. S. Sznitman, Courant Institute of Mathematical Sciences.

CONFERENCE TOPICS: Explorations in martingale theory and its applications; nonlinear filtering and the associated stochastic partial differential equations; propagation of chaos.


20–24. Ninth Annual Crypto Conference, University of California at Santa Barbara, Santa Barbara, California. (February 1989, p. 181)


ORGANIZERS: Institute of Mathematics of the Siberian Branch of the Academy of Sciences of the USSR and Novosibirsk State University.


21–25. EQUADIFF 7, Prague, Czechoslovakia. (February 1989, p. 181)
21–25. First Canadian Conference on Computational Geometry, McGill University, Montreal, Quebec, Canada. (February 1989, p. 181)

*24–26. Twenty-fourth Actuarial Research Conference, Concordia University, Montréal, Canada.

SPONSOR: The Society of Actuaries.

PROGRAM: The intent is to include preliminary reports on the research projects recently funded by the Society of Actuaries.

CALL FOR PAPERS: The deadline for abstracts of contributed papers is July 1, 1989.

INFORMATION: J. Garrido, Twenty-fourth Actuarial Research Conference, Department of Mathematics and Statistics, Concordia University, 1455 De Maisonneuve Boulevard W, Montréal, Quebec, H3G 1M8, Canada. Telephone: 514-848-3222.


LECTURER: F. Michael Christ.

INFORMATION: W. Derrick, Department of Mathematics, University of Montana, Missoula, Montana 59812, 406-243-5569.


INFORMATION: H. Fuchs, Academy of Sciences of the German Democratic Republic, Karlstrasse 33, D-1086 Berlin, German Democratic Republic.


CHAIRMEN: M. Cathelineau, Nice; P. Cartier, Palaiseau; J. Dupont, Aarhus; M. Sah, Stony Brook.

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

28–September 1. International Conference on Symplectic Geometry and Computational Hamiltonian Dynamics, Beijing, China. (January 1989, p. 69)
28–September 2. Second International Conference on Function Spaces, Poznań, Poland. (November 1988, p. 1387)
Meetings and Conferences

28–September 8. Topical Meeting on Variational Problems in Analysis, Trieste, Italy. (October 1988, p. 1245)

September 1989
1–10. Summer School of Algebra and Ordered Sets, The Jeseniky Mountains, Czechoslovakia. (January 1989, p. 69)
* 4–8. Twelfth CNMAC Brazilian Congress on Computational and Applied Mathematics, São José Do Rio Preto, São Paulo State, Brazil.

Program: The meeting will consist of minicourses, plenary lectures and minisymposia (still to be scheduled) and contributed papers. All papers must be mailed to the address given below by the end of May 1989.

Information: Twelfth CNMAC, Instituto De Matematica, 9500 Bento Goncalves, 91500 Porto Alegre RS Brazil.

* 5–7. Twelfth CNMAC Brazilian Congress on Computational and Applied Mathematics, São José Do Rio Preto, São Paulo State, Brazil.


Information: United Kingdom Simulation Council, c/o D. J. Murray-Smith, Department of Electronics and Electrical Engineering, University of Glasgow, Glasgow G12 800, Scotland, United Kingdom.


8–14. COSMEX'89: International Conference on Stochastic Methods in Experimental Sciences, Technical University of Wroclaw, Poland. (November 1988, p. 1388)


Information: Institut National de Recherche en Informatique et en Automatique, Domaine de Voluceau, Rocquencourt, F-78153 Le Chesnay cedex.

11–15. Fifth International Conference on Numerical Methods in Engineering, Lausanne, Switzerland. (November 1988, p. 1388)

16–October 26. Sixth World Congress on Medical Information, Beijing, China. (April 1988, p. 639)


* 18–22. Bifurcations et Orbites Peri­odiques de Champs de Vecteurs du Plan, Marseille, France.

Information: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

* 24–October 6. Extrapolation et Approximation Rationale, Marseille, France.

Chairman: C. Brezinski, Lille.
Information: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.


Conference Topics: Air quality modelling; bushfire modelling; ecosystem modelling; modelling for forestry and agriculture; catchment modelling; groundwater modelling.
Information: SSA-89 Secretariat, A. J. Jakeman, Centre for Resource and Environmental Studies, Australian National University, GPO Box 4, Canberra ACT 2601, Australia. Telephone: (062) 49 4277.


Call for Papers: A brief description of each talk, not exceeding 100 words.
must be submitted on a SIAM abstract form, which can obtained from the address given below. A contributed presentation consists of a 17-minute talk, followed by three minutes of questions. The deadline for abstracts is April 12, 1989.


* 29-October 1. Sixth IFAC/IFIP/IFORS/IMACS Symposium on Information Control Problems in Manufacturing Technology, Madrid, Spain.

Conference Purpose: The aim of the symposium is to present, discuss, and summarize research on new theories, as well as advanced applications, of automatic systems used in Computer Integrated Manufacturing.

INFORMATION: E. A. Puente, Head of Systems Engineering Department, UPM, Jose Gutierrez Abascal 2, E-28006 Madrid, Spain.

October 1989

*2-6. IMACS-GAMM International Symposium on Computer Arithmetic and Self-Validating Numerical Methods, University of Basel, Basel, Switzerland. (Please note date change from November 1988, p. 1388)

INFORMATION: C. Ullrich, Institut fur Informatik, Universitat Basel, Mittlere Strasse 142, CH-4056 Basel, Switzerland.


Invited Speakers: M. F. Atiyah; I. M. Singer; C. Taubes; K. Uhlenbeck.

Program: The lectures are aimed to cover both a survey of developments in mathematical physics and geometry in recent years as well as material of current research. A one-hour lecture will be presented by each of the four speakers on each of the three days.

INFORMATION: H. Simpson, G. Baker, R. Svirsky, Department of Mathematics, the University of Tennessee, Knoxville, Tennessee 37996-1300, 615-974-4261, 974-2461, or 974-4350.


16-20. Sixth World Congress on Medical Informatics, Beijing, China. (February 1989, p. 182)

16-20. Workshop: Patterns and Dynamics in Reactive Media, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (February 1989, p. 182)


INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


INFORMATION: BICSC Conference Secretary Group, Automatic Control Department, Beijing Institute of Aeronautics and Astronautics, Beijing 100083, China.

26-28. The Riccati Equation In Control, Systems and Signals, Villa Gallia, Como, Italy. (January 1989, p. 70)

27-28. Central Section Meeting of the AMS, Ball State University, Muncie, Indiana. (May/June 1988, p. 732)

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


CHAIRMAN: D. Braess, Bochum; P. Ciarlet, Paris; E. Stein, Hannover.


* 30-November 2. Workshop on Homotopy Theory, Mathematical Sciences Research Institute, Berkeley, California.

Program: This is the first of three workshops planned as part of MSRI's yearlong 1989-1990 program on Algebraic Topology and its Applications.

Organizer: G. Carlsson.

INFORMATION: I. Kaplansky, Director, Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley, California 94720.

* 30-December 1. College on Differential Geometry, Trieste, Italy.

Chairmen: J. P. Bourgignon; B. Lawson; M. Do Carmo; R. Tribuzy.

INFORMATION: International Center for Theoretical Physics, Post Office Box 586, Miramare, Strada Costiera 11, I-34100 Trieste.

November 1989

* 2-4. Second Annual Conference on Technology in Collegiate Mathematics, The Ohio State University, Columbus, Ohio.

Program: The conference will feature lectures by nationally recognized technology innovators, papers describing current work in colleges across the United States, workshops, and minicourses.

Call for Papers: Individuals wishing to present a paper at the conference should send a one-page abstract and two self-addressed, stamped envelopes to the address below by June 1, 1989. Papers accepted for presentation will be included in the Conference Proceedings. Papers are restricted to at most four pages in length.

INFORMATION: F. Demana and B. Waits, 1989 Technology Conference, the Ohio State University Department of Mathematics, 231 W. 18th Avenue, Columbus, Ohio 43210.


MARCH 1989, VOLUME 36, NUMBER 3 313
Meetings and Conferences


ORGANIZER: R. E. Barnhill, Arizona State University.

CALL FOR PAPERS: The deadline for abstracts is June 1, 1989.

CONFERENCE TOPICS: Teleological modeling; computer graphics; parametric curves and surfaces in CAGD; images of matrices; domain processing and manipulation; surface fitting and other related subjects.

INVITED SPEAKERS: A. Barr, California Institute of Technology; P. J. Davis, Brown University; R. Farouki, IBM; D. Gossard, Massachusetts Institute of Technology; J. Gregory, Brunel University; C. Moler, Ardent Computer Corporation; J. Rice, Purdue University; L. Schumaker, Vanderbilt University; T. Sederberg, Brigham Young University; P. Wilson, General Electric; M. Wozny, Rensselaer Polytechnic Institute.


18–19. Far Western Section Meeting of the AMS, University of California, Los Angeles.

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

December 1989


CHAIRMEN: R. Beran, Berkeley; D. W. Müller, Heidelberg.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Oberstrasse 24 D-7800 Freiburg im Breisgau.


CONFERENCE TOPICS: Massively parallel computing; visualization of scientific computation; tools for parallel algorithm development, and other related subjects.

INVITED SPEAKERS: W. D. Hillis, The Thinking Machines Corporation; J. Sethian, University of California, Berkeley; A. Egolf, United Technologies Research Center; K. A. Winkler, Los Alamos National Laboratory; A van Dam, Brown University; W. Goddard, California Institute of Technology; D. B. Gannon, Indiana University, Bloomington; K. Kennedy, Rice University; D. Gelernter, Yale University.

INFORMATION: J. J. Dongarra, Argonne National Laboratory.

ABSTRACT DEADLINE: June 1, 1989.


CHAIRMEN: H. O. Kreiss, Los Angeles; J. Lorenz, Pasadena.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Oberstrasse 24 D-7800 Freiburg im Breisgau.

January 1990


INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Oberstrasse 24 D-7800 Freiburg im Breisgau.


CHAIRMEN: B. Korte, Bonn; K. Ritter, München.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Oberstrasse 24 D-7800 Freiburg im Breisgau.

February 1990


CHAIRMEN: H. Begehr, Berlin; E. Meister, Darmstadt.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Oberstrasse 24 D-7800 Freiburg im Breisgau.


CHAIRMEN: E. Dubinsky, Potsdam; R. Meise, Düsseldorf; D. Vogt, Wuppertal.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Oberstrasse 24 D-7800 Freiburg im Breisgau.
Meetings and Conferences


CHAIRMEN: F. Gehring, Ann Arbor; E. Mues, Hannover; Ch. Pommereneke, Berlin.


CHAIRMEN: W. Alt, Bonn; K. P. Hadeler, Tübingen; U. an der Heiden, Witten.


CHAIRMEN: J. Albrecht, Clausthal; L. Collatz, Hamburg; P. Hagedorn, Darmstadt; W. Velte, Würzburg.


March 1990


CHAIRMEN: O. E. Lanford, Zürich; A. Neumaier, Freiburg.


CHAIRMEN: H. Föllmer, Bonn.


16–17. Central Section Meeting of the AMS, Kansas State University, Manhattan, Kansas.

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


CHAIRMEN: D. Kölzow, Erlangen.


CHAIRMEN: G. Herrmann, Stanford; H. Lippmann, München.


May 1990


25–31. Tenth International Conference on Pattern Recognition, Resorts Hotel, Atlantic City, New Jersey. (March 1988, p. 466)

June 1990

6–12. 1990 Barcelona Conference on Algebraic Topology, Centre de Recerca Matematica, Barcelona, Spain. (September 1988, p. 1060)


INFORMATION: C. V. Negoita, Congress Chairman, Department of Computer Science, Hunter College, City University of New York, 695 Park Avenue, New York, New York 10021.


*18–20. Joint WNAR-IMS Regional Meeting, Montana State University, Bozeman, Montana.

INFORMATION: WNAR information from G. Morris Southward, Department of Experimental Statistics, New Mexico State University, Las Cruces, New Mexico 88003, 505-646-2936. IMS information from L. Billard, Department of Statistics and Computer Science, University of Georgia, Athens, Georgia 30602, 404-542-5232.

July 1990

*1–18. Twentieth Summer Session on Probability Theory, Saint-Flour (Cantal), France.

INVITED SPEAKERS: D. Donoho, University of California, Berkeley; M. Friedlin, University of Maryland; J. F. Legall, Université de Paris VI.

CONFERENCE TOPICS: Open problems related to statistical applications; large deviations and nonlinear differential equations; fine analysis of Brownian motion.


August 1990

6–9. 1990 Joint Statistical Meetings, Anaheim, California. (March 1988, p. 466)

8–11. 93rd Summer Meeting of the AMS, Ohio State University, Columbus, Ohio.

INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

12–18. Pre-Congress Topology Conference, University of Hawaii, Honolulu, Hawaii. (February 1989, p. 183)

INFORMATION: A. Javor, Central Research Institute for Physics of the Hungarian Academy of Sciences, H-1525 Budapest 114, Post Office Box 49, Hungary.

September 1990

* Neuronet-90: IMACS International Symposium on Neural Nets and Neural Computers, Prague, Czechoslovakia.
INFORMATION: V. Hamata, General Computing Center, Czechoslovak Academy of Sciences, 182 07 Prague 8, Post Office Box 5, Czechoslovakia.

* IMACS Symposium on Modelling and Simulation of Electrical Machines, ENSEM - Nancy, France.
INFORMATION: J. Robert, Institut Montefiore, B-28, Sart Tilman, B-4000 Liege, Belgium or R. LeDoeuff, ENSEM 2, Rue de la Citadelle, BP850-54100 Nancy, France.

* 3–6. Fourth Asian Logic Conference, Tokyo, Japan.
CALL FOR PAPERS: Submissions to the conference are invited from areas relating to mathematical logic. The deadline for submissions will be March 1990.
INFORMATION: Send all correspondence, including requests for further information, to K. Kakehi, Department of Mathematics, Waseda University, 3-4-1 Okubo, Shinjuku-ku, Tokyo 160, Japan.

INFORMATION: S. Tzafestas, National Technical University of Athens, Division of Computer Science, Department of Electrical Engineering, 157 73 Zographou, Athens, Greece.

November 1990

2–3. Central Section Meeting of the AMS, University of North Texas, Denton, Texas.
INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

December 1990


January 1991

INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

July 1991


INFORMATION: J. H. Miller, University of Dublin, School of Mathematics, 39 Trinity College, Dublin 2, Ireland.

August 1991

8–11. 94th Summer Meeting of the AMS, University of Maine, Orono, Maine.
INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

January 1992

8–11. 98th Annual Meeting of the AMS, Baltimore, Maryland.
INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

June 1992

INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

January 1993

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

January 1994

5–8. 100th Annual Meeting of the AMS, Cincinnati, Ohio.
INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.
New AMS Publications

ABELIAN GROUP THEORY
Laszlo Fuchs, Rüdiger Göbel, and Phillip Schultz, Editors
(Contemporary Mathematics, Volume 87)

The traditional biennial international conference of abelian group theorists was held in August, 1987 at the University of Western Australia in Perth. With some 40 participants from five continents, the conference yielded a variety of papers indicating the healthy state of the field and showing the significant advances made in many areas since the last such conference in Oberwolfach in 1985. This volume brings together the papers presented at the Perth conference, together with a few others submitted by those unable to attend.

The first section of the book is concerned with the structure of p-groups. It begins with a survey on H. Ulm’s contributions to abelian group theory and related areas and also describes the surprising interaction between set theory and the structure of abelian p-groups. Another group of papers focuses on automorphism groups and the endomorphism rings of abelian groups. The book also examines various aspects of torsion-free groups, including the theory of their structure and torsion-free groups with many automorphisms. After one paper on mixed groups, the volume closes with a group of papers dealing with modules which generalize corresponding properties of abelian groups.

Contents
R. Göbel, Helmut Ulm: His work and its impact on recent mathematics
K. Benabdallah, D. Cutler, and A. Mader, Extensions of torsion-complete p-groups
K.-Y. Honda, Plain global bases of reduced abelian p-groups
Patrick Keef, On set theory and the balanced-projective dimension of $C_0$ groups
D. Cutler, A. Mader, and Ch. Megibben, Essentially indecomposable abelian p-groups having a filtration of prescribed type
W. Liebert, Isomorphic automorphism groups of primary abelian groups II
W. May, Endomorphism rings of mixed abelian groups
P. Schultz, Endomorphism rings of finite valued p-groups
D. Arnold and C. Vinsonhaler, Quasi-endomorphism rings for a class of butler groups
D. M. Arnold, Representations of partially ordered sets and abelian groups
R. Göbel and C. Sengelhoff, Vector spaces with four distinguished subspaces and applications to modules
U. Albrecht, Abelian groups A such that the category of $A$-solvable groups is preabelian
O. Mutzbauer, Type invariants of torsion-free abelian groups
U. Albrecht and P. Hill, Separable vector groups
C. Metelli, Bihomogeneous groups
H. P. Goeters and J. D. Reid, On the $p$-rank of $\text{Hom}(A, B)$
M. Dugas and J. Hausen, Torsion-free $E$-uniserial groups of infinite rank
M. Dugas and S. Shelah, $E$-transitive groups in L
P. Hill and Ch. Megibben, The local equivalence theorem
R. S. Pierce, $E$-modules
L. Fuchs, Some applications of abelian group theory to modules
L. Salce and P. Zanardo, Finitely generated modules over valuation domains
T. H. Fay, Torsion divisible dimension
A. D. Sands, Some remarks on $A$-radicals
K. Eda, Cardinality restrictions on preradicals
S. H. Mohamed and B. J. Müller, Continuous modules have the exchange property

1980 Mathematics Subject Classifications: 20KXX, 06B15, 13C05, 16A21, 16A65
ISSN 0271-4132
312 pages (softcover),
Individual member $30, List price $33,
Institutional member $26
To order, please specify CONM/87N

LARGE DERIVATIONS, FREE ENERGY FUNCTIONAL AND QUASI-POTENTIAL FOR A MEAN FIELD MODEL OF INTERACTING DIFFUSIONS
D. A. Dawson and J. Gärtner
(Memoirs of the AMS, Number 398)

Large exchangeable systems of reversible diffusions in $R^d$ with mean field interaction serve as useful models for studying the dynamical aspects of the phenomena of phase transitions, tunneling, and metastability in statistical physics. The nonlinear McKean-Vlasov equation describes the limiting behavior of the empirical measure process in a fixed time interval as the number of particles increases to infinity.

Use the order form in the back of this issue or call 800-556-7774 to use VISA or MasterCard.
Shipping and handling charges will be added.
The objective of this work is to study large deviations for such systems in order to investigate such dynamical behavior as metastability in longer time scales. The main result deals with the relationship between the quasipotential, which is related to the large deviation behavior of the nonequilibrium dynamics, and the free energy functional, which is related to the equilibrium distribution of the system. The quasipotential of a measure with respect to a stable stationary state of the McKean-Vlasov equation is obtained by minimizing the action along all paths joining the stationary state to the measure. The authors show that this quasipotential coincides with the domain of attraction of the stationary state with additive constant. Moreover, they establish that the time reversed trajectory of the McKean-Vlasov dynamics attains the minimum action. These results make precise the heuristic fact that the free energy functional serves as a potential for the McKean-Vlasov dynamics with respect to a weak Riemannian structure on the space of probability measures on $R^d$, viewed as an infinite-dimensional manifold.

Contents
The mean field model. Basic notation

Main results
The equilibrium behavior
The dynamical behavior
Quasipotential and free energy functional

Large deviations for the invariant distributions
Quasipotential and free energy functional for non-interacting systems
Transition operators, Doeblin's condition, and exponential $F^0$-convergence to equilibrium
The quasipotential

Quasipotential and free energy functional for interacting systems
Recurrence properties of the empirical process
Transition probability functions and Doeblin's condition
The quasipotential

1980 Mathematics Subject Classifications: 60K35, 60F10; 82A05
ISBN 0-8218-2461-9, LC 89-164
ISSN 0065-9266
100 pages (softcover), March 1989
Individual member $8, List price $13,
Institutional member $10
To order, please specify MEMO/398N

SEMICLASSICAL THEORY OF SHAPE RESONANCES IN QUANTUM MECHANICS
P. D. Hislop and I. M. Sigal
(Memoirs of the AMS, Number 399)

Semiclassical methods have helped greatly to expand understanding of the discrete spectrum of Schrödinger operators. Recently, these methods have been combined with geometric perturbation theory and the method of spectral deformation in order to study the spectral resonances of certain Schrödinger operators. These resonances describe metastable states of a physical system: they behave as localized bound states over short time periods, but are coupled to the continuum and therefore eventually move off to infinity.

This work focuses on one example of resonances, that of shape resonances, which are formed by potentials that are attractive inside a compact set and repulsive outside of it. In this case, the coupling to the continuum is achieved by quantum mechanical tunneling through the potential barrier. In the classical limit—which corresponds to the situation in which the height of the barrier becomes infinite—all tunneling is suppressed, and the analogous quantum mechanical system, described by a Hamiltonian $H_0$, has eigenvalues embedded in its continuous spectrum. As soon as the coupling is restored by lowering the height of the barrier, these eigenvalues disappear.

By comparing this approximate Hamiltonian $H_0$ to the full Hamiltonian $H$ in the semiclassical regime of small Planck's constant, the authors show that the embedded eigenvalues of $H_0$ move into the lower half of the complex plane and become spectral resonances of $H$. Moreover, they prove that the imaginary part of these resonances, which has the physical interpretation of the inverse of the lifetime of the state, is exponentially small. The exponential factor has a geometric interpretation: it is the geodesic distance, in the Agmon metric associated with the potential, through which the particle must tunnel in order to become free. This is the multidimensional generalization of the one-dimensional result obtained by the WKB theory.

Contents
The model and the approximate Hamiltonian
Preliminaries: The spectra of $H_0(\lambda)$ and $H(\lambda)$
The distorted Hamiltonians
Harmonic approximation
Existence of resonances
Exponential decay of eigenfunctions
Width of the resonances
Comments

1980 Mathematics Subject Classifications: 81C12, 35J10; 81F99
ISBN 0-8218-2462-7, LC 89-182
ISSN 0065-9266
132 pages (softcover), March 1989
Individual member $10, List price $16,
Institutional member $13
To order, please specify MEMO/399N

Use the order form in the back of this issue or call 800-556-7774 to use VISA or MasterCard.
Shipping and handling charges will be added.
In this work, the author introduces and studies the Eisenstein series and scattering operator for Kleinian groups. He also formulates and proves the inner product formula and the "Maass-Selberg" relations for Kleinian groups. Two different points of view in the present theory are particularly emphasized. The first considers the theory as part of the Selberg-Langlands program concerning the analytic continuation of Eisenstein series for nonarithmetic groups. The second point of view is related to the spectral theory of certain hyperbolic manifolds. This spectral theory becomes, in light of Thurston's work, especially significant in the case of 3-dimensional manifolds. The techniques the author has developed also form the main ingredients for producing a trace formula and a zeta function for such groups.

Contents
Scattering operator and Eisenstein series
   Analytical and geometrical considerations
   The scattering operator and Eisenstein integral
   "Desingularizations" of the scattering operator and construction of a smooth parametrix
The inner product formula
   Integration over a horosphere
   The constant term theorem
   Formulation and proof of the inner product formula
"Maass-Selberg" relations and functional equation
   Two modified $L^2$-versions of the Eisenstein integral
   The first "Maass-Selberg" relation
   The second "Maass-Selberg" relation and the functional equation
Epilogue
   Extension to discrete groups on $H^{n+1}$

1980 Mathematics Subject Classifications: 10D20, 11F72, 58G25, 35P25, 30F40, 22E40, 53C20
ISBN 0-8218-2463-5, LC 89-180
ISSN 0065-9266
96 pages (softcover), March 1989
Individual member $59, List price $98,
Institutional member $78
To order, please specify MEMO/400N

PROBABILISTIC PROBLEMS OF DISCRETE MATHEMATICS
V. F. Kolchin, Editor
(Proceedings of the Steklov Institute, Volume 177)
The papers in this collection are devoted to probabilistic questions in discrete mathematics and focus mainly on three areas: random mappings of finite sets, problems connected with the polynomial distribution, and the theory of branching processes.

Contents
V. A. Vatutin and S. M. Sagitov, A decomposable critical branching process with two types of particles
O. V. Viskov, A noncommutative approach to classical problems of analysis
A. M. Zubkov, Estimates for sums of finitely dependent indicators and for the instant of first occurrence of a rare event
V. A. Ivanov, Randomized decomposable statistics
G. I. Ivchenko, Yu. I. Medvedev, and A. F. Ronzhin, Decomposable statistics and goodness-of-fit tests for polynomial samples
I. B. Kalugin, A class of random mappings
V. G. Mikhailov, On the asymptotic normality of U-statistics with nonnegative kernels
A. I. Pavlov, On an equation in a symmetric semigroup
Yu. L. Pavlov, On random mappings with constraints on the number of cycles
V. E. Tarakanov, Linear transformations and $(0, 1)$-matrices
A. N. Trunov, Limit theorems in the problem of distributing identical particles in different cells
A. V. Chistyakov and N. V. Chistyakova, On asymptotically efficient estimators of system parameters from complex testing designs
A. L. Yakymiv, Asymptotics of the survival probability of critical Bellman-Harris branching processes

1980 Mathematics Subject Classifications: 05, 15, 20, 40, 41, 60, 62; 05, 19, 26, 43, 82
ISSN 0081-5438
224 pages (softcover), March 1989
Individual member $59, List price $98,
Institutional member $78
To order, please specify STEKLO/177N

SPACE MAPPINGS WITH BOUNDED DISTORTION
Yu. G. Reshetytnak
(Translations of Mathematical Monographs, Volume 73)
This book is intended for researchers and students concerned with questions in analysis and function theory. The author
provides an exposition of the main results obtained in recent years by Soviet and other mathematicians in the theory of mappings with bounded distortion, an active direction in contemporary mathematics. The mathematical tools presented can be applied to a broad spectrum of problems that go beyond the context of the main topic of investigation. For a number of questions in the theory of partial differential equations and the theory of functions with generalized derivatives, this is the first time they have appeared in an internationally distributed monograph.

Contents

Introduction
Some facts from the theory of functions of a real variable
Functions with generalized derivatives
Möbius transformations
Definition of a mapping with bounded distortion
Mappings with bounded distortion on Riemannian spaces
Main facts in the theory of mappings with bounded distortion
Estimates of the moduli of continuity and differentiability almost everywhere of mappings with bounded distortion
Some facts about continuous mappings on $R^n$
Conformal capacity
The concept of the generalized differential of an exterior form
Mappings with bounded distortion and elliptic differential equations
Topological properties of mappings with bounded distortion
Local structure of mappings with bounded distortion
Characterization of mappings with bounded distortion by the property of quasiconformity
Sequences of mappings with bounded distortion
The set of branch points of a mapping with bounded distortion and locally homeomorphic mappings
Extremal properties of mappings with bounded distortion
Some further results
Some results in the theory of functions of a real variable and the theory of partial differential equations
Functions with bounded mean oscillation
Harnack's inequality for quasilinear elliptic equations
Theorems on semicontinuity and convergence with a functional for functionals of the calculus of variations
Some properties of functions with generalized derivatives
On the degree of a mapping

ISBN 0-8218-4526-8, LC 89-72
ISSN 0065-9282
380 pages (hardcover), March 1989
Individual member $77, List price $129,
Institutional member $103
To order, please specify MMONO/73N

SOME MAJOR RESEARCH DEPARTMENTS OF MATHEMATICS
Saunders MacLane

With a biting wit and an engaging manner, Saunders Mac Lane, elder statesman of the American mathematical community, provides a historical perspective on the development of mathematics research departments in this country in this videotaped presentation. Starting with Berlin at the turn of the century and Götttingen in the 1930s, Mac Lane chronicles the influence of these departments on the development of mathematics in this country. He describes the strengths of some of the most influential American departments and evaluates the theory of "mathematical inheritance" as a method of building an excellent research department. He also provides interesting commentary on such issues as "objective rankings" of departments, some science policy issues, and the ills of calculus textbooks. In addition, Mac Lane's well-known affinity for verse comes into play as he enlivens the lecture with a number of humorous poems illustrating various themes in his talk.

1980 Mathematics Subject Classification: 01
VHS format, approx. one hour, March 1989
Price $59
To order, please specify VIDMACLANE/N

GEORG CANTOR: THE BATTLE FOR TRANSFINITE SET THEORY
Joseph W. Dauben

In this lively and engaging videotaped lecture, Dauben presents a fascinating look at Georg Cantor and the development of transfinite set theory. Dauben traces the evolution of Cantorian set theory with an emphasis on the opposition it met from Cantor's contemporaries. This meticulously researched lecture covers the mathematical, technical, philosophical, theological, and even psychological aspects of Cantor's struggle. Dauben describes Cantor's mental illness, the personal and mathematical attacks he endured, and his single-minded approach to his work. The use of photographs and other illustrations bring the subject to life as Dauben paints a gripping portrait of the brilliant but tormented life of Georg Cantor.

1980 Mathematics Subject Classification: 01, 00
VHS format, approx. one hour, March 1989
Price $59
To order, please specify VIDDAUBEN/N

Use the order form in the back of this issue or call 800-556-7774 to use VISA or MasterCard. Shipping and handling charges will be added.
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.


Boris Schein has been appointed by President William Browder to the Advisory Committee for the Russian-English Dictionary. Continuing members of the committee are Joseph N. Bernstein, Ralph P. Boas, chairman, James R. Bunch, Courtney S. Coleman, Joseph L. Doob, Bogdan Dudzik, Eugene Dynkin, Mark I. Freidlin, Paul R. Halmos, Edwin Hewitt, John R. Isbell, John McCarthy, Boris Mitryagin, Eric John Fye Primrose, Lawrence A. Shepp, and Ben Silver (ex officio).

President William Browder has appointed Morris W. Hirsch (1990), Rhonda J. Hughes (1990), and Irwin Kra (1990) to the Committee on Committees. Continuing members of the committee are William Browder (ex officio) and Robert M. Fossum (ex officio).

Hugh L. Montgomery (AMS), David P. Roselle (MAA), Mary Ellen Rudin (MAA), and Peter Sarnak (AMS) have been appointed by Presidents William Browder (AMS) and Lida K. Barrett (MAA) to the Joint Program Committee for the Louisville Meeting. Professor Sarnak will serve as chairman.

Reports of Past Meetings

The October Meeting in Lawrence

The eight-hundred-and-forty-fifth meeting of the American Mathematical Society was held at the University of Kansas in Lawrence, Kansas on Friday, October 28, and Saturday, October 29, 1988. There were 333 registrants, including 289 members of the Society.

Invited Addresses

By invitation of the Committee to Select Hour Speakers for Central Sectional Meetings, there were four invited one-hour addresses as follows: BJORN DAHLBERG, Washington University, Elliptic boundary value problems in nonsmooth domains, introduced by JILL PIPHER, STEVEN E. HURDER, University of Illinois at Chicago, Geometry and the index theory of foliations, introduced by NORBERTO SALINAS, PETER SCOTT, University of Michigan, Ann Arbor, Least area surfaces in 3-manifolds, introduced by DARRYL MCCULLOUGH, and SIDNEY M. WEBSTER, University of Minnesota, Minneapolis, The integrability problems of complex analysis, introduced by CHARLES HIMMELBERG.

Special Sessions

By invitation of the same committee, there were twelve special sessions of selected twenty-minute papers. The topics, organizers, and speakers follow: Partial differential equations – Geometric theory, ANDREW ACKER, Wichita State University. Speakers included Andrew Acker, Alan Elcrat, Victor Isakov, Kirk E. Lancaster, Gary Lieberman, Kenneth Miller, Harold R. Parks, George Paulik, Edward W. Stredulinski, Gerhart Stromer, Thomas Vogel, and Henry C. Wente.


Algebraic geometry, BRUCE CRAUDER and SHELDON KATZ,

Control theory, Tyronne Duncan, University of Kansas. Speakers include: Thomasz Bielecki, William M. Boothby, Richard Datko, Tyronne Duncan, Kurt Helmes, P. R. Kumar, Irena Lasiecka, Lawrence Markus, Clyde F. Martin, Bozenna Pasik-Duncan, Raymond Rishel, Roberto Triggiani, and F. S. Van Vleck.


Contributed Papers
There were 3 sessions for contributed papers. The session times, numbers of papers, and names of presiders follow: Friday afternoon, 1 paper, Sherry Gale of the University of Kansas. Saturday morning, 4 papers, Al Jenab of the University of Kansas. Saturday afternoon, 5 papers, Dave Nelson of the University of Kansas.

Local Arrangements
Local arrangements were handled by Philip Montgomery of the University of Kansas.

Andy Roy Magid
Associate Secretary
Norman, Oklahoma

The Council Meeting
in Phoenix
The Council met at 5:00 p.m. on 10 January 1989 in the Phoenix Ballroom of the Hyatt Regency Hotel. President William Browder was in the chair.


The Council received the report of the Tellers for the 1988 Election. (The results are noted elsewhere in this issue of Notices.) It received the report of the Teller for the Election to the Nominating Committee. The new members of the Nominating Committee are:

Joan S. Birman
James E. Humphreys
Victor Klee
Alan D. Weinstein
The Council received reports from several committees, among them the Committee on Science Policy, the Committee on Human Rights of Mathematicians, the Committee on Fellowship Policy, the AMS-MAA Committee on Employment and Educational Policy, the AMS-AAAS-MAA Mathematics for Underrepresented Minorities, the Committee on Election Scheduling (see below), and the Committee to Review Procedures of the Council in Considering Issues.

The Council, on recommendation of the Chairman of the Bulletin Editorial Committee, Roger Howe, authorized the Bulletin Editorial Committee to treat Research Announcements for the Bulletin in a manner in which it feels appropriate, for a period of two years. The Committee proposed a "shift in focus, to more heavily weighted expository values" and this shift has been approved by the Council for a trial period.

In the 1988 Election, the membership approved an amendment to the bylaws that removed the selection of editors from the election ballot to the membership. The selection of editors is now lodged with the Council according to Council action of 5 January 1988. The Council has established an Editorial Boards Committee (EBC) that will be elected by the membership in a manner similar to that in which the Nominating Committee is elected. In the steady state, two members of the EBC are elected by the membership by 10 November of each year. Since the bylaw affecting this change was not in place for the 1988 Election, but is in place now, the manner in which an Editorial Boards Committee should be named was referred to the Council. The Council recommended that the President immediately appoint six members of the EBC, two with terms through 1989, two with terms through 1990, and two with terms through 1991.

The Council supported and endorsed the vision of school mathematics contained in the National Council of Teachers of Mathematics "Curriculum and Evaluation Standards for School Mathematics" by passing the following resolution:

The AMS recognizes and appreciates the quality and quantity of effort of the Working Groups of the Commission on Standards for School Mathematics of the National Council of Teachers of Mathematics. The Society welcomes the proposal of these Standards as a model set of valued outcomes for school mathematics (K-12) and supports and endorses the vision of school mathematics contained in the Standards.

The Society joins in calling for:

i. considerable strengthening of programs to train teachers of school mathematics;
ii. efforts to promote sufficient funding and support by local, state, federal and private sources to ensure that the Standards can be effectively implemented;
iii. active involvement by AMS members in joining with local groups to work for the betterment of school mathematics.

The Council approved participation of the Society for Industrial and Applied Mathematics (SIAM) in the AMS-MAA joint publication UME TRENDS, a newsletter for collegiate mathematics.

The Council considered several items from the report of the Committee on Election Scheduling. (A detailed account of this report appears elsewhere in this issue of Notices.) It approved the report's recommendation on the term and number of members of the Nominating Committee. The term of office for the Nominating Committee will be three years, the term will begin on September 1 the year after election, and three members will be elected each year.

The Council tabled a motion that would increase the term of office of the Vice-President to three years. The Council agreed to consider further the recommendations in the report at its meeting in April 1989.

The Council heard a report from Kenneth Hoffman, the Head of the Office of Governmental and Public Affairs of the Joint Policy Board for Mathematics. Also, Marcia Sward, the Executive Director of the Mathematical Sciences Education Board, reported on Mathematics Education in the National Spotlight.

The Council and the Board of Trustees have agreed on one new publishing venture and a modification of an already existing series. The Council agreed to establish a series entitled Proceedings of Regional Conferences of the USSR that the Board of Trustees had provisionally approved. It agreed to co-publish, with the London Mathematical Society, the series History of Mathematics, again following the Board of Trustees' provisionally approval.

The Council approved the following resolution (at the request of ArborText, Inc.):

The Council agrees that orders from South Africa for ArborText, Inc. products sold by the Society be returned to the sender along with a statement that ArborText, Inc. does not allow sales in South Africa.

Finally, the Council agreed with the Board of Trustees to establish...
an annual prize to be administered by Pi Mu Epsilon, the national honorary mathematics society, with the stipulation that the name of the Society be associated with the prize.

The Council had recessed for dinner from 7:00 p.m. to 8:00 p.m. and adjourned at 12:50 a.m. the following day.

**Robert M. Fossum**
Secretary
Urbana, Illinois

### The Business Meeting in Phoenix

The Business Meeting was held on 12 January 1989 in the Ballroom of the Civic Plaza immediately following the session for the award of the Bocher Prize. President Browder was in the chair.

The President announced that Herbert Freedman of the Canadian Mathematical Society had presented the Society with a copy of the Fields Medal struck from the original molds as a gift from the Canadian Mathematical Society in honor of the Centennial of the Society.

The President then gave the floor to Ronald L. Graham who in turn introduced Dr. Boris Stechkin, member of the Steklov Institute and Secretary of the Soviet Committee of the Bernoulli Society for Mathematical Statistics and the Theory of Probability. In commemoration of the Society's Centennial, Dr. Stechkin presented it with a bronze medal struck in the Soviet Union on the occasion of the First General World Congress on Mathematical Statistics and the Theory of Probability held in Tashkent, Soviet Union, in 1986.

The Secretary reported that Professor Marshall Stone, President 1943-1944, had died earlier that week (see the article in the front of this issue of *Notices*) and that Dr. Gordon Walker, Executive Director of the Society from 1959 to 1977, had died in December 1988 (see page 139 of the February 1989 issue of *Notices*). After brief mention that the Society is embarking on its second century, the Secretary reported on the actions of the Council as detailed above.

The meeting then dissolved itself into a Committee of the Whole, with Andrew Gleason in the chair, to discuss the report to the Council of the Society by the ad hoc Election Scheduling Committee. (This report is discussed elsewhere in this issue of *Notices*.)

After rising from the Committee of the Whole (with no report) and with President Browder in the chair, the Meeting thanked the Local Arrangements Committee for its efforts in arranging the 95th Annual Meeting and then adjourned.

**Robert M. Fossum**
Secretary
Urbana, Illinois

### Election Results of 1988

The Tellers for the 1988 Election reported counting 3741 and 2/3 ballots. The newly elected Vice-President is Sun-Yung Alice Chang. The newly elected Members-at-Large of the Council are Jonathan L. Alperin, Fan R. K. Chung, Lawrence J. Corwin, Michael C. Reed, and Hugo Rossi. The newly elected Trustee is Paul J. Sally, Jr.

All candidates in uncontested elections were elected to their respective offices.

The candidates elected to the Nominating Committee of 1989-1990 are Joan S. Birman, James E. Humphreys, Victor L. Klee, Jr., and Alan D. Weinstein.

The two proposed amendments to the bylaws, the one concerning sexist language and the other concerning the Editorial Boards Committee, were approved.

The composition of the Council for 1989 follows.

**COUNCIL FOR 1989**

Ex-President
George Daniel Mostow

President
William Browder

Vice Presidents
Sun-Yung Alice Chang
Barry Simon
William P. Thurston

Former Secretary
Everett Pitcher

Secretary
Robert M. Fossum

Associate Secretaries
Joseph A. Cima
W. Wistar Comfort
Andy Roy Magid
Lance W. Small

Treasurer
Franklin P. Peterson

Associate Treasurer
Steve Armentrout

Members-at-Large
Jonathan L. Alperin
Fan R. K. Chung
Lawrence J. Corwin
Richard K. Guy
Rhonda J. Hughes
Robion C. Kirby
Irwin Kra
H. Blaine Lawson, Jr.
Albert Marden
Yiannis N. Moschovakis
Linda A. Ness
Michael C. Reed
Marc A. Rieffel
Hugo Rossi
Harold M. Stark
William A. Veech
Carol S. Wood
ALGEBRAIZABLE LOGICS
W. J. Blok and Don Pigozzi
(Memoirs of the AMS, Number 396)

Although most of the familiar logical systems are known to have an algebraic counterpart, no general and precise notion of an algebraizable logic exists upon which a systematic investigation of the process of algebraization can be based. In this work, the authors propose and begin such an investigation. Their main result is an intrinsic characterization of algebraizability in terms of the Leibniz operator $\Omega$, which associates to each theory $T$ of a given deductive system $S$ a congruence relation $\Omega T$ on the formula algebra. $\Omega T$ identifies all formulas that cannot be distinguished from one another, on the basis of $T$, by any property expressible in the language of $S$. The characterization theorem states that a deductive system $S$ is algebraizable if and only if $\Omega$ is one-to-one and order-preserving on the lattice of $S$-theories and also preserves directed unions. The authors illustrate these results with a large number of examples from modal and intuitionistic logic, relevance logic, and classical predicate logic.

1980 Mathematics Subject Classifications: 03G99; 03B45, 03B55, 03B60, 03C05, 08C15
ISSN 0065-9266
88 pages (softcover), January 1989
Individual member $8$, List price $13$.
Institutional member $10$
To order, please specify MEMO/396NA

Shipping/Handling: 1st book $2$, each add’l $1$, $25$max. By air, 1st book $5$, each add’l $3$, $100$ max.
Prepayment required. Order from AMS, P.O. Box 1571,
Annex Station, Providence, RI 02901-1571, or call
800-556-7774 to use VISA or MasterCard.
**Personal Items**

Zhao Yi Chun, of the People's Republic of China, will be a visiting professor at Appalachian State University during the spring semester of 1989. His area of research interest is operator theory.

Lawrence H. Cox, Director, Board on Mathematical Sciences, National Academy of Sciences, has been elected to membership in the International Statistical Institute.

Otomar Hajek, Professor of Mathematics at Case Western Reserve University, has received a joint appointment as Professor of Systems Engineering at this same institution.

Benoit Mandelbrot was one of the joint recipients of the newly created Moët Hennessy-Louis Vuitton (LVMH) Science for Art prize. He was honored for his work in fractal geometry.

Patrick L. Reilly, of Alcatel Network Systems, was appointed a reviewer for IEEE Transactions on Communications and listed in Who's Who in the South and Southwest, 1989.

Ellen Torrance, formerly of M & R Services, Inc., is now an Associate Actuary at First Colony Life Insurance Company in Lynchburg, Virginia.

**Deaths**

Elliot T. Adams, of Newtonville, Massachusetts, died on January 3, 1989, at the age of 89. He was a member of the Society for 11 years.

J. Frank Adams, Lowndean Professor of Astronomy and Geometry at the University of Cambridge, died on January 7, 1989, at the age of 58. He was a member of the Society for 31 years. (See the News and Announcements section of this issue of Notices.)

Luther Thomas Conner, Jr., Associate Professor Emeritus of the College of William and Mary, died on November 4, 1988, at the age of 56. He was a member of the Society for 23 years.

Ronald J. DiPerna, of the University of California, Berkeley, died on January 8, 1989, at the age of 41. He was a member of the Society for 18 years. (See the News and Announcements section of this issue of Notices.)

Manfred Kochen, of Ann Arbor, died on January 7, 1989, at the age of 60. He was a member of the Society for 35 years.

Kenneth P. McDowell, formerly of Wilfred Laurier University, died on September 26, 1988, at the age of 41. He was a member of the Society for 14 years.

Marshall H. Stone, Professor Emeritus of the University of Massachusetts, Amherst, died on January 9, 1989, at the age of 85. He was a member of the Society for 62 years. A memorial service will be held for him on Sunday, April 8, 1989 at the University of Massachusetts, Amherst. For details, please contact T. A. Cook, 413-545-0874, or M. K. Bennett, 413-549-0545, at the Department of Mathematics and Statistics. (See the item at the beginning of this issue of Notices.)
## New Members of the AMS

### ORDINARY MEMBERS

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alexander B Abacus</td>
<td>La Jolla, California</td>
<td></td>
</tr>
<tr>
<td>Lara L Aist</td>
<td>Catonsville, Maryland</td>
<td></td>
</tr>
<tr>
<td>Alton L Amidon</td>
<td>Havelock, North Carolina</td>
<td></td>
</tr>
<tr>
<td>E Ya Arnaudova</td>
<td>Higher Institute of Architecture and Construction</td>
<td>Sofia, Bulgaria</td>
</tr>
<tr>
<td>Czeslaw Baginski</td>
<td>University of Warsaw</td>
<td>Bialystok, Poland</td>
</tr>
<tr>
<td>Randall K Bahr</td>
<td>Tucson, Arizona</td>
<td></td>
</tr>
<tr>
<td>Lucas M Bernard</td>
<td>New York, New York</td>
<td></td>
</tr>
<tr>
<td>David P Blecher</td>
<td>University of Houston</td>
<td>Houston, Texas</td>
</tr>
<tr>
<td>Dona V Boccio</td>
<td>Bayside, New York</td>
<td></td>
</tr>
<tr>
<td>Jerald S Brodkey</td>
<td>Beachwood, Ohio</td>
<td></td>
</tr>
<tr>
<td>Alton R Brown</td>
<td>McLean, Virginia</td>
<td></td>
</tr>
<tr>
<td>Michael J Bryan</td>
<td>Terre Haute, Indiana</td>
<td></td>
</tr>
<tr>
<td>Elmer J Bryson</td>
<td>National City, California</td>
<td></td>
</tr>
<tr>
<td>L-Liang Chern</td>
<td>New York University, Courant Institute of Mathematical Sciences New York, New York</td>
<td></td>
</tr>
<tr>
<td>Zhong Wu Chu</td>
<td>Harbin Institute of Technology</td>
<td>Harbin, People's Republic of China</td>
</tr>
<tr>
<td>Victor V Cifarelli</td>
<td>University of California, San Diego</td>
<td>La Jolla, California</td>
</tr>
<tr>
<td>Joseph N Closs</td>
<td>Philadelphia, Pennsylvania</td>
<td></td>
</tr>
<tr>
<td>Stephane Blaise Collart</td>
<td>Zurich, Switzerland</td>
<td></td>
</tr>
<tr>
<td>J Kevin Colligan</td>
<td>Silver Spring, Maryland</td>
<td></td>
</tr>
<tr>
<td>Manuel De Leon</td>
<td>Consejo Superior de Investigaciones Cientificas</td>
<td>Madrid, Spain</td>
</tr>
<tr>
<td>Matthew J Dempsey</td>
<td>St Louis, Missouri</td>
<td></td>
</tr>
<tr>
<td>Tong Ren Ding</td>
<td>Peking University</td>
<td>Beijing, People's Republic of China</td>
</tr>
<tr>
<td>Do Van Lu</td>
<td>Hanoi, Socialist Republic of Vietnam</td>
<td></td>
</tr>
<tr>
<td>Michael A Eckhoff</td>
<td>Bay St Louis, Mississippi</td>
<td></td>
</tr>
<tr>
<td>Alexandre Ern</td>
<td>Ecole Polytechnique</td>
<td>Palaiseau, France</td>
</tr>
<tr>
<td>Marian Fabian</td>
<td>Prague, Czechoslovakia</td>
<td></td>
</tr>
<tr>
<td>Jin Xuan Fang</td>
<td>Nanjing, People's Republic of China</td>
<td></td>
</tr>
<tr>
<td>S S Goncharov</td>
<td>Novosibirsk, U S S R</td>
<td></td>
</tr>
<tr>
<td>Carol Harris</td>
<td>Lexington, Kentucky</td>
<td></td>
</tr>
<tr>
<td>John C Hedreen</td>
<td>Baltimore, Maryland</td>
<td></td>
</tr>
<tr>
<td>Robert E Heyman</td>
<td>University of Maryland</td>
<td>College Park, Maryland</td>
</tr>
<tr>
<td>Robert N Hightower</td>
<td>Ann Arbor, Michigan</td>
<td></td>
</tr>
<tr>
<td>Kris L Holderness</td>
<td>Grand Junction, Colorado</td>
<td></td>
</tr>
<tr>
<td>Bruce D Holenstein</td>
<td>Compucon Service</td>
<td>West Chester, Pennsylvania</td>
</tr>
<tr>
<td>Askol'd Georgievic Hovanskii</td>
<td>VNIISI</td>
<td>Moscow, U S S R</td>
</tr>
<tr>
<td>Everett W Howe</td>
<td>San Leandro, California</td>
<td></td>
</tr>
<tr>
<td>Paul M Hunt</td>
<td>Williamston, Michigan</td>
<td></td>
</tr>
<tr>
<td>Cheryl L Ingram</td>
<td>Joplin, Missouri</td>
<td></td>
</tr>
<tr>
<td>Antal Ivanyi</td>
<td>Eotvos Lorand University</td>
<td>Budapest, Hungary</td>
</tr>
<tr>
<td>Piotr Jaworski</td>
<td>University of Warsaw</td>
<td>Warsaw, Poland</td>
</tr>
<tr>
<td>Nitin S Joshi</td>
<td>Flushing, New York</td>
<td></td>
</tr>
<tr>
<td>V M Kharlamov</td>
<td>Leningrad, U S S R</td>
<td></td>
</tr>
<tr>
<td>John F Kinkel</td>
<td>Irvine, California</td>
<td></td>
</tr>
<tr>
<td>I A Klipker</td>
<td>Tbilisi, U S S R</td>
<td></td>
</tr>
<tr>
<td>Kenneth A Kobun</td>
<td>San Ramon, California</td>
<td></td>
</tr>
<tr>
<td>Ulle Kotta</td>
<td>Estonian SSR Academy of Sciences</td>
<td>Tallinn, U S S R</td>
</tr>
<tr>
<td>Dimitry A Leites</td>
<td>University of Stockholm</td>
<td>Stockholm, Sweden</td>
</tr>
<tr>
<td>S Z Levendorskii</td>
<td>Rostov-on-Don, U S S R</td>
<td></td>
</tr>
<tr>
<td>Florence J Lin</td>
<td>Upton, New York</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Institution 1</td>
<td>Location 1</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Long Wei Lin</td>
<td>Zhongshan University</td>
<td>Guangzhou, China</td>
</tr>
<tr>
<td>Paul R Lowe</td>
<td>Monterey, California</td>
<td></td>
</tr>
<tr>
<td>Adam Lozowicki</td>
<td>Szczecin, Poland</td>
<td></td>
</tr>
<tr>
<td>Rodney Neal Lynch</td>
<td>Crawfordsville, Indiana</td>
<td></td>
</tr>
<tr>
<td>Satyagopal Mandal</td>
<td>University of Kansas</td>
<td>Lawrence, Kansas</td>
</tr>
<tr>
<td>Dragan Marusic</td>
<td>Koper, Yugoslavia</td>
<td></td>
</tr>
<tr>
<td>Deborah Gibson McAtee</td>
<td>Montana State University</td>
<td>Bzman, Montana</td>
</tr>
<tr>
<td>Phillip E McNeil</td>
<td>Norfolk State University</td>
<td>Norfolk, Virginia</td>
</tr>
<tr>
<td>Albert J Milani</td>
<td>University of Wisconsin-Milwaukee</td>
<td>Milwaukee, Wisconsin</td>
</tr>
<tr>
<td>Ralph J Money Jr</td>
<td>Bridgeport, Connecticut</td>
<td></td>
</tr>
<tr>
<td>Michael S Moore</td>
<td>Pomona, California</td>
<td></td>
</tr>
<tr>
<td>Richard P Morris</td>
<td>Centreville, Virginia</td>
<td></td>
</tr>
<tr>
<td>Rajeev Motwani</td>
<td>Stanford University</td>
<td>Stanford, California</td>
</tr>
<tr>
<td>Toshikazu Natsume</td>
<td>State University of New York at Buffalo</td>
<td>Buffalo, New York</td>
</tr>
<tr>
<td>Mary Louise Nigro</td>
<td>Newton Square, Pennsylvania</td>
<td></td>
</tr>
<tr>
<td>David M Obrzut</td>
<td>Laurel, Maryland</td>
<td></td>
</tr>
<tr>
<td>Anatol Odzijewicz</td>
<td>Warsaw University</td>
<td>Biatystok, Poland</td>
</tr>
<tr>
<td>Haluk Ogmen</td>
<td>University of Houston</td>
<td>Houston, Texas</td>
</tr>
<tr>
<td>John Pais</td>
<td>Webster University</td>
<td>St Louis, Missouri</td>
</tr>
<tr>
<td>Tim F Parrott</td>
<td>Easley, South Carolina</td>
<td></td>
</tr>
<tr>
<td>Cornel Pasnicu</td>
<td>INCREST</td>
<td>Bucharest, Romania</td>
</tr>
<tr>
<td>Luca F Pavarino</td>
<td>New York University, Courant</td>
<td>Institute of Mathematical Sciences</td>
</tr>
<tr>
<td>Wieslaw Pawlukici</td>
<td>Jagiellonian University</td>
<td>Krakow, Poland</td>
</tr>
<tr>
<td>Pham Huy Dien</td>
<td>Institute of Mathematics</td>
<td>Hanoi, Socialist Republic of Vietnam</td>
</tr>
<tr>
<td>Glenn A Pico</td>
<td>Sacramento, California</td>
<td></td>
</tr>
<tr>
<td>Robert M Purcell</td>
<td>King of Prussia, Pennsylvania</td>
<td></td>
</tr>
<tr>
<td>Charles C Quillen</td>
<td>Gate City, Virginia</td>
<td></td>
</tr>
<tr>
<td>Fuyao Ren</td>
<td>Fudan University</td>
<td>Shanghai, People's Republic of China</td>
</tr>
<tr>
<td>Diane Resek</td>
<td>Berkeley, California</td>
<td></td>
</tr>
<tr>
<td>Nenad Rijavec</td>
<td>Fort Collins, Colorado</td>
<td></td>
</tr>
<tr>
<td>Roger A Roberts</td>
<td>Littleton, Colorado</td>
<td></td>
</tr>
<tr>
<td>Michael H Ruge</td>
<td>Louisiana State University</td>
<td>Baton Rouge, Louisiana</td>
</tr>
<tr>
<td>William Joseph Ryan</td>
<td>Willingboro, New Jersey</td>
<td></td>
</tr>
<tr>
<td>Ronald D Sandstrom</td>
<td>Fort Hays State University</td>
<td>Hays, Kansas</td>
</tr>
<tr>
<td>Leland Sapiro</td>
<td>Paul Quinn College</td>
<td>Waco, Texas</td>
</tr>
<tr>
<td>Stanislaw Sedziwy</td>
<td>Jagiellonian University</td>
<td>Krakow, Poland</td>
</tr>
<tr>
<td>Michael Joseph Segal</td>
<td>Williamsville, New York</td>
<td></td>
</tr>
<tr>
<td>Douglas A Sharp</td>
<td>St John's School</td>
<td>Houston, Texas</td>
</tr>
<tr>
<td>Diana Frost Shelstad</td>
<td>Tarrytown, New York</td>
<td></td>
</tr>
<tr>
<td>Meir Shillor</td>
<td>Oakland University</td>
<td>Rochester, Michigan</td>
</tr>
<tr>
<td>Jun Yong Shin</td>
<td>Arlington, Texas</td>
<td></td>
</tr>
<tr>
<td>James S Sochacki</td>
<td>James Madison University</td>
<td>Harrisonburg, Virginia</td>
</tr>
<tr>
<td>Carol J Stafney</td>
<td>Platteville, Wisconsin</td>
<td></td>
</tr>
<tr>
<td>Elizabeth K Stage</td>
<td>University of California, Berkeley</td>
<td>Berkeley, California</td>
</tr>
<tr>
<td>William W Symes</td>
<td>Rice University</td>
<td>Houston, Texas</td>
</tr>
<tr>
<td>James Sochacki</td>
<td>China</td>
<td></td>
</tr>
<tr>
<td>Luca F Pavarino</td>
<td>James Madison University</td>
<td>Harrisonburg, Virginia</td>
</tr>
<tr>
<td>Paul R Lowe</td>
<td>Monterey, California</td>
<td></td>
</tr>
<tr>
<td>Phillip E McNeil</td>
<td>Norfolk State University</td>
<td>Norfolk, Virginia</td>
</tr>
<tr>
<td>Albert J Milani</td>
<td>University of Wisconsin-Milwaukee</td>
<td>Milwaukee, Wisconsin</td>
</tr>
<tr>
<td>Ralph J Money Jr</td>
<td>Bridgeport, Connecticut</td>
<td></td>
</tr>
<tr>
<td>Michael S Moore</td>
<td>Pomona, California</td>
<td></td>
</tr>
<tr>
<td>Richard P Morris</td>
<td>Centreville, Virginia</td>
<td></td>
</tr>
<tr>
<td>Rajeev Motwani</td>
<td>Stanford University</td>
<td>Stanford, California</td>
</tr>
<tr>
<td>Toshikazu Natsume</td>
<td>State University of New York at Buffalo</td>
<td>Buffalo, New York</td>
</tr>
<tr>
<td>Mary Louise Nigro</td>
<td>Newton Square, Pennsylvania</td>
<td></td>
</tr>
<tr>
<td>David M Obrzut</td>
<td>Laurel, Maryland</td>
<td></td>
</tr>
<tr>
<td>Anatol Odzijewicz</td>
<td>Warsaw University</td>
<td>Biatystok, Poland</td>
</tr>
<tr>
<td>Haluk Ogmen</td>
<td>University of Houston</td>
<td>Houston, Texas</td>
</tr>
<tr>
<td>John Pais</td>
<td>Webster University</td>
<td>St Louis, Missouri</td>
</tr>
<tr>
<td>Tim F Parrott</td>
<td>Easley, South Carolina</td>
<td></td>
</tr>
<tr>
<td>Long Wei Lin</td>
<td>Zhongshan University</td>
<td>Guangzhou, China</td>
</tr>
<tr>
<td>Paul R Lowe</td>
<td>Monterey, California</td>
<td></td>
</tr>
<tr>
<td>Adam Lozowicki</td>
<td>Szczecin, Poland</td>
<td></td>
</tr>
<tr>
<td>Rodney Neal Lynch</td>
<td>Crawfordsville, Indiana</td>
<td></td>
</tr>
<tr>
<td>Satyagopal Mandal</td>
<td>University of Kansas</td>
<td>Lawrence, Kansas</td>
</tr>
<tr>
<td>Dragan Marusic</td>
<td>Koper, Yugoslavia</td>
<td></td>
</tr>
<tr>
<td>Deborah Gibson McAtee</td>
<td>Montana State University</td>
<td>Bzman, Montana</td>
</tr>
<tr>
<td>Phillip E McNeil</td>
<td>Norfolk State University</td>
<td>Norfolk, Virginia</td>
</tr>
<tr>
<td>Albert J Milani</td>
<td>University of Wisconsin-Milwaukee</td>
<td>Milwaukee, Wisconsin</td>
</tr>
<tr>
<td>Ralph J Money Jr</td>
<td>Bridgeport, Connecticut</td>
<td></td>
</tr>
<tr>
<td>Michael S Moore</td>
<td>Pomona, California</td>
<td></td>
</tr>
<tr>
<td>Richard P Morris</td>
<td>Centreville, Virginia</td>
<td></td>
</tr>
<tr>
<td>Rajeev Motwani</td>
<td>Stanford University</td>
<td>Stanford, California</td>
</tr>
<tr>
<td>Toshikazu Natsume</td>
<td>State University of New York at Buffalo</td>
<td>Buffalo, New York</td>
</tr>
<tr>
<td>Mary Louise Nigro</td>
<td>Newton Square, Pennsylvania</td>
<td></td>
</tr>
<tr>
<td>David M Obrzut</td>
<td>Laurel, Maryland</td>
<td></td>
</tr>
<tr>
<td>Anatol Odzijewicz</td>
<td>Warsaw University</td>
<td>Biatystok, Poland</td>
</tr>
<tr>
<td>Haluk Ogmen</td>
<td>University of Houston</td>
<td>Houston, Texas</td>
</tr>
<tr>
<td>John Pais</td>
<td>Webster University</td>
<td>St Louis, Missouri</td>
</tr>
<tr>
<td>Tim F Parrott</td>
<td>Easley, South Carolina</td>
<td></td>
</tr>
</tbody>
</table>
### New Members of the AMS

| Jorge Passamani Zubelli  
| University of California, Berkeley  
<table>
<thead>
<tr>
<th>Berkeley, California</th>
</tr>
</thead>
</table>

**RECIPIROCITY MEMBERS**

| Allahabad Mathematical Society  
| M S Mittal  
<table>
<thead>
<tr>
<th>Balasubramanian Natarajan</th>
</tr>
</thead>
</table>

| Deutsche Mathematiker-Vereinigung e. V.  
| Wilhelm Plesken  
<table>
<thead>
<tr>
<th>Horst R Thieme</th>
</tr>
</thead>
</table>

| Gesellschaft für Angewandte Mathematics und Mechanik  
<table>
<thead>
<tr>
<th>Herbert Niessner</th>
</tr>
</thead>
</table>

| Iranian Mathematical Society  
<table>
<thead>
<tr>
<th>Ali A Alikhani</th>
</tr>
</thead>
</table>

| Sociedade Portuguesa de Matemática  
<table>
<thead>
<tr>
<th>Olga Azenhas</th>
</tr>
</thead>
</table>

| Svenska Matematikersamfundet  
<table>
<thead>
<tr>
<th>Henrik O.Egnell</th>
</tr>
</thead>
</table>

**NOMINEE MEMBERS**

| Beloit College  
<table>
<thead>
<tr>
<th>Tames Lengyl</th>
</tr>
</thead>
</table>

| Bowdoin College  
<table>
<thead>
<tr>
<th>Susan M L Anderson</th>
</tr>
</thead>
</table>

| Bowling Green State University  
| Alphonse K A Amey  
| Gregory A Bastian  
| Stephen P Bean  
| Kaddour Boukaab  
| John H Carson  
| Dexin Chen  
| Elise C Goldie  
| Sunil M Koswatta  
| Dianne I Mesker  
| Supriya Mohanty  
| Piotr J Wojciechowski  
<table>
<thead>
<tr>
<th>John E Zimmerman</th>
</tr>
</thead>
</table>

| Brock University  
<table>
<thead>
<tr>
<th>Peggy Ann Rosehart</th>
</tr>
</thead>
</table>

| Bucknell University  
<table>
<thead>
<tr>
<th>Carmen O Acuna</th>
</tr>
</thead>
</table>

| Carnegie Mellon University  
| Nenad Antonic  
| Edgar O Baules  
| Chih-Wen Cheng  
| Enrico Tronci  
<table>
<thead>
<tr>
<th>Kostas Vassilakis</th>
</tr>
</thead>
</table>

| Central Michigan University  
| Paul M Carolin  
| Patti L Freet  
| William M Higdon  
<table>
<thead>
<tr>
<th>Patrick Lo Jennings</th>
</tr>
</thead>
</table>

| Michele Rene Norton  
| Gail E Nowicki  
| Troy E O'Brien  
| Linda K Smoke  
| Andrew Jay Tierman  
| Clark University  
| Jun Chang  
| College of the Holy Cross  
| Michele Intermont  
| Tamara S Trombetta  
| Colorado College  
| Mary K Gessley  
| Cornell University  
| Chung-Kwan Choi  
| Darroch Faught  
| Boris Goldfarb  
| Vee Ming Lew  
| Jiqil Luo  
| Scott Alan Mitchell  
| Claudia M Neuhauser  
| Poorvi L Vora  
| Patrick A Worfolk  
| Dartmouth College  
| David N Bray  
| Alisa A DeStefano  
| Michael J Glenn  
| Margaret Hagopian  
| Thalia D Jeffre  
| Peter J Kostelec  
| Larry Joseph Langley  
| Thomas E Leathram  
| Stephen R Peeples  
| Duke University  
| Shandelle M Henson  
| Christopher Scott Peterson  
| Charles M Vuono  
| Duquesne University  
| Vivien C Wang  
| Florida Atlantic University  
| Manny B DeCastro  
| Arumugam Muhundan  
| Xuegong Wu  
| Xuan Xu  
| Franklin & Marshall College  
| Marjolien de Wit  
| Harvard University  
| Eric David Belsley  
| Srdjan Divac  
| Kefeng Liu  
| Michael Liam McQuillan  
| Luca Migliorini  
| Wei-Dong Ruan  
| Jeffrey Silver  
| Donald C Weitzman  
| Haverford College  
<table>
<thead>
<tr>
<th>Marc J Melitz</th>
</tr>
</thead>
</table>

| Institute for Defense Analyses  
<table>
<thead>
<tr>
<th>David L desJardins</th>
</tr>
</thead>
</table>

| Loyola Marymount University  
<table>
<thead>
<tr>
<th>Connie J Weeks</th>
</tr>
</thead>
</table>

| Mankato State University  
| Tim Braam  
| Shu-Ling Chang  
| Chien-Chow Chen  
| Charles J Felber  
| Chien-Chuan Tang  
<table>
<thead>
<tr>
<th>Shu-Chin W Weng</th>
</tr>
</thead>
</table>

| McMaster University  
| Anita Bhardwaj  
| Xiangdong Chen  
| Yannis Papageorgiou  
| Peter Teichner  
<table>
<thead>
<tr>
<th>Qiang Zhu</th>
</tr>
</thead>
</table>

| Miami University, Oxford  
| Jeremy S Case  
| Joan Elizabeth Hart  
<table>
<thead>
<tr>
<th>David L Stuckey</th>
</tr>
</thead>
</table>

| Michigan State University  
| Fauuzi Azzouz  
| Richard Weston Beverly  
| Brian K Bury  
| Benjamin E Caldwell  
| Douglas Olaf Carlson  
| Halil I Celik  
| Tsyr-Min Chang  
| Jing-Fen Chen  
| Dawn Aisha Crumpler  
| Patrick M Garrity  
| Cynthia Gwilym  
| Ming Jin  
| Stanley S Johnson  
| Jack A Jordan  
| Mirjana S Jovovic  
| Jeffrey W Koch  
| Timothy M Koponen  
| Timothy F LaVan  
| Samir I Lababidi  
| Meng-Shiuin Lai  
| Jungho Lee  
| Bo Ling  
| Sanjay Sadanand Mundkur  
| Ecaterina Nagy  
| Fouad S Nakhli  
| Edgar A Ramos  
| Richard A Reynolds  
| Hossen Sadri  
| Radhouane Sellami  
| Wenxian Shen  
| Kejian Shi  
| Stephen P Smith  
| Todd M Swanson  
| Yoshihiko Tazawa  
| William A Wallace  
| Heungsuk Yi  
| Xiangfei Zeng  
<table>
<thead>
<tr>
<th>Zhonggang Zeng</th>
</tr>
</thead>
</table>

MARCH 1989, VOLUME 36, NUMBER 3

329
| New York University, Courant Institute of Mathematical Sciences  
Vincenzo Nesi  
|  
| Northeast Missouri State University  
David L Bergevin  
William J Schnett  
|  
| Northern Illinois University  
Wei-Han Chang  
Samar Choudhary  
Ran Baik Lee  
Frank J Marzano  
Janet M Norbrothen  
Sheryl L Wills  
|  
| Oklahoma State University, Stillwater  
Brian W Box  
Dorothy A Jones  
John D Lorch  
Charles A Matthews  
Deborah Ann Moore  
Kimberly A Overstreet  
Martha Ellen Waggner  
|  
| Princeton University  
Nikolaos Bourneavas  
Galina D Dafni  
Charles R Farenbaugh  
Chen-Hao Liu  
Robert F Sherry  
Jaroslaw Wroblewski  
|  
| Providence College  
Jeffrey T Hoag  
|  
| Purdue University  
Geon Cho  
Darrel F Czubala  
Donatella Delfino  
Kai Deng  
Steve Fan  
Mark R Johnson  
Shanzhong Lai  
Moibyin Lee  
Hua-Lun Li  
Xianjin Li  
Nianzheng Liu  
Radha Mohan  
Eun Jae Park  
Maria Tjani  
Bert G Wachsmuth  
Li-Ming Yeh  
Ikkkwon Yie  
Seongan Yie  
Bo Zhang  
Minda Zhang  
Zhuoyuan Zhang  
|  
| Rice University  
Ning Lu  
Chi Cheung Poon  
John W Zweck  
|  
| Shippensburg University of Pennsylvania  
Sandra Gorka  
Donald A Morton  
|  
| Kathryn M Sibert  
Kimberly M Storz  
Simon Fraser University  
S Bhattia  
Salil K Das  
Carlos A Wong  
Siming Zhar  
Southern Oregon State College  
Reider S Peterson  
Stanford University  
Victoria E Bourne  
David B Cruz  
John Whitaker Havlicek  
Bryna R Kra  
Jianan Lu  
Christopher D Overton  
Texas A & M University  
Gregory Lindstrom  
Michael Lee Wade  
Trinity College  
Stanislaus Whittlesey  
Tufts University  
Babette M Benken  
Martha A Sunderhauf  
Zhenhua Zhang  
Yiyi Zhou  
University of California, Irvine  
Ramakrishna Kakarala  
Michael J Shearer  
University of California, Los Angeles  
David S Blackwell  
Eric Neil Boe  
Douglas C Bowman  
Roger E Hagen  
Brian Joseph Hagerty  
Erik J Hanson  
Guanghan Liu  
Erding Luo  
Maria M Morril  
Bradley Moskowitz  
Mark N Olson  
Roberto Paolletti  
Jie Qing  
Eliaho Regwan  
Carlos Sanchez-Fuentes  
Larry Lucian Scott  
William R Sherman  
Rodney F Sinclair  
Martin G St Pierre  
Mark M Sussman  
Brian Scott Tabor  
Hai H Vu  
Brad Lee Wilson  
Yunwei Zhao  
Lisette G de Pillis-Lindheim  
University of California, San Diego  
Mark S Foskey  
University of Chicago  
Harel Barzilai  
Jan Cheah  
Youngsoo Choi  
Najmuddin A Fakhruddin  
Young-Rock Kim  
Holger Philipp Kley  
Byung Ho Song  
Troy R Zerr  
University of Florida  
Thomasenia Lott Adams  
James Timothy Bock  
Mohammad Habibi  
Tohien Thi Hoang  
Jun H Li  
Michael Alan Marks  
Melissa Landers McCool  
Renming Song  
T J Wangerman  
Yongzhui Yang  
Huixia Zhu  
University of Georgia  
Francis Levi Barnes  
Peiqing Jiang  
University of Idaho  
Peter Joel Bloomburg  
Tae Sug Do  
Burma L Hutchinson  
Chao-Hui Lan  
Mark C Lotspeich  
Charles H Newberg  
Robert R Park  
John J Thurber  
Stewart M Tung  
Kimberly M Vincent  
University of Illinois at Urbana-Champaign  
Maitreyee Bera  
Donna J Berg  
Q Y Bu  
Bruce F Carpenter  
Catherine E Cavagnaro  
Felix T K Cheng  
Rick G Faber  
Kevin F Fitzgerald  
M Fritz  
Steven Robert Gale  
Tom S Harke  
Karina Luisa Johnsgard  
Scootag Kim  
Joseph Gerard Leichter  
Soren Kaj Lundsgaard  
Christopher I Miller  
Kenneth R Neff  
Oki Neswan  
David T Ose  
Gareth Scott Rohde  
Randal K Sharpe  
Mark G Thomas  
Ming-Hwa Tong  
Marilea B Widick  

# New Members of the AMS

<table>
<thead>
<tr>
<th>Name</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harlili Wono</td>
<td>University of Lethbridge</td>
</tr>
<tr>
<td>Setya Budhi Wono</td>
<td></td>
</tr>
<tr>
<td>Jim Ma</td>
<td>University of North Florida</td>
</tr>
<tr>
<td>Yong Liu</td>
<td></td>
</tr>
<tr>
<td>John Conrad Merkel III</td>
<td>University of Notre Dame</td>
</tr>
<tr>
<td>Birte M Mesoy</td>
<td></td>
</tr>
<tr>
<td>Mojtaba Moniri</td>
<td></td>
</tr>
<tr>
<td>Hyun A Moon</td>
<td></td>
</tr>
<tr>
<td>Miguel A Moreles-Vazquez</td>
<td></td>
</tr>
<tr>
<td>Richard E Morrel</td>
<td></td>
</tr>
<tr>
<td>Preston Nichols</td>
<td></td>
</tr>
<tr>
<td>Arthur R Perleberg</td>
<td>University of North Florida</td>
</tr>
<tr>
<td>Ruth A Hendrix</td>
<td></td>
</tr>
<tr>
<td>Todd A Olson</td>
<td></td>
</tr>
<tr>
<td>David H Olwell</td>
<td></td>
</tr>
<tr>
<td>William L Oostendorp</td>
<td></td>
</tr>
<tr>
<td>Hauyao Pan</td>
<td></td>
</tr>
<tr>
<td>Yong Pan</td>
<td></td>
</tr>
<tr>
<td>Hyun A Moon</td>
<td></td>
</tr>
<tr>
<td>Arthur R Perleberg</td>
<td>University of North Florida</td>
</tr>
<tr>
<td>Teri René Herzog</td>
<td></td>
</tr>
<tr>
<td>Roy Q Yu</td>
<td></td>
</tr>
<tr>
<td>University of Lowell</td>
<td></td>
</tr>
<tr>
<td>Sharon L Grasso</td>
<td></td>
</tr>
<tr>
<td>John Conrad Merkel III</td>
<td>University of Notre Dame</td>
</tr>
<tr>
<td>James Ernst Helmreich</td>
<td></td>
</tr>
<tr>
<td>Dan-Run Huang</td>
<td></td>
</tr>
<tr>
<td>Max A Karlovitz</td>
<td></td>
</tr>
<tr>
<td>Joseph D Lakey</td>
<td></td>
</tr>
<tr>
<td>Claudia Troster Leme</td>
<td></td>
</tr>
<tr>
<td>Christopher J Mark</td>
<td></td>
</tr>
<tr>
<td>Christoph Schwab</td>
<td></td>
</tr>
<tr>
<td>James F Troendle</td>
<td></td>
</tr>
<tr>
<td>Zhimin Zhang</td>
<td></td>
</tr>
<tr>
<td>University of Maryland, College Park</td>
<td></td>
</tr>
<tr>
<td>Sin-Chuah Cheah</td>
<td></td>
</tr>
<tr>
<td>David Goldberg</td>
<td></td>
</tr>
<tr>
<td>Weimin Han</td>
<td></td>
</tr>
<tr>
<td>William H Heller</td>
<td></td>
</tr>
<tr>
<td>James Ernst Helmreich</td>
<td></td>
</tr>
<tr>
<td>Dan-Run Huang</td>
<td></td>
</tr>
<tr>
<td>Max A Karlovitz</td>
<td></td>
</tr>
<tr>
<td>Joseph D Lakey</td>
<td></td>
</tr>
<tr>
<td>Claudia Troster Leme</td>
<td></td>
</tr>
<tr>
<td>Christopher J Mark</td>
<td></td>
</tr>
<tr>
<td>Christoph Schwab</td>
<td></td>
</tr>
<tr>
<td>James F Troendle</td>
<td></td>
</tr>
<tr>
<td>Zhimin Zhang</td>
<td></td>
</tr>
<tr>
<td>University of Massachusetts, Amherst</td>
<td></td>
</tr>
<tr>
<td>Eileen Marie Adams</td>
<td></td>
</tr>
<tr>
<td>Maria Elsa Correal</td>
<td></td>
</tr>
<tr>
<td>Jinqiao Duan</td>
<td></td>
</tr>
<tr>
<td>William T Dugan Jr</td>
<td></td>
</tr>
<tr>
<td>Bo Guan</td>
<td></td>
</tr>
<tr>
<td>Pamela T Hardiman</td>
<td></td>
</tr>
<tr>
<td>Jean Karl</td>
<td></td>
</tr>
<tr>
<td>Gordon D Kieffer</td>
<td></td>
</tr>
<tr>
<td>Patrick D Miller</td>
<td></td>
</tr>
<tr>
<td>George O Omamo</td>
<td></td>
</tr>
<tr>
<td>Lincoln S Robertson</td>
<td></td>
</tr>
<tr>
<td>John A Valente</td>
<td></td>
</tr>
<tr>
<td>C D Yang</td>
<td></td>
</tr>
<tr>
<td>University of Minnesota, Minneapolis</td>
<td></td>
</tr>
<tr>
<td>David Carlos Adams</td>
<td></td>
</tr>
<tr>
<td>Jon R Anderson</td>
<td></td>
</tr>
<tr>
<td>Carl P Bostrom</td>
<td></td>
</tr>
<tr>
<td>Bill Christ</td>
<td></td>
</tr>
<tr>
<td>Jonathan M Hanen</td>
<td></td>
</tr>
<tr>
<td>Gary Hatfield</td>
<td></td>
</tr>
<tr>
<td>Dug Hun Hong</td>
<td></td>
</tr>
<tr>
<td>Qing Kang</td>
<td></td>
</tr>
<tr>
<td>Annette M Kavanaugh</td>
<td></td>
</tr>
<tr>
<td>Meejong Kim</td>
<td></td>
</tr>
<tr>
<td>Pekka J Koskela</td>
<td></td>
</tr>
<tr>
<td>Hyukjin Kwean</td>
<td></td>
</tr>
<tr>
<td>Stephan K Lapic</td>
<td></td>
</tr>
<tr>
<td>Seongwoo Lee</td>
<td></td>
</tr>
<tr>
<td>Sungyoung Lee</td>
<td></td>
</tr>
<tr>
<td>Changhun Lee</td>
<td></td>
</tr>
<tr>
<td>Li-Perng Liou</td>
<td></td>
</tr>
<tr>
<td>Wenxiong Liu</td>
<td></td>
</tr>
<tr>
<td>University of Missouri, Kansas City</td>
<td></td>
</tr>
<tr>
<td>Paula G Johnson</td>
<td></td>
</tr>
<tr>
<td>University of Missouri, St Louis</td>
<td></td>
</tr>
<tr>
<td>Jian Qin</td>
<td></td>
</tr>
<tr>
<td>University of Montana</td>
<td></td>
</tr>
<tr>
<td>John E Caratti</td>
<td></td>
</tr>
<tr>
<td>Renate R Elder</td>
<td></td>
</tr>
<tr>
<td>Pankaj Garg</td>
<td></td>
</tr>
<tr>
<td>Debra S Hawkins</td>
<td></td>
</tr>
<tr>
<td>Eva Kwok Yin Lee</td>
<td></td>
</tr>
<tr>
<td>Jui-Lan Andy Li</td>
<td></td>
</tr>
<tr>
<td>Kyung H Nam</td>
<td></td>
</tr>
<tr>
<td>Joe Nevin</td>
<td></td>
</tr>
<tr>
<td>Young H Park</td>
<td></td>
</tr>
<tr>
<td>Robert Lynn Turnquist</td>
<td></td>
</tr>
<tr>
<td>Ninghui Zhong</td>
<td></td>
</tr>
<tr>
<td>Xinghe Zhoul</td>
<td></td>
</tr>
<tr>
<td>University of North Dakota, Grand Forks</td>
<td></td>
</tr>
<tr>
<td>Scott C Binde</td>
<td></td>
</tr>
<tr>
<td>Patricia A Brown</td>
<td></td>
</tr>
<tr>
<td>Daryl M Delzer</td>
<td></td>
</tr>
<tr>
<td>Karen M Hagler</td>
<td></td>
</tr>
<tr>
<td>Cheryl L Hakrow</td>
<td></td>
</tr>
<tr>
<td>Shari G Hensrud</td>
<td></td>
</tr>
<tr>
<td>Myra Koch</td>
<td></td>
</tr>
<tr>
<td>Devon David Larson</td>
<td></td>
</tr>
<tr>
<td>Jeff A Morel</td>
<td></td>
</tr>
<tr>
<td>Tom A Murphy</td>
<td></td>
</tr>
<tr>
<td>University of Oregon</td>
<td></td>
</tr>
<tr>
<td>Mark C Henderson</td>
<td></td>
</tr>
<tr>
<td>Martin A Jackson</td>
<td></td>
</tr>
<tr>
<td>Daniel E Kotlar</td>
<td></td>
</tr>
<tr>
<td>Nathaniel A Meyers</td>
<td></td>
</tr>
<tr>
<td>University of Pittsburgh, Pittsburgh</td>
<td></td>
</tr>
<tr>
<td>Yolande N Au</td>
<td></td>
</tr>
<tr>
<td>Ronald E Barnhart</td>
<td></td>
</tr>
<tr>
<td>Anthony D Capriott</td>
<td></td>
</tr>
<tr>
<td>Paula J Friedrich</td>
<td></td>
</tr>
<tr>
<td>Jaecheul Kim</td>
<td></td>
</tr>
<tr>
<td>Chun Kong Law</td>
<td></td>
</tr>
<tr>
<td>Hugh W McViece</td>
<td></td>
</tr>
<tr>
<td>Sze-man Ngai</td>
<td></td>
</tr>
<tr>
<td>Ada Dawn Owens</td>
<td></td>
</tr>
<tr>
<td>Patricia Jo Saliga</td>
<td></td>
</tr>
<tr>
<td>Cun-Qi Wang</td>
<td></td>
</tr>
<tr>
<td>Jianrong Wang</td>
<td></td>
</tr>
<tr>
<td>Richard T Wenzel</td>
<td></td>
</tr>
<tr>
<td>Eric R Williams</td>
<td></td>
</tr>
<tr>
<td>Xi Xe</td>
<td></td>
</tr>
<tr>
<td>University of Richmond</td>
<td></td>
</tr>
<tr>
<td>James A Davis</td>
<td></td>
</tr>
<tr>
<td>Michael George Kerchove</td>
<td></td>
</tr>
<tr>
<td>University of Toledo</td>
<td></td>
</tr>
<tr>
<td>Kim Kuan Chan</td>
<td></td>
</tr>
<tr>
<td>Vijaya L Gompa</td>
<td></td>
</tr>
<tr>
<td>Karuna Jayathilake</td>
<td></td>
</tr>
<tr>
<td>Showwu Li</td>
<td></td>
</tr>
<tr>
<td>Jagath Kapila Silva</td>
<td></td>
</tr>
<tr>
<td>Prem Kumar Nayapati Swami</td>
<td></td>
</tr>
<tr>
<td>Yu Wang</td>
<td></td>
</tr>
<tr>
<td>University of Utah</td>
<td></td>
</tr>
<tr>
<td>Tim S Barclay</td>
<td></td>
</tr>
<tr>
<td>James P Brandt</td>
<td></td>
</tr>
<tr>
<td>Melanie Breake</td>
<td></td>
</tr>
<tr>
<td>Alessio Corti</td>
<td></td>
</tr>
<tr>
<td>Paul F Cox</td>
<td></td>
</tr>
<tr>
<td>Kathy Anne Dopp</td>
<td></td>
</tr>
<tr>
<td>Joseph E Dvorak</td>
<td></td>
</tr>
<tr>
<td>Mary Ellen Furner</td>
<td></td>
</tr>
<tr>
<td>Jill E Gebelt</td>
<td></td>
</tr>
<tr>
<td>Dale S Graeber</td>
<td></td>
</tr>
<tr>
<td>Nan C J Haymet</td>
<td></td>
</tr>
<tr>
<td>Jennifer Hooper</td>
<td></td>
</tr>
<tr>
<td>Laurel Fearley Langford</td>
<td></td>
</tr>
<tr>
<td>Heidi M Latvala</td>
<td></td>
</tr>
<tr>
<td>Tina Season Ma</td>
<td></td>
</tr>
<tr>
<td>Jeff S McGough</td>
<td></td>
</tr>
<tr>
<td>Tina Cavell Moore</td>
<td></td>
</tr>
<tr>
<td>University of Toledo</td>
<td></td>
</tr>
<tr>
<td>Kim Kuan Chan</td>
<td></td>
</tr>
<tr>
<td>Vijaya L Gompa</td>
<td></td>
</tr>
<tr>
<td>Karuna Jayathilake</td>
<td></td>
</tr>
<tr>
<td>Showwu Li</td>
<td></td>
</tr>
<tr>
<td>Jagath Kapila Silva</td>
<td></td>
</tr>
<tr>
<td>Prem Kumar Nayapati Swami</td>
<td></td>
</tr>
<tr>
<td>Yu Wang</td>
<td></td>
</tr>
<tr>
<td>University of Utah</td>
<td></td>
</tr>
<tr>
<td>Tim S Barclay</td>
<td></td>
</tr>
<tr>
<td>James P Brandt</td>
<td></td>
</tr>
<tr>
<td>Melanie Breake</td>
<td></td>
</tr>
<tr>
<td>Alessio Corti</td>
<td></td>
</tr>
<tr>
<td>Paul F Cox</td>
<td></td>
</tr>
<tr>
<td>Kathy Anne Dopp</td>
<td></td>
</tr>
<tr>
<td>Joseph E Dvorak</td>
<td></td>
</tr>
<tr>
<td>Mary Ellen Furner</td>
<td></td>
</tr>
<tr>
<td>Jill E Gebelt</td>
<td></td>
</tr>
<tr>
<td>Dale S Graeber</td>
<td></td>
</tr>
<tr>
<td>Nan C J Haymet</td>
<td></td>
</tr>
<tr>
<td>Jennifer Hooper</td>
<td></td>
</tr>
<tr>
<td>Laurel Fearley Langford</td>
<td></td>
</tr>
<tr>
<td>Heidi M Latvala</td>
<td></td>
</tr>
<tr>
<td>Tina Season Ma</td>
<td></td>
</tr>
<tr>
<td>Jeff S McGough</td>
<td></td>
</tr>
<tr>
<td>Tina Cavell Moore</td>
<td></td>
</tr>
</tbody>
</table>
### New Members of the AMS

<table>
<thead>
<tr>
<th>University of Vermont</th>
<th>Virginia Polytechnic Institute and State University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diane R Bergeron</td>
<td>Ravi S Krishnamurthy</td>
</tr>
<tr>
<td>Christopher James Compton</td>
<td>Peng Lei</td>
</tr>
<tr>
<td>Steve M Dosland</td>
<td>Arun N Shastri</td>
</tr>
<tr>
<td>Eric Heller</td>
<td>Ruben Daniel Spies</td>
</tr>
<tr>
<td>Robert M Maxham</td>
<td></td>
</tr>
<tr>
<td>Timothy J Molsberry</td>
<td></td>
</tr>
<tr>
<td>Carol A Murray</td>
<td></td>
</tr>
<tr>
<td>Tebogo Nyezi</td>
<td></td>
</tr>
<tr>
<td>Allan L Wilson</td>
<td></td>
</tr>
<tr>
<td>University of Western Ontario</td>
<td>Washington University</td>
</tr>
<tr>
<td>Zaiqing Li</td>
<td>Zhen Qing Chen</td>
</tr>
<tr>
<td>Chuanyi Zhang</td>
<td>Richard Ian Laugesen</td>
</tr>
<tr>
<td>University of Wisconsin-Milwaukee</td>
<td>Daniela Stalteri</td>
</tr>
<tr>
<td>George A Avirappatu</td>
<td>Jiye Yu</td>
</tr>
<tr>
<td>Xenia H Kramer</td>
<td></td>
</tr>
<tr>
<td>Lalit M Pattanaik</td>
<td></td>
</tr>
<tr>
<td>Seog-Hoon Rim</td>
<td></td>
</tr>
<tr>
<td>Jianping Yang</td>
<td></td>
</tr>
<tr>
<td>University of the West Indies</td>
<td>Wayne State University</td>
</tr>
<tr>
<td>Roland R Lloyd</td>
<td>Xisuo Liu</td>
</tr>
<tr>
<td>Priscilla W Sidrak</td>
<td>Washington State University</td>
</tr>
<tr>
<td></td>
<td>Mehdi Pousti</td>
</tr>
<tr>
<td></td>
<td>Williams College</td>
</tr>
<tr>
<td></td>
<td>Mark A Conger</td>
</tr>
<tr>
<td></td>
<td>Youngstown State University</td>
</tr>
<tr>
<td></td>
<td>Stephen G Gomori</td>
</tr>
<tr>
<td></td>
<td>David L Kweder</td>
</tr>
<tr>
<td></td>
<td>Daniel T Stephan</td>
</tr>
</tbody>
</table>

Karen L Myers
Mary Ellen Oman
Melinda J Schlafman
Robert D Shalla
Paula D White

Gregory A Langkamp
Mark G Lawrence
Adam B Levy
William Whipple Neely
Janet E Perdue
John Charles Roth
Vimaladevi Sivakumaran
Joanna M Staniszsz-Czapska

Melinda J Schlafman
Adam B Levy
Ravi S Krishnamurthy
Robert D Shalla
William Whipple Neely

Paula D White
Janet E Perdue

PARTITION PROBLEMS IN TOPOLOGY

Stevo Todorcevic
(Contemporary Mathematics, Volume 84)

This book presents results on the case of the Ramsey problem for the uncountable: When does a partition of a square of an uncountable set have an uncountable homogeneous set? This problem most frequently appears in areas of general topology, measure theory, and functional analysis. Building on his solution of one of the two most basic partition problems in general topology, the “S-space problem,” the author has unified most of the existing results on the subject and made many improvements and simplifications. The first eight sections of the book require basic knowledge of naïve set theory at the level of a first year graduate or advanced undergraduate student. The book may also be of interest to the exclusively set-theoretic reader, for it provides an excellent introduction to the subject of forcing axioms of set theory, such as Martin’s axiom and the Proper forcing axiom.

1980 Mathematics Subject Classifications: 04-02, 03E05, 03E50; 50-02, 54A25
ISBN 0-8218-5091-1, LC 88-39032
ISSN 0271-4132
130 pages (softcover), January 1989

Individual member $13, List price $22,
Institutional member $18
To order, please specify CONM/84 NA

Shipping/Handling: 1st book $2, each add’l $1, $25 max. By air, 1st book $5, each add’l $3, $100 max. Prepayment required. Order from AMS, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, or call 800-556-7774 to use VISA or MasterCard.
UNIVERSITY OF SOUTH CAROLINA
Department of Mathematics

Applications are invited for anticipated tenure-track faculty positions at all ranks. Applications in all areas of mathematics will be considered. The Department seeks to build on existing research strengths and to increase the scope of its programs, particularly in applied and computational mathematics. Faculty research is supported by excellent in-house library and computing facilities. The Department’s computer center supports network access to the University’s FPS array processor and 1.024 node hypercube supercomputer. The Ph.D. degree or its equivalent is required, and all appointments will be consistent with the Department’s commitment to excellence in research and teaching at the undergraduate and graduate levels. A detailed resume, containing a summary of research accomplishments and goals, and four letters of recommendation should be sent to:

Dr. Colin Bennett, Chairman
Department of Mathematics
University of South Carolina
Columbia, South Carolina 29208

The University of South Carolina is an Affirmative Action/Equal Opportunity Employer.

MARCH 1989, VOLUME 36, NUMBER 3
Applications are invited for a senior level tenured appointment in the general area of applied and computational mathematics, effective Fall 1989. Rank and salary depend on qualifications. A Ph.D. and demonstrated excellence in research and teaching are required. Applications will be accepted until the position is filled. Contact Jon Tolle, Mathematics Department, Box 3250 Phillips Hall, UNC at Chapel Hill, Chapel Hill, NC 27599. EO/AA Employer. Women and minorities are encouraged to identity themselves voluntarily.

Several tenure-track positions at all levels will be available beginning September 1989. Applicants showing significant research accomplishments or exceptional research promise, as well as evidence of a commitment to excellent teaching, are invited to apply. Initial tenure-track appointment is for four years. There is no restriction as to field. In addition to a curriculum vitae, candidates should send a summary of research plans, available preprints or reprints, and have at least three reference letters sent to: Samuel Gitler, Chairman Mathematics Department University of Rochester Rochester, New York 14627

An equal opportunity/affirmative action employer.

A second tenure track position (Assistant Professor) in mathematics is available in late August 1989. Applicants must have a Ph.D. in mathematics and a strong commitment to quality teaching. Salary and fringe benefits are competitive commensurate with credentials and experiences.

Applicants should send resume, transcripts and three letters of recommendation to Dr. Richard Escobales, Chairman, Dept. of Mathematics, Canisius College, Buffalo NY 14208.

The Department is looking to expand its offerings and options while at the same time maintaining its sound preparation for students with mathematical potential. EOE/AA.

This volume contains the proceedings of a Research Workshop on Banach Space Theory held at the University of Iowa in Iowa City in July 1987. The workshop provided participants with a collaborative working atmosphere in which ideas could be exchanged informally. Several papers were initiated during the workshop and are presented here in their final form. Also included are contributions from several experts who were unable to attend the workshop. None of the papers will be published elsewhere. During the workshop, two hours each day were devoted to seminars on current problems in such areas as weak Hilbert spaces, zonoids, analytic martingales, and operator theory, and these topics are reflected in some of the papers in the collection.

Shipping/Handling: 1st book $2, each add'$ $1, $25 max. By air, 1st book $5, each add'$ $3, $100 max. Prepayment required. Order from AMS, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, or call 800-556-7774 to use VISA or MasterCard.
Tenure-track, possibly senior, positions anticipated to begin August 15, 1989. Outstanding research record and/or teaching excellence required. Preferred areas: statistics and probability (including applications in physics, chemistry and computer science) but candidates in areas of global analysis, dynamical systems, functional analysis, partial differential equations, and numerical analysis will also be considered. Women and minority groups candidates are especially encouraged to apply. Visiting positions in the above areas also possible. Send vita plus three letters of recommendation to Professor W. A. Woyczynski, Chairman, Department of Mathematics and Statistics. Case Western Reserve University, Cleveland, OH 44106. An affirmative action equal opportunity employer.

UNIVERSITY OF OKLAHOMA

Applications are invited for one or more anticipated tenure or tenure-track positions in Mathematics beginning Fall 1989. Candidates must have a Ph.D. degree, demonstrated excellence in research, and potential for high-quality teaching. Strong candidates in all areas will be considered with preference given to research interests compatible with those of our current faculty. Duties include research, normally teaching six hours per semester, and Departmental and University service appropriate to rank. Salary and rank will be commensurate with qualifications and experience. There may also be visiting positions. Applicants should send their vita and have at least three letters of reference sent to Dr. Darryl McCullough, Search Committee Chair, Department of Mathematics, University of Oklahoma, 601 Elm Avenue, Norman, Oklahoma 73019. Closing dates are December 15, 1988 and every two weeks thereafter, until the final closing on April 20, 1989. The University of Oklahoma is an Affirmative Action/Equal Opportunity Employer.

THE COLLEGE OF INSURANCE

The Actuarial Science Department of The College of Insurance invites applications for a full time, tenure track position at the rank of Assistant Professor, beginning September 1, 1989.

A Ph.D. in Mathematics or a related discipline is required as is a demonstrated commitment to teaching excellence. Candidates in Statistics, Probability or a field of Applied Mathematics related to Actuarial Science are particularly encouraged as are those interested in developing and pursuing a career in Actuarial Science.

The College of Insurance is a private, selective institution located in New York City’s Financial District. The salary is competitive and the fringe benefits excellent.

Applications will be accepted until the position is filled. Send letter of application, curriculum vitae and letters of recommendation to: S. Ramanujam, Chairman, Actuarial Science Division, The College of Insurance, 101 Murray Street, New York, New York 10007. EOE/AA

FLORIDA INTERNATIONAL UNIVERSITY

The State University of Florida at Miami

The Department of Mathematics announces tenure track positions at the assistant professor level beginning August 1989. Candidates must have a Ph.D. in Mathematics and a commitment to research and quality teaching. Preferred areas of specialization include harmonic analysis, logic, representation theory, several complex variables, and functional analysis. Qualified candidates in other areas will be considered.

Teaching load consists of 15 semester hours per academic year. Send resume and 3 letters of recommendation to Recruitment Committee, Department of Mathematics, Florida International University, Miami, FL 33199.

Florida International University is the State University of Florida at Miami. The University is an equal opportunity/affirmative action employer.

ST. MARY’S COLLEGE OF MARYLAND

ST. MARY’S CITY, MARYLAND 20686

St. Mary’s College of Maryland invites applications for a one-year sabbatical replacement in mathematics beginning in August 1989. The position may lead to a permanent appointment pending approval of an additional line for mathematics/computer science.

St. Mary’s is a four-year state-supported liberal arts college of about 1400 students located 68 miles southeast of Washington, DC. The mathematics faculty consists of five full-time teachers. The program provides a general studies mathematics course for all students and many mathematics and computer science courses for science and mathematics majors. We would like to employ a person with a Ph.D. in mathematics who is interested in teaching undergraduates and willing to teach a wide variety of courses ranging from college algebra to upper-division courses for mathematics majors. Teaching in computer science is also possible. The teaching load is three courses (twelve credits) per semester, and the State of Maryland provides a good package of fringe benefits. St. Mary’s College is an AA/EOE employer.

Rank and salary are open. Applications will be considered until the position is filled. Send letter and resume to Dr. Paul Blanchette, Head, Division of Natural Science and Mathematics, St. Mary’s College of Maryland, St. Mary’s City, Maryland 20686. (301-862-0362)

GEORGIAN COURT COLLEGE

Applications are invited for position at the assistant professor level starting Fall 1989. Ph.D. in mathematics, algebra preferred, other areas considered. Publications and record of successful college teaching essential. Applicant will teach both graduate and undergraduate courses. Tenure-track; salary and fringe benefits competitive. Send letter of application, resume, transcripts, names, addresses and telephone numbers of three references to Chair, Mathematics Department, Georgian Court College, Lakewood, NJ 08701. Georgian Court College is an EO/AA employer.
Classified Advertisements

Positions Available

University of Alberta
Department of Mathematics

Applications are invited for a tenure-track position, in Approximation Theory (File AP-2) at the Assistant or Associate 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 April 30, 1989. Please quote file number when responding to this advertisement. The University of Alberta is committed to the principle of equity in employment.

The Citadel

Applications are invited for a tenure track position at the assistant or associate level. Qualifications include a Ph.D. in a mathematical science with a strong dedication to undergraduate teaching and a continuing interest in research. Preference will be given to individuals in applied or computational areas of mathematics. Salary negotiable.

The Citadel is a state-supported liberal arts, military college offering undergraduate degrees in the Arts, Sciences, Engineering, Education, and Business Administration. The Department of Mathematics and Computer Science offer the B.S. and B.A. degrees in mathematics and a B.S. degree in computer science. Please send resume and three letters of reference to Charles E. Cleaver, Head Department of Mathematics/Computer Science, The Citadel, Charleston, S.C. 29409. Review of applications will begin April 15 and continue until position is filled.

Minorities and women are encouraged to apply. The Citadel is an equal opportunity/affirmative action employer.

American University of Beirut

Teaching Overseas: The Department of Mathematics at the American University of Beirut, Beirut, Lebanon (AUB) invites applications for faculty positions at the level of Assistant Professor, available October 1, 1989, in the following fields: Analysis, Mathematical Statistics (Probability Theory), and Topology.

Applicants should hold the Ph.D. degree in mathematics and will be expected to engage in undergraduate and graduate teaching, as well as research. Postdoctoral experience is preferred.

Appointments are normally made for a three-year period. Interested persons should send a curriculum vitae and three letters of recommendation by March 31, 1989 to: Dean, Faculty of Arts & Sciences, American University of Beirut, c/o New York Office of AUB, 850 Third Avenue, 18th Floor, New York, New York 10022, USA.

AUB is an EO/AA employer.

U.S. passports are presently invalid for travel to, in or through Lebanon, and for residence in Lebanon, by order of the Department of State, and therefore applications from individuals who would travel to reside in Lebanon on a U.S. passport cannot at this time be considered.

Virginia Tech

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.

University of California at Berkeley

Department of Mathematics

Temporary Postdoctoral Positions

Several temporary positions beginning in Fall 1989 are anticipated for new and recent Ph.D.s of any age, in the areas of algebra, analysis, applied mathematics, foundations, or geometry and topology. The terms of these appointments may range from one to three years. Applicants for NSF or other postdoctoral fellowships are encouraged to apply for these positions; combined teaching/research appointments may be made for up to three years. Mathematicians whose research interests are close to those of regular department members will be given some preference. Send by April 1, 1989, a resume, and reprints, preprints, and/or a dissertation abstract. Ask three people to send letters of recommendation to Marc A. Rieffel, Vice Chair for Faculty Affairs, at the above address. (Applications received for our earlier January 15, 1989, deadline will automatically be considered for this deadline also.) The University of California is an Equal Opportunity/Affirmative Action Employer.

Augustana College

Mathematics: Augustana College (South Dakota) invites applications for an Assistant Professor of Mathematics. Two year appointment with possible conversion to tenure track. Teach undergraduate mathematics courses, lower and upper division courses and involvement in student research projects. Exact assignment will depend on qualifications. Ph.D. in Mathematics, or ABD preferred. Masters degree required. A commitment to the mission of a church-related liberal arts college expected. Preference given to applications received prior to April 1, 1989. Send letter of application, vita, complete graduate transcripts (direct from registrar's office), names, telephone numbers, an identities of at least three current references, and a statement of personal and professional goals to: Jeanne Kruse, Administrative Assistant, Augustana College, Sioux Falls, SD 57197. EOE/AA employer.
The University of North Texas invites nominations and applications for the position of director of the Texas Academy of Mathematics and Science to begin August 1, 1989. The Texas Legislature established the Texas Academy of Mathematics and Science in 1988 within the University of North Texas in Denton. The Academy is a two-year, public, coeducational, tuition-free institution which functions as an early admission program for Texas high school students who are particularly talented in science and mathematics.

A maximum of 200 students who have completed the tenth grade can be accepted on a competitive basis each year. The curriculum includes freshman and sophomore university courses taught by full-time University of North Texas faculty and provides the students with a rigorous program in science and mathematics and innovative study in the humanities. Graduates receive a high school diploma as well as two years of university credits. The Academy students are in residence at the University of North Texas campus. The University of North Texas is an emerging national research institution in the vibrant and rapidly expanding Dallas-Fort Worth metropolitan area with over 700 regular faculty and over 24,000 students.

Applicants should hold a Ph.D. preferably in science or mathematics, have earned tenure at the University level, and be willing to give long-term commitment to working with talented young freshmen. The duties of the director will include student recruitment, resource development and fund raising, working with constituents external to the university—local, state and national, overall curriculum development and the general direction and leadership of the Academy. Salary will be on a 12-month basis and will be commensurate with qualifications and experience. Applications should include a letter of interest, resume, and the names, addresses and phone numbers of three to five references to:

Jean B. Schaake, Chair; TAMS Search Committee, College of Arts and Sciences, University of North Texas, P.O. Box 5187, Denton, Texas 76203.

Review of applications will begin April 1, 1989, and continue until the position is filled.

The University of North Texas is an Affirmative Action/Equal Opportunity Employer.

---

The University of Oklahoma seeks a new dean. They are open to applicants from all regions. They should have earned Ph.D. in the one of the disciplines in the college and have substantial teaching and research experience. They should be prepared to lead the college to continued growth in the quality of instruction and the volume of research.

Salary is negotiable. The position is available on July 1, 1989. Nominations and applications should be sent to: Dr. William N. Free, Vice President for Academic Affairs, The University of Oklahoma, Tulsa, OK 74106.

The University of Oklahoma is an Equal Opportunity/Affirmative Action Employer.

---

Applications are invited for temporary faculty positions beginning in September 1989. These positions are funded at the Assistant Professor level, but there is some slight flexibility in salary. They are open to applicants from all research areas within Mathematics and Computer Science with significant accomplishments or high potential in both research and teaching.

Candidates should send a vita and arrange for at least three letters of recommendation to be sent to: John de Pillis, Chair, Search Committee, Department of Mathematics, University of California, Riverside, CA 92521. The University of California is an Equal Opportunity/Affirmative Action Employer.
Several Assistant Professor positions are expected subject to final budgetary approval. All are tenure track with salary $27,000 to $30,000 for 8.5 month to teach undergrad. and grad. courses in Mathematics 3 courses per semester starting 9-1-89. Requirements: Ph.D. in Mathematics with good research potential and dedication to teaching. All areas of Mathematics are of interest. Send resume, graduate transcripts, and letters of recommendation to: Dr. P. Saworotnow, Search Committee Chairman, Mathematics Department, CUA, tel. 202-635-5222. Deadline: April 7, 1989, or until positions are filled.

CUA is an AA/EO employer. Applications from women and minority group members are encouraged.

THE WITCHITA STATE UNIVERSITY
Wichita, KS 67208

Professor Stephen W. Brady, Search Committee Chairman, Department of Mathematics and Statistics
Assistant Professor tenure eligible position starting August 1989. Specialization in Complex Analysis and Several Complex Variables will be given special consideration. All areas of Applied Mathematics will be considered. A Ph.D. in Mathematics is required. Candidate is expected to be active in research, participate in the doctoral program, and have a strong interest in teaching. Salary competitive. Send application letter, detailed resume, and arrange to have three reference letters sent. Deadline March 15, 1989, then monthly until position is filled. The Wichita State University is an Equal Opportunity/Affirmative Action Employer.
JOHANNES KEPNER UNIVERSITY  
Tenured Position of a Full Professor for Symbolic Computation at the Johannes Kepler University in Linz (Austria)  
(Research Institute for Symbolic Computation)

Applications are invited for a newly created tenured position of a full professor at the School of Technical Sciences, Johannes Kepler University in Linz, Austria. Candidates should have an outstanding research record in at least one of the main areas of symbolic computation (computer algebra, computer analysis, computational geometry, computational logic, automatic programming etc.), a commitment to excellence in graduate teaching, and the ability and willingness to combine, in their field of expertise, mathematical/algorithmic foundations with potential industrial applications (for example, expert systems, geometrical modeling, robot programming, scientific software). Teaching and supervising of students may also be in English. Candidates from foreign countries are explicitly encouraged.

The School of Technical Sciences has installed an independent institute for symbolic computation (RISC-LINZ, Research Institute for Symbolic Computation) with an 8 member faculty under the direction of Prof. Bruno Buchberger. RISC-LINZ operates in close interaction with the Department of Computer Science (a twenty-six member faculty) and the Department of Mathematics (a twenty-two member faculty).

At Johannes Kepler University, the symbolic computation effort is a part of and a major driving force for a planned expansion (by 10 full professorships) of the School of Technical Science in the direction of "mechatronics" (intelligent control of technical production) in close cooperation with Austrian industry.

The new site of RISC-LINZ, a medieval castle 15 minutes from Linz, equipped with excellent computing facilities, combines the advantages of city life with the pleasures of a rural environment in one of the most beautiful landscapes and in the cultural heart of Austria and Europe.

Applicants should send a résumé (together with a few important publications representing the candidates research expertise) to the Dean of the School of Technical Sciences, Prof. Dr. Peter Weiß, Johannes Kepler University, A4040 Linz (Austria). (Telephone Austria (732) 2468-312), by March 31, 1989. Further information can also be obtained from the Chairman of RISC-LINZ, Prof. Dr. Bruno Buchberger, Johannes Kepler University, A4040 Linz. (Tel: Austria. (732) 2468-9219. Electronic mail: K313370@AEARN.bitnet.)

NATIONAL ACADEMY OF SCIENCES  
BOARD ON MATHEMATICAL SCIENCES  
Senior Program Officer

The BOARD ON MATHEMATICAL SCIENCES is preparing a project to update the 1984 David Report, "Reviewing U.S. Mathematics: Critical Resource for the Future," for the National Science Foundation. The update will analyze the current state of support for research in the mathematical sciences and assess progress against the recommendations of the original David Report. It will go further to briefly scientifically assess the field and identify promising opportunities for interdisciplinary research.

Incumbent will be responsible for organizing and supporting the work of the committee, chaired by Dr. Edward E. David, Jr., former presidential science advisor. Requires excellent organizational, writing, and interpersonal skills and familiarity with mathematical sciences research and issues. A Ph.D. or equivalent experience in a mathematical science is required. The National Research Council is an Equal Opportunity/Affirmative Action Employer.

The closing date is March 15, but applications will be accepted until a suitable candidate is identified. Please submit a resume or cv with salary history and the names of three references to:

NATIONAL RESEARCH COUNCIL
Board on Math Sciences
NAS 312 (LC)
2101 Constitution Ave., N.W.
Washington, DC 20418
EOE

UNIVERSITY OF BRISTOL  
England

Under the New Academic Appointments Scheme the University expects to appoint a Professor of Pure Mathematics in the Department of Mathematics from 1 August 1989 or as soon as possible thereafter. Suitable candidates will be considered from any area of pure mathematics. The successful candidate will be expected to provide academic leadership in both teaching and research. It is intended that further expansion in the general research area of the new professor will take place after the appointment.

Applications, including a curriculum vitae and the names and addresses of three referees, should be sent, to arrive not later than 24 March 1989 to the Registrar (for the attention of Nesta Babb), Senate House, University of Bristol, Bristol BS8 1TH, UK, quoting Ref 0188/A. Further particulars can be obtained by Tel: 010-44-272 303030 or FAX: (0272) 251424. For informal enquiries, telephone Prof D V Evans on 010-44-272-303532.

THE UNIVERSITY OF ALABAMA  
Senior Position

The department anticipates filling a senior level position (Full Professor or, possibly, senior Associate Professor), to begin August 16, 1989. Applications are invited from mathematicians whose credentials demonstrate excellence in both teaching and research and an ability to provide programmatic leadership. Areas of special interest are: algebra, analysis, continuum mechanics, computational mathematics, differential equations, differential geometry, optimization, stochastic modeling, and topology. In the event that a permanent appointment is not made, we also invite applications from visitors. Women and minorities are particularly encouraged to apply. Send a curriculum vitae, a sample of recent reprints and/or preprints, and the names of at least three references to: Professor Alan Hopenwasser, Department of Mathematics, The University of Alabama, Box 870350, Tuscaloosa, AL 35487-0350. The University of Alabama is an Equal Opportunity Employer.


**POSITIONS AVAILABLE**

**UNIVERSITY OF WISCONSIN-SUPERIOR**  
Mathematical Sciences  
Superior, WI 54880

One tenure track position in Mathematics beginning September 1989. A Ph.D. in a Mathematical Science is required. Excellence in teaching and continuing scholarly activity is expected. All areas considered but preference given to areas of analysis or operations research. A Computer Science Option is offered within the department. Computer experience is desirable. Rank and salary are negotiable/competitive. Applications will be accepted until March 15, 1989, or until a successful candidate is found. Submit a formal letter of application expressing interest, a resume, and arrange for three letters of recommendation to be sent to Dr. Ronald Roubal, Division of Sciences and Mathematics, University of Wisconsin-Superior, Superior, WI 54880. AA/EO Employer.

**FAIRFIELD UNIVERSITY**

The Department invites applications for a tenure track position at the Assistant Professorship level beginning in Sept. 1989. The normal teaching load is 3 courses a semester with some research expected. A Ph.D. in Mathematics is required with teaching competence in Numerical analysis or Statistics desirable. Fairfield is a Jesuit University located on the Connecticut coast 60 minutes from New York City. For full consideration, send curriculum vitae and 3 letters of reference to Joseph B. Dennin, Chair, Department of Mathematics and Computer Science, Fairfield University, Fairfield, CT 06430-7524. Fairfield is an Equal Opportunity/Affirmative Action Employer.

**PUBLICATIONS**

**NEW PUBLICATION**


MATH SCI PRESS, 53 Jordan Rd., Brookline, MA 02146, 617-739-0307. TOPICS IN PHYSICAL GEOMETRY, by R. Hermann. $80. Sale on selected back list titles.

**The Foundations of Mathematics Based Upon a Cosmological Constant New to Natural Science**  
By John Lawrence Waters

**ABSTRACT**

Analysis of the counting process yields the equilibration formula for the natural unity. The author introduces a two dimensional dynamic model for unity which replaces the traditional static segment of the number line. The author constructs the correct mathematical model for natural space.

Mathematical analysis of verbalization, counting and spontaneous activity in autistic and non-autistic human subjects leads to the product of two radius vectors spinning in opposite directions by the power of a vibrational energy “omega” of constant frequency. Repeated testing suggests this model is valid. For a copy of this paper, send eight U.S. dollars to: John Waters POB 706, Trinidad, CA 95570-0706 U.S.A. No personal checks. Foreign currency OK.
FOR SALE

WYSIWYG for Macintosh.

With SCIPAGE, type, reposition, reshape: complex fractions, roots, integrals, matrices, frames and grids... Anywhere on a page! Ideal for lecture notes, exams, ... $40 postpaid. Write for samples. METAMATH, Box 26, Christiansa, PA 17509.

CLIFFORD ALGEBRA MICRO-COMPUTER PACKAGE for IBM PC. CLICAL, Clifford algebra calculator program can be used for teaching or research in complex number, vector and Clifford algebra calculations. CLICAL for single personal use $20; 13 copies for local department use $95. Order from: Pertti Lounesto Institute of Mathematics Helsinki University of Technology SF-02150 Espoo, Finland

SITUATIONS WANTED

DISTINGUISHED RESEARCH AND TEACHING MATHEMATICIAN

Exceptionally wide experience in pure and applied mathematics (algebraic topology, algebra, differential geometry, analysis, PDE's, mathematical physics, dynamic meteorology), over 90 publications, seeks teaching/research position, preferably involving Ph.D. supervision. Details upon request. Write to: "Applicant Code 123, Advertising Department, AMS. P.O. Box 6248, Providence, RI 02940.

Doctorate in Applied Mathematics seeking assistant professorship, one publication in Computer and Mathematics, 5 years teaching assistant experience, won a teaching award, available now, resume upon request phone: (412) 361-5338

MEMOIRS
of the
American Mathematical Society
No. 388

TOPOLOGICAL INVARIANTS
OF QUASI-ORDINARY
SINGULARITIES
by Joseph Lipman

EMBEDDED TOPOLOGICAL
CLASSIFICATION OF QUASI-
ORDINARY SINGULARITIES
by Yih-Nan Gau

is dedicated to the memory of PETER SCHERK. We regret that this dedication was inadvertently omitted from the book.

American Mathematical Society
This comprehensive 12-volume set contains both author and subject listings for all of the reviews that appeared in Mathematical Reviews during the years 1980 to 1984. Containing over 9600 pages, it is an important addition to any mathematics library and is now available at further discount to individual AMS members and reviewers of MR.

With this set of indexes at hand, readers can:

- access fully, by both author and subject area, the mathematical literature of five years, 1980 through 1984
- discover listings for approximately 200,000 papers, books, and conference proceedings – all the items reviewed in Mathematical Reviews during these years
- obtain information about approximately 8000 additional items that were not reviewed individually, but which are fully classified and cross-referenced in these indexes
- find complete bibliographic information for each article under any author associated with the article, and cross-references for the names of editors, translators, and other persons associated with an item
- access, via a key index, all those publications that do not have named authors or editors
- locate, under each subject index heading, all items having this classification as either a primary or a secondary classification

ISBN 0-8218-0105-08, LC 42-4221
12 volumes, 9653 pages; 1986
List $1875, Inst. mem. $1500,
Indiv. mem. $1125, Rev. $938
To order, please specify MREVINI80I84NA

Combination offer. A special price is offered when the Author and Subject Indexes of Mathematical Reviews, 1980-84 (MREVIN/80/84) is purchased together with the Author and Subject Indexes of Mathematical Reviews, 1973-79 (MREVIN/73/79).
List $2950, Inst. mem. $2360,
Indiv. mem. $1770, Rev. $1475
To order, please specify MRCINI73I84NA

Prepayment required. Order from the American Mathematical Society, Annex Station, P. O. Box 1571, Providence, RI 02901-1571 or call 401-272-9500 (800-556-7774 from within the continental U. S.) to use VISA or MasterCard.
a conference on

Computers & Mathematics

June 13 - 17, 1989, MIT, Cambridge, Mass

A conference focusing on the relationship of computers to research and education in the mathematical sciences

The conference will serve as a forum for the interaction between developers of computer-related tools for mathematics and those interested in their use.

KEYNOTE ADDRESS

Sir Peter Swinnerton-Dyer (Cambridge)

INVITED TALKS

Computers & Mathematical Education
Judah Schwartz (Harvard), Dennis Stanton (Minnesota)

Computers & Physics
Rodney J. Baxter (Aust. Nat. Univ), Alan H. Guth (MIT), Michael J. Creutz (Brookhaven), Richard H. Miller (Chicago)

Mathematics & Supercomputing
David V. & Gregory V. Chudnovsky (Columbia), Monty M. Denneau (IBM Research), Joseph W. Goodman (Stanford)

Computers & New Directions in Mathematics
George Andrews (Penn State), Peter Borwein (Dalhousie), Alexandre Chorin (Berkeley), R. William Gosper

Mathematics & Computer Graphics
George K. Francis (Illinois), Michael F. Barnsley (Georgia Tech), Donna Cox (Illinois), Alvey Ray Smith (Pixar, Inc)

Computers & Combinatorics
J. H. Conway (Princeton), N. J. A. Sloane (AT&T Bell Labs), Andrew Odlyzko (AT&T Bell Labs), Herbert S. Wilf (Pennsylvania)

SPECIAL EVENTS

Scientific Visualization: Lecture and Video Program
Maxine Brown (Illinois)

Computer Art, Music, and Video Show
Carol Chiani (NYC/SIGGRAPH), Producer

Wine and Demo Buffet (The Computer Museum)
Demos of mathematical software
Boston Schools Computer Contest Awards

TUTORIAL MINICOURSES

Comp. Graphics & Diff. Geometry in 2-, 3- & 4-Space
Thomas Banchoff (Brown)

Groebner Bases: Foundation for Constructive Algebra
Lorenzo Robbiano (Genoa)

The Regrettable Failure of Automated Error Analysis
William M. Kahan (Berkeley)

Computers in Undergraduate Mathematics
Stanley Devitt (Saskatchewan), Michael Henle (Oberlin)

Symbolic Integration is Algorithmic!
Manuel Bronstein (IBM Research), James H. Davenport (Bath), Barry M. Trager (IBM Research)

An Introduction to Computational Group Theory
John Cannon (Sydney), Gregory Butler (Sydney)

The HP-28S: A Bridge Between Theory & Applications
Yves Nievergelt (E. Washington)

The Science of Fractal Images
Heinz-Otto Peitgen (Bremen), Richard F. Voss (IBM)

DEMONSTRATIONS

CAYLEY (Sydney), DELIA (Acad. Sciences, USSR)
Derive (Soft Warehouse), MACSYMA (Symbolics)
Macaulay (Columbia), Maple (Waterloo), Mathematica (Wolfram Research), Milo (Paracomputer), REDUCE (RAND Corp.), Scratchpad (IBM Research)

EXHIBITS

Products relating to Research and Education
Institution-based Research Projects
Computer Mathematics Classrooms
Boston Schools Computer Competition Winners
Publishers

For registration and campus housing forms, contact:
Heather A. Schmidt, Conference Secretary
Computers & Mathematics 1989
62 Eastview, Pleasantville, New York 10570
CSNET: cm89 at ibm.com; BITNET: cm89 at yktvmz
Telephone: (914) 769-2725
Games and Economic Behavior

IMPACT of Computing in Science and Engineering

Sample copies and privileged personal rates are available upon request. For more information, please write or call:

ACADEMIC PRESS, INC.
Journal Promotion Department
1250 Sixth Avenue
San Diego, CA 92101 U.S.A.
(619) 699-6742

Editor
Ehud Kalai
Northwestern University, Evanston, Illinois

Games and Economic Behavior publishes original and survey papers dealing with game-theoretic modeling in the social, biological, and mathematical sciences. Papers published are mathematically rigorous as well as accessible to readers in related fields. The purpose of the journal is to facilitate cross-fertilization between the theory and application of game-theoretic reasoning.

Managing Editor
Peter Deuflhard
Konrad Zuse Center, Berlin, Federal Republic of Germany

IMPACT of Computing in Science and Engineering focuses on articles from the areas of mathematical and scientific modeling, scientific computing, computer science, and scientific and engineering applications. The journal is interdisciplinary. Its papers will touch upon a combination of at least two of the four main areas—with the exception of the combination of modeling and applications, for which other journals may be more appropriate. Articles typically will describe real-life problems attacked by a new or specifically adapted algorithm or by any other new computing technique.
NUMBER THEORY, TRACE FORMULAS AND DISCRETE GROUPS
Symposium in Honor of Atle Selberg, Oslo, Norway, July 14-21, 1987
edited by Karl Egil Aubert, Enrico Bombieri, and Dorian Goldfeld

One of the most powerful mathematicians of this century, Atle Selberg has almost single handedly changed the course of modern analytic number theory. This volume contains the proceedings of an international conference that was held in honor of his 70th birthday in Oslo, July 14-21, 1987. The aim of the conference was to survey Selberg's principal contributions to mathematics in the areas of prime number theory and zeta functions, sieve methods, trace formulas and discrete groups, and also to focus on their most recent development. The nine survey papers can serve as a graduate-level introduction to the field.

February 1989, c. 536 pages $69.95 (tentative) ISBN: 0-12-067570-6

INITIAL-BOUNDARY VALUE PROBLEMS
Heinz-Otto Kreiss and Jens Lorenz

This book provides a systematic treatment of time dependent partial differential equations of parabolic, hyperbolic or mixed type. Written for graduate students and researchers in mathematics and engineering, the book covers the theory of an important class of evolutionary systems and provides background material for their numerical treatment. The Navier-Stokes equations of fluid dynamics—compressible and incompressible—serve as an important example to illustrate the results. Constructive methods (difference schemes, iterations) are used throughout the text to show the existence of solutions.

March 1989, c. 400 pages $49.50 (tentative) ISBN: 0-12-426125-6

ALGEBRAIC ANALYSIS
Papers Dedicated to Professor Mikio Sato on the Occasion of His Sixtieth Birthday
Volumes I and II
edited by Masaki Kashiwara and Takahiro Kawai

This is a collection of very high level research papers in the area of analysis and mathematical physics edited by two outstanding Japanese mathematicians on the occasion and in honor of Professor Mikio Sato's 60th birthday.

Volume I

Volume II
March 1989, 504 pages, $59.95 ISBN: 0-12-400466-0

VERTEX OPERATOR ALGEBRAS AND THE MONSTER
Igor B. Frenkel, James Lepowsky, and Arne Meurman

This book is motivated by and develops connections between several branches of mathematics and physics—the theories of Lie algebras, finite groups and modular functions in mathematics, and string theory in physics. The first part of the book presents a new mathematical theory of vertex operator algebras, the algebraic counterpart of two-dimensional holomorphic conformal quantum field theory. The remaining part constructs the Monster finite simple group as the automorphism group of a very special vertex operator algebra, called the "moonshine module" because of its relevance to "monstrous moonshine."


REPRESENTATIONS OF FINITE GROUPS
Hirosi Nagao and Yukio Tsushima

This book is a self-contained exposition of the general theory of ordinary and modular representations of finite groups, including some recent results. It provides sufficient preparation for reading recent research articles on this subject. The authors have kept their explanations as comprehensive as possible by only assuming familiarity with the basic undergraduate algebra and some Galois theory.

April 1989, c. 448 pages $59.50 (tentative) ISBN: 0-12-513660-9

ACADEMIC PRESS
Harcourt Brace Jovanovich, Publishers

CALL TOLL FREE 1-800-321-5068

© 1989 by Academic Press, Inc. All Rights Reserved. Prices subject to change without notice CB/ES #35039.
Michel Hervé

Analyticity in Infinite Dimensional Spaces


(de Gruyter Studies in Mathematics, Volume 10)

In recent years, infinite dimensional holomorphy has been the object of intensive research, both in its own right and because of the often unexpected, nontrivial applications to other areas such as, for instance, potential theory and quantum field theory. Much of the impetus for the study of holomorphic functions in infinite dimensions has been provided by the investigation of topological properties of spaces of such mappings. The aim of this book is to present the analytic aspects of the theory in its setting of complex analysis in locally convex spaces. The exposition is entirely self-contained and links together the beautiful results obtained in the last twenty years mainly by Cœuré, Dineen, Lelong, Vigué, but also by Kiselman, Nguyen, Noverraz, Siciak, Vesentini, and others.

Group Theory

Proceedings of the Singapore Group Theory Conference held at the National University of Singapore, June 8-19, 1987

Edited by K. N. CHENG and Y. K. LEONG


This volume contains thirty-nine selected articles based on short lecture courses and talks presented at the conference by leading experts in the field. Both survey and original research articles cover a wide spectrum of modern group theory and related areas, ranging from finite simple groups, Galois realizations for certain finite groups, Burnside-type problems, locally finite groups, cohomological methods in infinite groups to combinatorial and computational aspects of the theory.

Contents:

Workshop Lectures. O. H. Kegel: Four lectures on Sylow theory in locally finite groups · D. J. S. Robinson: Cohomology in infinite group theory.

Invited Lectures. S. I. Adian, A. A. Razborov, N. N. Repin: Upper and lower bounds for nilpotency classes of Lie algebras with Engel conditions · R. D. Blyth, D. J. S. Robinson: Recent progress on rewritability in groups · W. Feit: Some finite groups with nontrivial centers which are Galois groups · B. Hartley: Actions on lower central factors of free groups · G. Higman: Some countably free groups · N. Ito: Automorphism groups of DRADS · A. I. Kostrikin: Invariant lattices in Lie algebras and their automorphism groups · B. H. Neumann: Yet more on finite groups with few defining relations · M. Suzuki: Elementary proof of the simplicity of sporadic groups · J. G. Thompson: Fricke, free groups and SL₂ · J. G. Thompson: Hecke operators and noncongruence subgroups.


Appendices. List of participants · List of lectures.

Prices are subject to change

Walter de Gruyter, Inc.

200 Saw Mill River Road, Hawthorne, New York 10532, Phone: (914) 747-0110
## AMERICAN MATHEMATICAL SOCIETY

Please read the reverse side of this form to determine what membership category you are eligible for. Then fill out this application and return it as soon as possible. Your name will be added to our mailing lists upon our receipt of your completed application, and payment for member dues.

Subscriptions to the Notices and the Bulletin (New Series) are included as part of your membership.

### Application for Membership 1989

**Date**            19 ..............

### Fields of Interest

If you wish to be on the mailing lists to receive information about publications in fields of mathematics in which you have an interest, please consult the list of major headings of the 1980 Mathematics Subject Classification below. Select no more than five category numbers and fill in the numbers where indicated on the left. These categories will be added to your computer record so that you will be informed of new publications or special sales in the fields you have indicated.

<table>
<thead>
<tr>
<th>Category Number</th>
<th>Field of Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>General</td>
</tr>
<tr>
<td>01</td>
<td>History and biography</td>
</tr>
<tr>
<td>02</td>
<td>Mathematical logic and foundations</td>
</tr>
<tr>
<td>03</td>
<td>Set theory</td>
</tr>
<tr>
<td>04</td>
<td>Combinatorics</td>
</tr>
<tr>
<td>05</td>
<td>Order, lattices, ordered algebra systems</td>
</tr>
<tr>
<td>06</td>
<td>General mathematical systems</td>
</tr>
<tr>
<td>07</td>
<td>Number theory</td>
</tr>
<tr>
<td>08</td>
<td>Field theory and polynomials</td>
</tr>
<tr>
<td>09</td>
<td>Commutative rings and algebras</td>
</tr>
<tr>
<td>10</td>
<td>Algebraic geometry</td>
</tr>
<tr>
<td>11</td>
<td>Linear and multilinear algebra; matrix theory</td>
</tr>
<tr>
<td>12</td>
<td>Associative rings and algebras</td>
</tr>
<tr>
<td>13</td>
<td>Algebraic geometry</td>
</tr>
<tr>
<td>14</td>
<td>Linear and multilinear algebra; matrix theory</td>
</tr>
<tr>
<td>15</td>
<td>Nonassociative rings and algebras</td>
</tr>
<tr>
<td>16</td>
<td>Category theory; homological algebra</td>
</tr>
<tr>
<td>17</td>
<td>K-theory</td>
</tr>
<tr>
<td>18</td>
<td>Group theory; generalizations</td>
</tr>
<tr>
<td>19</td>
<td>Topological groups; Lie groups</td>
</tr>
<tr>
<td>20</td>
<td>Real functions</td>
</tr>
<tr>
<td>21</td>
<td>Measure and integration</td>
</tr>
<tr>
<td>22</td>
<td>Functions of a complex variable</td>
</tr>
<tr>
<td>23</td>
<td>Potential theory</td>
</tr>
<tr>
<td>24</td>
<td>Several complex variables and analytic spaces</td>
</tr>
<tr>
<td>25</td>
<td>Special functions</td>
</tr>
<tr>
<td>26</td>
<td>Ordinary differential equations</td>
</tr>
<tr>
<td>27</td>
<td>Partial differential equations</td>
</tr>
<tr>
<td>28</td>
<td>Finite differences and functional equations</td>
</tr>
<tr>
<td>29</td>
<td>Sequences and summability</td>
</tr>
<tr>
<td>30</td>
<td>Approximations and expansions</td>
</tr>
<tr>
<td>31</td>
<td>Fourier analysis</td>
</tr>
<tr>
<td>32</td>
<td>Abstract harmonic analysis</td>
</tr>
<tr>
<td>33</td>
<td>Integral transforms, operational calculus</td>
</tr>
<tr>
<td>34</td>
<td>Integral equations</td>
</tr>
<tr>
<td>35</td>
<td>Functional analysis</td>
</tr>
<tr>
<td>36</td>
<td>Operator theory</td>
</tr>
<tr>
<td>37</td>
<td>Calculus of variations and optimal control; optimization</td>
</tr>
<tr>
<td>38</td>
<td>Geometry</td>
</tr>
<tr>
<td>39</td>
<td>Convex sets and related geometric topics</td>
</tr>
<tr>
<td>40</td>
<td>Differential geometry</td>
</tr>
<tr>
<td>41</td>
<td>General topology</td>
</tr>
<tr>
<td>42</td>
<td>Algebraic topology</td>
</tr>
<tr>
<td>43</td>
<td>Manifolds and cell complexes</td>
</tr>
<tr>
<td>44</td>
<td>Global analysis, analysis on manifolds</td>
</tr>
<tr>
<td>45</td>
<td>Probability theory and stochastic processes</td>
</tr>
<tr>
<td>46</td>
<td>Statistics</td>
</tr>
<tr>
<td>47</td>
<td>Numerical analysis</td>
</tr>
<tr>
<td>48</td>
<td>Computer science</td>
</tr>
<tr>
<td>49</td>
<td>Mechanics of particles and systems</td>
</tr>
<tr>
<td>50</td>
<td>Mechanics of solids</td>
</tr>
<tr>
<td>51</td>
<td>Fluid mechanics</td>
</tr>
<tr>
<td>52</td>
<td>Optics, electromagnetic theory</td>
</tr>
<tr>
<td>53</td>
<td>Classical thermodynamics, heat transfer</td>
</tr>
<tr>
<td>54</td>
<td>Quantum mechanics</td>
</tr>
<tr>
<td>55</td>
<td>Statistical physics, structure of matter</td>
</tr>
<tr>
<td>56</td>
<td>Relativity</td>
</tr>
<tr>
<td>57</td>
<td>Astronomy and astrophysics</td>
</tr>
<tr>
<td>58</td>
<td>Geophysics</td>
</tr>
<tr>
<td>59</td>
<td>Economics, operations research, programming, games</td>
</tr>
<tr>
<td>60</td>
<td>Biology and behavioral sciences</td>
</tr>
<tr>
<td>61</td>
<td>Systems theory; control</td>
</tr>
<tr>
<td>62</td>
<td>Information and communication, circuits</td>
</tr>
</tbody>
</table>

## Prepayment Methods and Mailing Addresses

All payments must be in U.S. Funds.

Send checks, money orders, UNESCO coupons to American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-9930

**To use VISA or MasterCard,** fill in information requested and mail to American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

**For Foreign Bank Transfers:** The name and address of the AMS bank is Rhode Island Hospital Trust National Bank, Account #000-753-111, One Hospital Trust Plaza, Providence, RI 02903, U.S.A.

**VISA** O **MasterCard** O

---

**Signature**
Membership Categories

Please read the following to determine what membership category you are eligible for, and then indicate below the category for which you are applying.

For ordinary members whose annual professional income is below $38,000, the dues are $66; for those whose annual professional income is $38,000 or more, the dues are $88.

The CMS Cooperative Rate applies to ordinary members of the AMS who are also members of the Canadian Mathematical Society and reside outside of the U.S. For members whose annual professional income is $38,000 or less, the dues are $56 and for those whose annual professional income is above $38,000, the dues are $75.

For a joint family membership, one pays ordinary dues, based on his or her income, and the other pays ordinary dues based on his or her income, less $20. (Only the member paying full dues will receive the Notices and the Bulletin as a privilege of membership, but both members will be accorded all other privileges of membership.) Minimum dues for contributing members are $132.

For either students or unemployed individuals, dues are $22, and annual verification is required.

The annual dues for reciprocity members who reside outside the U.S. and Canada are $44. To be eligible for this classification, members must belong to one of those foreign societies with which the AMS has established a reciprocity agreement, and annual verification is required. Reciprocity members who reside in the U.S. or Canada must pay ordinary member dues ($56 or $88).

The annual dues for external members, those who reside in developing countries which do not have any mathematical society, are $47.

Members can purchase a multi-year membership by prepaying their current dues rate for either two, three, four or five years. This option is not available to either unemployed or student members.

1989 Dues Schedule

For any category of membership where no dues prices are given, the higher one is to be paid by persons whose annual professional income is $30,000 or more.

Ordinary member ................................................... $66 $88

CMS Cooperative rate ........................................... $56 $75

Joint family member (full rate) ................................. $66 $88

Joint family member (reduced rate) ......................... $46 $68

Contributing member (minimum $132) ...................... $132

Student member (please verify) ............................... $22

Unemployed member (please verify) ....................... $22

Reciprocity member (please verify) ....................... $44 $66 $88

External member .................................................... $47

Multi-year membership ........................................ $ . . . . for . . . . . . years

1 Student Verification (sign below)

I am a full-time student at .................................................. currently working toward a degree.

2 Unemployed Verification (sign below) I am currently unemployed and actively seeking employment. My unemployment status is not a result of voluntary resignation or of retirement from my last position.

3 Reciprocity Membership Verification (sign below) I am currently a member of the society indicated on the right and am therefore eligible for reciprocity membership.
**Order Form**

For VISA or MasterCard orders, send to:
American Mathematical Society  
P.O. Box 6248  
Providence, Rhode Island 02940  
(800) 556-7774

Ordered by: ____________________________

____________________________________

____________________________________

Use your peel-off Notices label.

<table>
<thead>
<tr>
<th>QTY</th>
<th>CODE</th>
<th>AUTHOR and TITLE</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Shipping and Handling  
☐ Surface  
☐ Air

Total due (All orders must be prepaid in U.S. funds) $

**Charge by phone in the continental U.S.**  
800-556-7774

☐ Check or Money Order  
☐ VISA  
☐ MasterCard

Card Number

Card Expiration Date ___________ Signature ___________

**Shipping and Handling**

<table>
<thead>
<tr>
<th></th>
<th>First Book</th>
<th>Each Additional</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>$2</td>
<td>$1</td>
<td>$25</td>
</tr>
<tr>
<td>Air</td>
<td>$5</td>
<td>$3</td>
<td>$100</td>
</tr>
</tbody>
</table>

Prices are subject to change without notice.

Books are sent via surface mail (UPS to U.S. addresses and printed matter elsewhere) unless air delivery is requested. The shipping and handling charges for book orders are shown in the table. Journal back numbers, Mathematical Reviews indexes and review volumes are sent via surface mail to any destination unless air delivery is requested. Postage for surface mail is paid by the AMS. Air delivery rates, which will be quoted upon request, must be paid by the purchaser. Software: Nonindividual customers need not prepay provided a Purchase Order number is given with the order. Software/books are sent via UPS to U.S. addresses, first class mail to Canada, and air delivery elsewhere. Add shipping and handling for Software/Books: $6 per order in the U.S. and Canada; $25 per order air delivery outside the U.S. and Canada.

Customers in these areas should request price information from and direct their orders to the following distributors:

**Europe/Middle East/Africa:** Barry Emms, Clarke Associates—Europe Ltd., 13a Small Street, Bristol BS1 1DE. England. Tel. 01-272-68864, Telex 445591 CALORB G: exclusive distributor of AMS books.

**Japan:** Maruzen Co. Ltd., P.O. Box 5050, Tokyo International 100-31, Japan. Tel. Tokyo 272-7211, Telex J26516

**India:** Allied Publishers Pvt. Ltd., 15, J. N. Herdia Marg., Ballard Estate, Bombay 400038, India
Change of Address

Members of the Society who move or who change positions are urged to notify the Providence Office as soon as possible.

Journal mailing lists must be printed four to six weeks before the issue date. Therefore, in order to avoid disruption of service, members are requested to provide the required notice well in advance.

Besides mailing addresses for members, the Society's records contain information about members' positions and their employers (for publication in the Combined Membership List). In addition, the AMS maintains records of members' honors, awards, and information on Society service. Information of the latter kind appears regularly in Notices.

When changing their addresses, members are urged to cooperate by supplying the information requested below. The Society's records are of value only to the extent that they are current and accurate.

If your address has changed, or will change within the next two or three months, please place the peel-off label from the back cover (which contains your name, member code, and address) in the rectangle provided below (or on a copy of this page), supply any other information appropriate for the AMS records, and mail to the address given below.

---

Place Notices label here

Change effective as of: __________________________________________

New mailing address: __________________________________________

________________________________________________________________

________________________________________________________________

New position: ________________________________________________

If mailing address is not that of your employer, please supply the following information:

New employer: ________________________________________________

Location of employer: __________________________________________

<table>
<thead>
<tr>
<th>City</th>
<th>State/Province</th>
<th>Country</th>
<th>Zip Code</th>
</tr>
</thead>
</table>

Recent honors and awards: ______________________________________

________________________________________________________________

________________________________________________________________

Personal items for publication in Notices: ________________________

________________________________________________________________

Mail completed form to:

Membership Department, AMS, P.O. Box 6248, Providence, RI 02940
1989 AMS PURE MATHEMATICS SYMPOSIUM
HOUSING RESERVATION FORM
Sundance Resort, Sundance, Utah

PLEASE PRINT OR TYPE

NAME ___________________________________________ (MALE) _________

Last            First            Initial

(MALE) _________

(FEMALE) _________

ADDRESS

_________________________________________ __________________________

ZIP

________________________________________

OFFICE PHONE ( ) ________________________ HOME PHONE ( )

________________________________________

*Single occupancy @ $60.00 per day  __________ meal plan @ $225.00

*Double occupancy @ $30.00 per person __________ meal plan @ $225.00

Complete information below

# Date of arrival______________ Date of departure______________

Airline / Flight Number ________________ Time of Arrival (SLC) ________________

*Room rate does not include tax.
$65.00 ROOM DEPOSIT GUARANTEE REQUIREMENT.
MAKE CHECKS PAYABLE TO SUNDANCE RESORT. DEADLINE IS APRIL 7, 1989.

Sharing with: ____________________________________________________________

Spouse/Children: __________________________________________________________

Smoking/Nonsmoking: _______________________________________________________

Handicapped: _______________________________________________________________

Special Requirements: _______________________________________________________

Note: YOU MUST ARRANGE FOR SHARED OCCUPANCY. ROOMING ASSIGNMENTS WILL
BE MADE BY THE ORGANIZING COMMITTEE AND PREFERENCE CANNOT BE
GUARANTEED.

MEAL PLAN MUST BE PAID IN FULL BY CHECK.
PLEASE MAKE CHECKS PAYABLE TO THE AMS.
DEADLINE IS APRIL 7, 1989.

Please send this completed reservation form to:

WAYNE DRADY
Conference Coordinator
AMS PURE MATHEMATICS SYMPOSIUM
P. O. Box 6248
Providence, RI 02940

Deadline for receipt of reservation forms at the AMS is April 7, 1989

Date received______________ Room assigned _________

Date to Sundance______________ Confirmation sent _________
New titles from
Birkhäuser Boston
Your source for major mathematical developments

PROGRESS IN MATHEMATICS

Riemannian Foliations
Piero Molino
This book presents the first elementary exposition of basic results in Riemannian foliations obtained in the last ten years. Jan. 89 / 360 pages / 0-8176-3370-7 / $44.00 / PM, Vol. 73

Andreatti-Grauert Theory by Integral Formulas
Gennadi Henkin and Jurgen Leiterer
In the last twenty years, integral representation formulas for solutions of the Cauchy-Riemann equation have had an important influence on the theory of functions of several complex variables. This monograph develops the Andreatti-Grauert theory, i.e. the theory of the Dolbeault cohomology of q-convex and q-concave manifolds, from this standpoint Oct. 88 / 272 pages / 0-8176-3413-4 / $44.90 / PM, Vol. 74

Seminaire de Theorie des Nombres, Paris 1986-87
Catherine Goldstein, ed.
Nov. 88 / 408 pages / 0-8176-3414-2 / $49.00 / PM, Vol. 75

Enriques Surfaces I
Francoise Cossec and Igor Dolgachev
Enriques surfaces are key examples of the classification theory of complex algebraic surfaces. Using the arithmetic and combinatorial structures on the Picard group, this book explores the geometry of these surfaces by purely geometric methods, involving delicate combinatorial analysis, valid in arbitrary characteristics Jan. 89 / 400 pages / 0-8176-3417-7 / $42.50 / PM, Vol. 76

CONTEMPORARY MATHEMATICIANS

Collected Works of Arne Beurling
Arne Beurling contributions to mathematics include the areas of complex analysis, functional analysis, operator theory, potential theory, harmonic analysis and semi-groups of operators. These volumes make available for the first time his extensive body of published work. Apr. 89 / 2 volume set / 0-8176-3412-6 / $120.00 (tent.)
Volume 1 / approx. 450 pages / 0-8176-3415-0 / $60.00 (tent.)
Volume 2 / approx. 450 pages / 0-8176-3416-9 / $60.00 (tent.)

Julio Rey-Pastor: Selected Papers
Eduardo Ortiz, ed.
A careful selection of the most important papers of the Argentinean mathematician Julio Rey-Pastor, especially noted for his work on classical projective geometry, conformal representation, the theory of functional analysis and the theory of series. Introduction in English. Papers in Spanish and French. May 89 / approx. 350 pages / 0-8176-3447-7 / $39.00 (tent.)

Available at your local scientific bookstore or order directly from the publisher:

Birkhäuser Boston, Inc.
c/o Springer-Verlag Distribution Center
PO. Box 2485
Secaucus, NJ 07096-2491

MONOGRAPHS IN MATHEMATICS

Singularities of Differentiable Maps, Vol. I
The Classification of critical points, caustics and wave fronts
V.I. Arnold, A.N. Varchenko, S.M. Gusein-Zade
1984 / 372 pages / 0-8176-3187-9 / $44.95 / MMA, Vol. 82

Singularities of Differentiable Maps, Vol. II
Monodromy and Asymptotic Integrals
V.I. Arnold, S.M. Gusein-Zade, A.N. Varchenko
Nov. 88 / 400 pages / 0-8176-3185-2 / $95.00 / MMA, Vol. 83

OTHER NEW TITLES IN MATHEMATICS

Jean Dieudonné
Written by a world-renowned mathematician, this book traces the history of algebraic topology beginning with its creation by Henri Poincare in 1900, and describing in detail the important ideas introduced in the theory before 1960. Feb. 89 / approx. 672 pages / 0-8176-3398-x / $79.00

Textual Studies in Ancient and Medieval Geometry
Wilbur Knorr
An important new study of the problems of documentation in ancient technical texts. Coverage includes: the primary Greek evidence on cubic duplication; selected medieval Arabic texts on cubic duplication and angle trisection; an in-depth look at Archimedes Dimension of the Circle.
June 89 / approx. 640 pages / 0-8176-3387-1 / $89.00

Graded Orders
L. Le Bruyn, M. Van den Bergh, and F. Van Oystaeyen
In a clear, well-developed presentation, this book provides the first systematic treatment of structure results for algebras which are graded by a group. Aug. 88 / approx. 300 pages / 0-8176-3360-x / $25.00 (Paper)

Complex Analysis
Articles dedicated to Albert Pfluger on the occasion of his 80th birthday
Joseph Hersch and Alfred Huber, eds.
This volume contains articles pertaining to a wide variety of subjects such as conformal and quasiconformal mappings and related extremal problems, Riemann surfaces, meromorphic functions, subharmonic functions, approximation and interpolation, and other questions of complex analysis. Nov. 88 / 240 pages / 0-8176-1958-5 / $72.50

Numerical Methods for Grid Equations
A.A. Samarskii and E.S. Nikolaev
These volumes are devoted to the construction and analysis of numerical methods of solving systems of algebraic equations that arise in the application of the network method to problems of mathematical physics. Direct Methods — Vol. 1 / 242 pages / 0-8176-2276-4 / $99.50 Iterative Methods — Vol. 2 / 302 pages / 0-8176-2277-2 / $190.00 Nov. 88 / 2 volume set / 0-8176-2278-0 / $260.00
Revised Edition!

DIFFERENTIAL AND DIFFERENCE EQUATIONS THROUGH COMPUTER EXPERIMENTS

With a Supplementary Diskette Containing PHASER: An Animator/Simulator for Dynamical Systems for IBM Personal Computers

SECOND EDITION

By Hüseyin Koçak

An illustrated guide to the wonderful world of experimental and theoretical dynamics in which the subject of ordinary differential and difference equations comes alive!

PHASER, a sophisticated program for IBM Personal Computers,* which enables users to experiment with differential and difference equations and dynamical systems in an interactive environment using graphics, now has the capacity to take advantage of the higher resolution EGA or VGA graphics.**

*XT, AT, or PS/2 with an IBM Color Graphics Board.

**For those who have only CGA graphics, the original version of PHASER is also included. This low resolution version has now been modified to run on EGA/VGA boards as well, primarily for use with inexpensive projectors.

From reviews of the first edition:

"Both the book and its accompanying software are of the highest quality in terms of mathematical taste, pedagogical usefulness, and professional programming technique." — Byte

"The program worked so well that not only students, but also researchers, are interested in using it!" — Mathematical Reviews


Diskettes Available Separately:


Version 1.1 (two 3 1/2 in. diskettes): $34.95 ISBN 14202-9

ORDER INFORMATION:

Call Toll-Free 1-800-SPRINGER. For mail orders, send payment plus $2.50 for postage to: Springer-Verlag New York, Inc., Attn.: S. Klamkin, 175 Fifth Avenue, New York, NY 10010. Or, use our new FAX # (201) 464-4055. We accept Visa, MasterCard, American Express, personal checks and money orders. Please include exp. date and signature for all charges and add applicable sales tax if you reside in NY, NJ or CA.

New!

CRITICAL POINT THEORY AND HAMILTONIAN SYSTEMS

By Jean Mawhin and Michel Willem

The aim of this book is to initiate the reader to the fundamental techniques of critical point theory and apply them to periodic solutions problems for Hamiltonian systems. The presentation of the text should be appealing to people trained and interested in ordinary differential equations and as well as by specialists in differential topology, partial differential equations, and optimization.


Bibliography (with extensive references).

1989. 277 pp. 1 illus. Hardcover $54.00

ISBN 96908-X

Applied Mathematical Sciences, Volume 74

ELEMENTS OF MATHEMATICS

By Nicolas Bourbaki

COMMUTATIVE ALGEBRA

2ND PRINTING (1989)

The thorough coverage of this book enables the reader to go further and study algebraic or arithmetical geometry. It includes useful exercises at the end of each chapter.


LIE GROUPS AND LIE ALGEBRAS

Part 1: Chapters 1-3

2ND PRINTING (1989)

This is one of the best references on this subject.


GENERAL TOPOLOGY

Chapters 5-10

2ND PRINTING (1989)

A continuation of Chapters 1-4 of General Topology. Both volumes include a historical note and numerous exercises.


[Springer-Verlag]

New York Berlin Heidelberg Vienna London Paris Tokyo Hong Kong