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 besubmitted 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

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<tr>
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<th>Place</th>
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<td>845</td>
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<td>Lawrence, Kansas</td>
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<td>846</td>
<td>* November 12-13, 1988</td>
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<td>847</td>
<td>* January 11-14, 1989 (95th Annual Meeting)</td>
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<td>848</td>
<td>* April 15-16, 1989</td>
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<td>849</td>
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<td>June 29-July 1, 1992 (Joint Meeting with the London Mathematical Society)</td>
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<td>January 5-8, 1994 (100th Annual Meeting)</td>
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* Please refer to page 1236 for listing of special sessions
† Preregistration/Housing deadline is November 10
‡ Preregistration/Housing deadline is June 1

Conferences


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* 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

1119 Renewing U.S. Mathematics: An Agenda to Begin the Second Century
   Edward E. David Jr.
   The full text of Edward E. David Jr.’s keynote address at the AMS Centennial is presented.

1123 Research Mathematics in Mathematics Education
   In the second of a two-part series, a number of major national projects influencing the current thinking about mathematics education and a number of educational programs run by research mathematicians are examined.

FEATURE COLUMNS

1132 Inside the AMS: Support of Conferences
   The financial, administrative, and scientific components of support of AMS conferences are examined.

1134 Computers and Mathematics Jon Barwise
   Jon Barwise introduces two articles which deal with the issues of providing resources to mathematicians and their students: D. F. Holt reviews CAYLEY, the computer program designed as an aid to research in modern algebra; and Richard Palais explores various aspects of computer communication having to do with networking and electronic bulletin board systems.

1149 Washington Outlook Kenneth Hoffman
   Ken Hoffman, in his spirit of reporting mathematical activities involving public information, comments on the numerous contributions of William J. LeVeque.

DEPARTMENTS

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New Directions at the AMS

Over the past year, you may have noticed that the AMS has expanded its publication program with several new book series and journals that have a broader appeal to the mathematical community. The Society is well-known for its research journals, including the new Journal of the American Mathematical Society, and for its book series which include both monographs and proceedings of symposia and conferences. These publications will continue to form the core of the AMS information services.

The new look began last winter with the publication of I Have a Photographic Memory by Paul Halmos. This is a delightful collection of photographs of mathematicians being themselves as seen by Paul Halmos over the past forty-five years. More recently the History of Mathematics book series was inaugurated with A Century of Mathematics in America edited by Peter Duren with the assistance of Richard Askey and Uta Merzbach. This volume recounts some of the political, social, and mathematical forces that shaped American mathematics in the past century. Future volumes in this series will present historical perspectives on individuals who influenced the development of mathematics or will trace the growth of a particular research area.

Two other book series, the University Lecture Series and AMS Reprints, are designed to fill a publication gap. The University Lecture Series will be a vehicle for the presentation of important lecture series given by outstanding mathematicians. In the past, these lectures have gone unrecorded or the lecture notes have had limited distribution. The AMS Reprint Series will be an opportunity to provide copies of classical mathematical books that have gone out of print. In recent years, economic factors have forced publishers to cease publication of many research monographs and graduate level texts even though they are still popular and in demand. Consistent with the AMS policy of not letting its own publications go out of print, the Society will reprint some of these discontinued books as a service to the community.

A new journal of general interest is Sugaku Expositions which is a translation of articles from the Mathematical Society of Japan’s journal, Sugaku. These articles will be expository in nature and will provide information on a variety of current areas of mathematical research.

One other publication that should be cited is The Collected Papers of R.H. Bing. This two volume set is not part of the various series described above but is a venture by the Society which brings together the papers of a great American mathematician. In the past, the AMS has not published collected works but the opportunity occurred in this case, and other collected works may become a part of the AMS list of publications in the future.

While describing areas of general interest to the mathematical community, two other activities should be mentioned. The first is the AMS-MAA Joint Invited Address videotape program. These are tapes of lectures given at the Joint Annual and Summer meetings by famous mathematicians giving expository talks. This is an attempt to preserve the content of the lecture and provide a lasting picture of the lecturer. The other activity is the publication of the Collegiate Mathematics Education Newsletter. This will be a bi-monthly publication beginning in 1989, and, for the first three years, will be funded, in part, by the NSF. The Newsletter will concentrate on issues involving mathematics education and will have the joint support of the AMS, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics.

All of these ventures are in sharp contrast to the normal publication activities of the AMS, but, on the other hand, each is an effort by the Society to continue to provide valuable information to the mathematical community.
Reminiscences
A footnote to Everett Pitcher’s article on “The Growth of the American Mathematical Society” in the July/August 1988 issue of Notices: My father, Wilson L. Miser (who was a member of the Society for well over half a century), recalls a meeting of the Society at the University of Chicago’s Eckart Hall about 1910, when he was a graduate student there. The research papers had all been read by mid-afternoon, whereupon the attendees played a softball game on the lawn. There were just enough people present to make up two teams, with one left over to umpire the game.

Hugh J. Miser
Farmington, Connecticut
(Received July 27, 1988)

A Request to the AMS Council

EDITOR’S NOTE: The following letter to the Council was also submitted to Notices as a letter to the editor. The Council of 7 August 1988 considered the letter and decided not to take any action.

To the Council of the AMS:

I bring to your attention an item in the 2 April 1988 issue of Science News. Ken Hoffman is mentioned as “a member of all three societies [including the AMS] who has played an important role in pushing for increased funding for mathematics research...”. Science News states:

He contends that most AMS members had too little information about how funding decisions are actually made to vote knowledgeable.

The vote is the vote on the referendum. I object very strongly to any such position by someone purporting to represent AMS interests to the government and the public. It is not for a representative of the AMS to presume what information members had or had not. It is tautological and irrelevant that we all make decisions on the basis of partial information.

Serge Lang
Yale University
(Received April 22, 1988)

EDITOR’S NOTE: The Executive Committee of the Council, at its meeting in May 1988, suggested that, if Serge Lang’s letter were published, a statement concerning Ken Hoffman’s activities should also be published. President-Elect William Browder wrote the following letter.

To the Editor of Notices:

For almost ten years now, first as executive director of the David Committee, and more recently in the Office of Government and Public Affairs of the Joint Policy Board for Mathematics, Ken Hoffman has been a strong and effective voice representing the Mathematical Community in Washington. This period has seen a reversal of the declining trend of math research funding of the 70’s, with greatly increased appropriations in NSF, and new programs in other agencies, such as the research grant program at NSA. During this time Ken also contributed significantly to the setting up of the Board of Math. Sciences and the Board on Math Education at the National Research Council.

In a word, Hoffman has been the most energetic and effective spokesman the math community has ever had in Washington. He deserves our appreciation, thanks and support.

Now Serge Lang attacks him for the (inaccurate) journalistic description of his opinions on the referenda of last spring. Even if he held the opinions attributed to him, Hoffman is entitled to his opinions, and to express them, as long as they are not represented as policy of the Math. Societies.

Our community faces many tests and challenges in the next years, such as the decline of individual grants.
and the problems of educational reform. A search for ideological purity on the part of some of our members will be highly counterproductive, and exacerbate the bad feelings engendered in many parts of the math community by the debates of last year.

Ours is a society of mathematicians whose main common purpose is to advance scientific research, a goal we can all agree on. To be effective, we need the broadest support among ourselves, from people of all political viewpoints and personal styles, for our political efforts in Washington and elsewhere, where the key decisions are made which have such a profound effect on these issues.

And it is not the business of our Society to tell anyone what to think or say, how to do their research or where to look for funding.

William Browder
Princeton University
(Received July 29, 1988)

Uniform Style for Papers

As individuals many of us have, at times, had disagreements about style of typesetting and related questions with journals publishing our papers. Often we notice these problems when we are reading galley proofs, which is not a propitious time for working out differences; moreover, the production staff of a journal cannot always know whether some wish of an author is an individual quirk, or something that the mathematical community would agree about for good reasons. I therefore think it would be desirable if a discussion of such questions were begun among mathematicians (and members of the editorial staff of journals if they wish to participate), and the conclusions of this discussion passed on to the journals. This is not to ask that all journals adopt a uniform set of conventions; but we can hope that, knowing what we want and why, they will come up with styles closer to our needs.

Though the Society’s journals are not guilty of many of the faults I will mention, these Notices seem a good forum in which to bring up these questions.

It may be that computerized manuscript-production by authors will soon make the topic irrelevant. But at present, even if we have such facilities available, and produce a manuscript according to our own wishes, which we could in theory send to a camera-copy journal, considerations of field and backlog-time often lead to a different choice.

I mention below a few of my concerns, and hope that others will continue the discussion.

(1) In constructions such as \( F_i = G_i(i = 1, \ldots, n) \), journals often run the condition “\( i = 1, \ldots, n \)” up against the preceding equation, with no intervening space. I think that their staff simply needs to be made aware that there is a distinction between functional constructions, such as \( G_i(x_1, \ldots, x_n) \), and the above construction, in which the range of a variable is indicated following a formula. This latter, which calls for space before the parenthesis, can usually be recognized by the presence of predicate symbols, such as \( =, \in \), etc. within the parentheses. When in doubt, the copy editor should look at the spacing in the manuscript.

(2) Many journals number displayed formulas on the right end of the line, while many of us have strong feelings that the numbers should go on the left. Probably the journals’ reason is that they indent displayed formulas by a fixed amount, and an equation-number, which can occasionally be rather long, e.g. (3.15 bis), might come uncomfortably close to the formula. However, to the mathematician it is natural to put the label on the left for the same reason that we write “Theorem 1” at the beginning of the statement of the Theorem rather than at the end. This is especially true when the display is not a formula, but a condition or an assertion, which may be more than one line long.

(3) Although it is preferable to choose our notation so as to minimize the use of second-order superscripts and subscripts, it is sometimes desirable to allow a couple of instances of these in a paper, rather than modifying the notation throughout for the sake of one or two points. Unfortunately, many journals set second-order superscripts and subscripts in almost illegibly small point-size. I think that the standard convention, that superscripts and subscripts are set three points smaller than the material they are attached to, is itself excessive. (I use a change of just one point-size in my own preprints and camera-ready material, with rare ad hoc exceptions when this looks insufficient.) I suspect that the three-point convention is a result of the fact that numerals are taller than lower-case letters, so that with less of a reduction, an expression like \( x^2 \) can appear top-heavy. The symbols that become illegible in second-order subscripts and superscripts are typically not numerals but lower-case letters. Even if the standard convention is followed for first order superscripts and subscripts, there should be a lesser reduction for the second-order case.

(4) Some journals could improve their choice of font-systems: characters with some strokes so thin that they disappear in a less-than-perfect photoreproduction, and script capital letters so elegant that it is hard to guess the letter intended, have particularly bothered me. In nontechnical use, such things are not serious faults because the surrounding letters in a word disambiguate the unclear letter, but for mathematical work they are a problem.

The above are points on which I think most of us will agree. I give below a few points that have troubled me, though I do not know whether others will feel the same way.
(5) It is standard for statements marked Theorem, Proposition, Lemma and Corollary to be set in italics. Unfortunately, some journals stop there, and refuse to italicize the text of an item marked Definition, Conjecture, etc., even if the authors request this. But I think the same considerations apply to these headings as to the former group: They introduce self-contained formal statements, which one wishes to set apart from the surrounding discussion in such a way that the reader can easily locate them when they are referred to, and see exactly where they begin and end.

(6) In typing mathematics, one often makes the separation between text and formulas more clear by leaving double spaces around symbols; e.g., around the \( x \) in

If the element \( x \) has the above property...

I have found it useful to extend this to typeset text. E.g., I prefer

If the element \( x \) has the above property...

rather than

If the element \( x \) has the above property...

and suggest that this practice be made standard.

(7) I have begun adding my electronic mail address after the address line in my papers. It usually gets deleted by the copy editor, but I have usually succeeded in getting it restored in the galley proofs. Since such addresses are extremely convenient for communication, it would be valuable if their inclusion were considered normal.

Generally, journals should be tolerant of diversity of usage among authors, though there must be a balance between this and their need to maintain a certain consistency, and to sometimes let rules they have learned by experience prevail. A decade ago, many journals routinely deleted “end-of-proof” signs; happily, this battle has been won by the authors who wish to use them. On the other hand, when I submitted my first paper to the AMS Transactions, and had to decide on a way to distinguish, in the introductory section, between certain results and definitions that would be needed in what followed, and other paragraphs of background material that would not be needed but which helped put the needed material in a more meaningful context, I came up with the silly idea of having the latter set in smaller type. The editorial staff gently informed me that this would not be possible, and after my initial annoyance, I agreed to put these paragraphs in square brackets instead; a change for which I remain grateful.

George M. Bergman
University of California, Berkeley
(Received June 13, 1988)

Handouts at Mathematics Meetings

While waiting to give my presentation at the AMS meeting at College Park, Maryland on 24 April 1988, I attended the one immediately preceding mine, given by G. Arthur Mihram. On concluding he passed out a collection of pages, the first of which bore the title of his talk. The succeeding pages, however, turned out to contain a great deal of religious and political innuendo which not only has nothing to do with his talk, but also nothing to do with mathematics.

The pages present his very distorted opinions of the Bible; for example that the Old and New Testaments have entirely different concepts of truth, an assertion that is inimical to Christianity and demeaning to Judaism. On the last page, during a discussion of tenure, he gratuitously insults religious believers by suggesting that the Old Testament concepts of morality (presumably based on the Ten Commandments) amount to nothing more than “Image + Money.”

The main purpose of the pages, however, is to present his defamatory attacks on the Jewish community. The tenor of these attacks can be illustrated by the title of one of the pages, “ISRAELI ESPIONAGE, ITS MEDIA COVER-UP: UNDERSTANDING WHO REALLY RUNS AMERICA.” To present at an academic meeting material which has no connection with the topic is merely unprofessional. To twist, ridicule, and defame the religious commitments of people is profoundly morally offensive.

Charles E. Ford
Saint Louis University
(Received May 27, 1988)

Note from Everett Pitcher, the Secretary of the AMS:

The Secretary has ascertained that at the conclusion of his talk Dr. Mihram stated that he had handouts to distribute if anyone wanted one and that after the talk he did distribute some on request. Abstracts offered to the Society for publication are subject to scrutiny and are sometimes rejected for various reasons, including bad taste. Mihram’s abstract was unexceptional. However, the Society has no control over what an individual writes and people receive by request.

Louis Weisner Remembered

The July-August 1988 issue of Notices lists (pages 826-827) those individuals whose AMS memberships span at least half of the Society’s century of existence. One of those named, Louis Weisner, died while the issue was in press. He was 89.

I would like to acquaint the readers with his life; it merits being remembered.

Born and educated in New York, Weisner made important contributions to the study of group-theoretic properties of special functions, including Bessel functions and the classical orthogonal polynomials. His work in what he called hierarchies (better known as lattices), the theory of equations and other topics in
classical algebra also earned him professional respect. His methods and results remain valuable to current workers. He was also an excellent expositor and gifted teacher. His personality was modest and gracious.

Following a National Research Council Fellowship, one of the very few post-doctoral awards available in those days, in 1927 he began his teaching career at Hunter College, part of what today is the City University of New York, governed by the Board of Higher Education.

In the 1950s came McCarthyism, with or without McCarthy. Two of his Hunter College colleagues in other departments were denounced as Communists to the Board and were ordered to trial by that Board, with dismissal as the intended result.

Weisner stepped forward in their defense. He volunteered that he too had been a member of the Communist Party along with the defendants and testified that in the meetings he had attended with them the discussions had been concerned solely with general political questions, current events and trade union matters, that never had anything illegal ever been done or advocated, nor had force and violence ever been proposed. Well and good, quoth the trial committee, provide us with the names of all who ever attended Communist meetings with you so that they can be brought to trial. Weisner refused to name names and was brought up on charges himself for that reason.

The Board trial was held. Eminent personalities testified to Weisner's solid integrity, but to no avail. The two colleagues were dismissed. To assure his family of a modest pension following 27 years of distinguished service, Weisner found it necessary to apply for early retirement before the Board could implement its formal action to dismiss him. This was 1954.

Hunter College lost its most eminent mathematician, its students one of their finest teachers, but little was said of this in the American Mathematical Society or elsewhere in academia.

For well over a year he was unemployed. No U.S. university or organization offered him anything. Late in 1955 he received an unsolicited offer from the University of New Brunswick in Canada. He became a valued and valuable member of its faculty for the remaining fourteen years of his teaching career, contributed frequently-cited papers to the Canadian Journal of Mathematics and participated in the activities of the Canadian Mathematical Congress. As far as I know, he never attended another meeting of the American Mathematical Society.

Predeceased by his wife, he spent the nineteen years of life left to him after retirement in Fredericton, New Brunswick, Canada.

Of fine character, modest and kindly disposition, recognized talent and devoted labors, this worthy colleague was driven from the city and country of his birth, abandoned by his professional society, humiliated and unemployed. That he was saved for the international mathematical community is to Canada's credit as it was to its benefit.

Let him and the lessons of his life and experiences not be forgotten now.

Lee Lorch
York University
(Received July 28, 1988)

EDITOR'S NOTE: A reference to Weisner's research may be found on page 967 of the September 1988 Notices.

ASYMPTOTIC BEHAVIOR OF DISSIPATIVE SYSTEMS
Jack K. Hale
(Mathematical Surveys and Monographs, Volume 25)

This book is directed at researchers in nonlinear ordinary and partial differential equations and at those who apply these topics to other fields of science. About one third of the book focuses on the existence and properties of the flow on the global attractor for a discrete or continuous dynamical system. The author presents a detailed discussion of abstract properties and examples of asymptotically smooth maps and semigroups. He also covers some of the continuity properties of the global attractor under perturbation, its capacity and Hausdorff dimension, and the stability of the flow on the global attractor under perturbation. The remainder of the book deals with particular equations occurring in applications and especially emphasizes delay equations, reaction-diffusion equations, and the damped wave equations. In each of the examples presented, the author shows how to verify the existence of a global attractor, and, for several examples, he discusses some properties of the flow on the global attractor.

1980 Mathematics Subject Classifications: 34, 35, 58
ISSN 0076-5376
200 pages (hardcover), March 1988
Individual member $32, List price $54,
Institutional member $43
To order, please specify SURV/25 NA

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 02901-9930, or call toll free 800-556-7774 to charge with Visa or MasterCard
It is certainly trite to remark about the seemingly inevitable utility of mathematics conceived symbolically without reference to the real world. Regardless, the startling practical impact of esoteric mathematics was brought home early in my experience at Bell Labs by the likes of Bode, Shannon, Tukey, and Brock McMillan. The value of limit theorems, math models, analytical methods, and rigorous proofs was profoundly evident. No other field better shows the practical value of untethered research—that is, investigator-initiated research that lets the performer run to the mathematical daylight. That is my central theme today; namely, the importance of preserving untethered mathematics research even while mathematics responds to increasing demands from other disciplines. That goal will be your burden, that will be your challenge in the coming decades.

I am here as a friend to mathematics; as someone with practical concerns about the way the health of mathematics affects our total R&D enterprise, and our society; as someone very concerned about the way you mathematicians deal with your “customer communities”—that is, with the other sciences, with engineering, with government, and with the general public.

I last spoke to you about these issues in Louisville, in 1984. I gave you a sneak preview of a report from the National Research Council called “Renewing U.S. Mathematics.” As you know, I chaired the Ad Hoc Committee that the NRC asked to prepare the report. The report came out six months later. Its message was simple—but very alarming. New mathematics was a major driving force in advancing this country’s science and technology. Current research opportunities were incredibly bright. Yet the absolute levels of support given to mathematics were profoundly out of balance with support for the fields that are the prime customer communities for mathematics.

The country had undernourished mathematics research to the point that it was in danger of not being able to continue its essential role. So few students were studying for the doctorate in mathematics at the time of our report that the university mathematics community did not seem able to replace itself with qualified people. Our report called for more than doubling federal support for mathematics over five years.

Well, five years have passed since our early work on the report began to have an impact. As I said, the report came out in mid-1984, but we saw the need to begin pushing for change in 1983. How have you done in the five years since mid-1983? Where does mathematics stand as you begin your second century?

The short answer is that you have made substantial progress in the face of mountainous odds. But you still have a long way to go, and the hour is late. So I’ll talk tougher than I talked in 1984.

True, you should be very proud of what you’ve accomplished. At first, many people in the Washington science establishment simply could not believe the conclusions of the report. But the governing body of the National Science Foundation—the National Science Board—took the unprecedented step of endorsing our report’s call for action. And the mathematics community took its case to the Congress, the federal agencies, and the Administration, where it won some dedicated champions. The honor role of champions is too long to recite here, but I want to be sure to name the Director of the NSF, Erich Bloch.

As a result, federal support for mathematics has gone up by 84 percent in as-spent dollars from FY 1983 to FY 1988, or about 50 percent in inflation-adjusted dollars. That compares to growth of some 18 percent in federal support for basic research at the universities. Meanwhile, the federal government has been fighting one of the fiercest budget-cutting battles in history. It’s been virtually a fixed sum game, with mathematics and science usually winning at the expense of others.

At the same time, U.S. mathematics went right on adding to its superb record of achievement. Dan Mostow just described this record, and he brought an insight to it that I would not attempt to emulate. This week you’ll hear Centennial Lectures from a dazzling array of mathematicians, and they will bring out the achievement and promise of mathematics in even greater detail.
A Closer Look at Goals and Progress, 1983-1988

But remember the issue that most concerned our Committee. American mathematics is strong—way out of proportion to its numbers, way out of proportion to its level of support today. But will it be able to sustain and renew itself in the future? Unfortunately, that problem has not gone away. It is in fact more pressing than ever. In 1983, some 800 students received doctorates in mathematics. That number had dropped from a peak of about 1,300 per year in the early 70s. Today the number has dropped further, to 700 per year. And half those people are not U.S. citizens. Clearly, the mathematics community faces an unfinished agenda. In my view, this agenda will be critical to your second century. I want to lay it out for you. But before trying that, let me review the approach we used in calling for a renewal of U.S. mathematics, and let me look more closely at what the results have been.

The Ad Hoc Committee was the brain child of a small group of distinguished mathematicians—led by your incoming president Bill Browder, and including your current president, Dan Mostow, along with Ken Hoffman, Iz Singer, and others. It was their idea to include nonmathematicians, too; people from the mathematics customer communities and leaders in setting science policy. That helped the Committee produce a report that I believe was extraordinary for its methods, scope, and implications. The report was not special pleading. Its recommendations rested on a general review and analysis of the total support needed to keep mathematics in a reasonable balance with the country’s entire research and development enterprise. The question was not what does mathematics deserve compared to the dollar support given to chemistry or physics. Rather, it was what does mathematics need in common with every other science: in respect to research time, graduate students, post docs, computer time, secretarial help, travel and so on, to make up a balanced science and technology national enterprise.

This line of argument has served the cause well. I recommend the basic same approach for the future. As I said, it helped get a 50 percent real increase in support for mathematics research. This increase came almost equally from the NSF and the Department of Defense, the two main supporters of mathematics research. Total federal support stands at about $121 million in 1988, compared to $66 million in FY 1983.

The argument for renewal led the NSF and other agencies to assign highest priority to young people in mathematics. The NSF quadrupled its support for graduate students—from $1.4 million for 370 graduate students in 1983, to $5.8 million for 875 graduate students in 1988. And the NSF more than doubled its spending on mathematics post docs; from $2.9 million for 125 post docs in 1983, to $5.9 million for 280 post docs in 1980.

Unfortunately, senior investigators have seen almost no improvement in support. Our report set a goal of 2600 senior investigators in five years. The government supported about 2000 in 1983 and it supports about the same number in 1988. Obviously, many factors are involved but this shortfall certainly helps explain why the number of doctoral students has gone down in mathematics. Still, the problem is widely perceived to be at least bottoming out. The universities are bidding fiercely against each other for the best new Ph.D.’s in mathematics. Salary offers are skyrocketing, and that may help change a perception among the young that the world does not want more mathematicians. Talent does follow money, so the flow of talent into the field should improve.

I’ve focused so far on the federal government, but the report made recommendations to the universities and the mathematics community as well. Among other things, we asked the university administrations to speak up about the imbalance in federal support for mathematics research, and that they fund more support services for mathematics departments. I’m told that the mathematics community has met with little success here. Presidents, vice presidents and deans at the universities simply don’t understand that federal support for mathematics has been, and still is, unbalanced. They seem to think that if their mathematics departments are not getting as much support as their physics departments, then their mathematics departments are not as worthy as their physics departments. And they parcel out their resources accordingly.

On the other hand, there has been spectacular progress in implementing other recommendations that we made to the mathematics community. The biggest challenge we saw was simply educational: you had to unite in educating not just university administrators, but Congress and the federal establishment, other scientists, the outside world, and even your students. You had to teach them why new mathematics is so important to them, how dynamic modern mathematics is, and how new mathematics promotes science, technology, and economic growth. And you had to teach them what resources mathematics must have if it is to contribute as much in the future as it has in the past.

So the mathematics societies united to form the Joint Policy Board for Mathematics. The Board operates an Office of Governmental and Public Affairs in Washington. Under the leadership of Ken Hoffman, this Office has become one of the most effective advocates that mathematics has ever had with the federal bureaucracy.

And through its public information programs, it has helped boost mathematics coverage in the mass media by a factor of ten. Part of this effort is the year-long celebration of “100 Years of Mathematics.” You can communicate the excitement of mathematics to the
layman. If nowhere else, the proof is in James Gleick’s new book called Chaos. Believe it or not, the book has been on the best seller list of the New York Times for 24 weeks.

The mathematics community is also moving vigorously to reform mathematics programs in the nation’s schools and universities. It’s doing this under the aegis of two boards that your leaders have persuaded the National Research Council to establish. The Mathematical Sciences Education Board will publish a framework for the reform of school mathematics in February, 1989. In addition, it is developing a series of recommendations for improving mathematics curricula, testing, and instruction. Another board—the Board on Mathematical Sciences—is informing mathematicians and their colleagues in science and engineering about opportunities for cross-fertilization of ideas. The same board is helping to unite the community through a new colloquium for chairpersons of mathematics departments. And, together, the two boards have launched a new project called MS2000. The project aims to reinvigorate college mathematics.

An Agenda for the Second 100 Years

So there has been major progress. Now what’s next? The first thing to remember is that we face some very tough political realities. Both presidential candidates clearly equate even talk of raising taxes with political disaster. Federal budget constraints will be a problem for as far as the eye can see.

It’s hard to believe, but federal research and development now accounts for 25 percent of the domestic, discretionary, nondefense federal budget. We hear a lot these days about helping the federal government to set priorities for science spending. We hear about the conflict between “big” and “little” science. Those may be real issues. But the fact is that science also competes against social programs for funds during the actual Congressional budget hearings—for example, against housing for the elderly and veterans benefits. As I said, it has been a fixed sum game and yet science has been winning.

Consider what happened to the budget for the National Science Foundation this year. After considerable lobbying by science organizations, the authorization committees in Congress supported the first 15 percent increment in Erich Bloch’s plan to double the NSF budget over five years. Then the guillotine fell. In a rash of backroom horsetrading, Congress passed an appropriations package that gave NSF Research less than an inflationary increase. Mathematics came out better than inflation because NSF is committed to “protecting” the gains in mathematics funding. And NSF came out better than some of the social programs it was competing with.

Congress will continue to face harsh choices in the years ahead. Mathematics probably cannot expect another 84 percent increase in the next five years.

That said, let me suggest some key agenda items for the mathematics community as you begin your second 100 years. Before beginning, let me say the obvious. Of highest priority for the future is to sustain and even increase the quality and productivity of mathematics research. That will ultimately determine how you are judged.

Now a first agenda item beyond that one. You need to update the report prepared five years ago by our ad hoc committee. As you have heard, we do have some sense of progress in federal funding. Such an update should document the situation in detail, from all federal agencies. It should provide quantitative information about the situation in the universities. It should evaluate the infrastructure for supporting mathematics research. It should give an overview of the most exciting research opportunities, both from the perspective of mathematics and the perspective of the users of mathematics in other fields. It should show where the field is poised to go with its partners in science and engineering. And it should make a series of recommendations on how mathematics should be supported—for example, on how it should modulate its growth in accord with the trends in other sciences. And such reports should be done every five years. A dependable mechanism for this updating needs to be established, maintaining the ecumenical committee membership which proved so effective last time.

A second agenda item. You will need to recommit yourselves to your goals in Washington. You must sustain the gains you’ve already made and increase them. For example, in my view the health of mathematics hinges on raising support for senior investigators from the 2,000 we have toward the goal of 2,600 set in our report. That will be very difficult. Success may depend on repackaging mathematics projects in nonstandard ways. Let me just mention the powerful trend toward integrating research projects into block grant programs, including programs at science and engineering centers. The trick will be to figure out how to preserve investigator initiative while responding to the trend—or should I say by shaping the trend. The alternative will be a continued growth in government-initiated, micro-managed, programmed research.

Offsetting this trend is not an impossible dream. During my years at Bell Laboratories, the management set the mission. The mission was “to improve electronic communications.” Management chose the research fields with advice from the technical staff. They educated their people about the mission. But scientists initiated the research.

You academic mathematicians can work in similar ways. To do so, you need to know what’s going on in
Renewing U.S. Mathematics

the world. You need to know what problems your fellow mathematicians think are important, and you need to know what problems the consumers of mathematics think are important. Your research may address principally your own interests, the interests of other mathematicians, or the interests of the consumers of mathematics. It doesn't really matter. But after you make progress, you should ask what your results mean for all these people. Perhaps your results are meaningful for only your own research agenda, but that will likely be a rarity. Other mathematicians and consumers will often need to be informed. This post hoc view is altogether more appropriate for mathematics than an ad hoc distinction between pure and applied research.

A third agenda item. You will need to strengthen your organizations and your strategies for relating to the government and the public.

You can think about the outlook for mathematics research funding in at least three ways. You can think about it in terms of the outlook for balance in research funding for the sciences. You can think about it in terms of the outlook for research as a whole. And you can think about it in terms of the outlook for the discretionary budget of the federal government.

You have to tread lightly when arguing any of these cases. You can argue for greater balance but you can't deny the needs of the other sciences. You can argue for more money for all research, but you can't deny the needs of our homeless and the veterans. You can argue for a bigger discretionary budget, but you can't deny our country's need to reduce the federal deficit nor the American peoples' strong dislike of higher taxes.

To wend your way through this morass successfully, you will need to acquire even greater political sophistication and tact. You will need show even more political cohesiveness. You will need to think more about your place and responsibilities vis-a-vis the other sectors of society. And you will have to think about how you look to society—about appearances and perceptions as well as realities.

There is an important caveat here. If it sounds like I'm telling you all to become political activists, I'm not. Yes, mathematicians should coalesce and look to the needs of their discipline in the ways I've described. Yes, mathematicians and scientists should offer advice about technical issues where they can base what they say on objective evidence or informed judgment. Yes, you should offer such advice in statesmanlike ways. But otherwise mixing science and math with politics is poison.

As citizens, of course, we have a right and a duty to engage in the political process. But in Washington something very counterproductive happens if, as scientists, we try to use the prestige of our disciplines to sway opinion on what are predominantly nonscientific issues. If we act like partisan politicians, we are treated like politicians. When Washingtonians believe that political opinions are shading or coloring our scientific opinions, then they don't accept any of our opinions or causes as objective.

A fourth agenda item. You need to find better ways to attract the young to your field. More financial "goodies" won't do the job alone. Like it or not, my perception is that too many of you offer mathematics on a take-it-or-leave-it basis in the universities. The result is that some of the brightest mathematical minds elect to leave it, or to enter an allied field. And they often leave it with an appalling ignorance of what modern mathematics is. The physicists, chemists, and even engineers are your natural allies. Yet I can say from personal experience that even the physicists and chemists often don't have a clue to what you are up to. And need I bring up university presidents, vice-presidents and deans again?

Your students deserve better. Most students seem to think that mathematics courses are chiefly designed to winnow out the weak and grind down the ungifted. We need a change in attitude. The president of the National Academy of Engineering, Bob White, puts it this way: "Mathematics needs to become a pump and not a filter in the pipeline." I could not agree with him more.

And a fifth and last agenda item. You need to meet your responsibility for improving mathematics education in the schools. I've already mentioned the start you've made in helping to create and support the Mathematical Sciences Education Board. I urge you to keep up that support. We do have an educational crisis in this country. Mathematics is a part of that crisis. Our failure to educate the young will bear heavily on our pace of technological progress, on our ability to compete with other countries, and on our prosperity, not to mention the intellectual climate in the country. By rights, you should help, and if you do, Americans will appreciate it. Do you know that 25 million students take mathematics every day of the school year? That's far more than ever take science. So you obviously have a golden opportunity to win them and their parents to the cause of mathematics. More important, you have a big responsibility for helping to ensure that those students get the mathematical knowledge and attitudes they will need to survive in the modern world.

Summary and Conclusion

So that is my agenda for renewing mathematics as you begin your second hundred years. Mathematics is still making spectacular progress as a discipline. But your success in renewing mathematics has been mixed at best over the past five. Yes, salaries are rising for new Ph.D.'s, but where are the Ph.D.'s? Without more mathematics Ph.D.'s the whirligig of research and development in this country will spin out of balance even more dangerously
than it is now. You must attract more grad students, you must get funding for them, and you must give them reason to believe they will have a future as senior investigators.

You must continue to reach out. You need help from the universities and the federal government, but you must help them, too. You need help from other disciplines if you're going to get more support for your research, but you must help those disciplines, too. You need help from the schools in the form of better-prepared students, but you must help them and their teachers, too.

As I began by saying, I have unbounded personal admiration for you mathematicians and the awesome power of what you create. You hold a very special place in both the intellectual and practical spheres. I am your whole-hearted supporter. I hope you will accept my recommendations in the spirit I intend them. And please accept my congratulations on your hundredth birthday, and my best wishes for the century to come.

RESEARCH MATHEMATICIANS IN MATHEMATICS EDUCATION

Part II: The National Scene

This article is the second of a two-part series. Part I, which explored the issues and background of mathematicians' involvement in education, appeared in the July/August issue of Notices, page 790. The present article describes a number of major national projects that are influencing current thinking about mathematics education and a number of educational projects being run by mathematicians.

There is a new attitude toward education developing within the mathematical community. Increasingly, mathematicians are seeing education as an area in which their input is crucial. Reversing the decline in the number of mathematics Ph.D.'s is often cited as a chief motivator for the involvement of mathematicians in education, but many other, larger issues—such as the decreasing number of science degrees, increasingly sophisticated technology in the workplace, and the explosion of new applications of mathematics in all areas of science and engineering—make improving mathematics education an important national goal.

Indeed, there is a general perception that a crisis exists in mathematics education in this country. U.S. students do not learn as much mathematics as their international counterparts, factory workers have difficulty understanding mathematically based procedures, an alarming proportion of school teachers have taken no college mathematics courses—the list of ills goes on. Reform movements have begun, but they have been fragmented and in some cases have reinforced low standards. For example, under the pressure for "educational accountability," many school districts and states have reacted by simply increasing the required number of mathematics courses and stepping up standardized testing. Ironically, this reaction comes at a time when many experts are seriously questioning the effectiveness and validity of the existing mathematics curriculum and the standardized tests.

A National Push

A number of major national projects are pushing for coherence in the reform efforts and are advocating a more sophisticated and comprehensive approach. While these projects differ in approach and scope, they share several common themes, such as emphasizing conceptual understanding over rote learning, increasing the use of technology, and making mathematics instruction more responsive to the increased diversity of mathematical applications.

MSEB

Perhaps the most prominent on the national scene is the Mathematical Sciences Education Board (MSEB) at the National Research Council. Established in 1985, the Board came about at the request of the mathe-
matical community, based on a recommendation of a committee of the Conference Board on Mathematical Sciences, which represents 13 professional societies in the mathematical sciences.

The composition of the MSEB reflects a growing realization that substantial reform in mathematics education will come about only with the cooperation of all the various constituencies having a stake in improving mathematics instruction. Board members include mathematicians, educators, classroom teachers, school administrators, parents, and representatives from government and industry, as well as several researchers in the mathematical sciences, including David Blackwell, Morris de Groot, Andrew Gleason, Kenneth Hoffman, Paul J. Sally, Isadore Singer, and Guido Weiss.

"Central to everything we do is what is taught and how it's taught," says MSEB Executive Director Marcia P. Sward. "We're trying to reach the many groups and individuals concerned about mathematical education at all levels. We want to inform and activate them in improving mathematics education." The purpose of MSEB is to provide sustained, national leadership in mathematics education. MSEB is involved in a wide variety of projects, from an assessment of employers' needs for mathematically trained personnel, to the formulation of a curricular framework for school mathematics.

NCTM Standards

A major MSEB project has been the coordination of a national review of "Curricular and Evaluation for School Mathematics," a document developed by the National Council of Teachers of Mathematics (NCTM). According to John Dossey, past president of NCTM, "The standards provide people with a target for reasonable, achievable change in mathematics instruction over the next five to ten years, without wild changes in resources." The standards do not propose curricula; rather, they provide a yardstick for judging the quality of curricula and methods of evaluation. They establish a basis for reforming present courses and for developing new courses, in addition to providing methods of gathering evidence to evaluate not only students' abilities but also the effectiveness of the ideas the standards put forth.

Dossey says that a major thrust of the standards is to move away from pencil-and-paper computations and toward deeper conceptual understanding and the communication and utilization of mathematical ideas. Bringing the curricula up to date through the use of technology and by introducing such topics as discrete mathematics, statistics, and probability are also important features. In addition, the standards embody a style of teaching designed to stimulate the students' natural curiosity and to help develop ways of judging their own mathematical ability. Now in the process of final revision, the standards will form the centerpiece for the NCTM convention, to be held in Orlando, Florida in March 1989.

Department of Education

About a year ago, the U.S. Department of Education established a number of centers for research in various school subject areas. One of these is the National Center for Research in Mathematical Sciences Education at the University of Wisconsin at Madison. Thomas A. Romberg, chairman of the NCTM standards commission, is the director of the center. To oversee the center, MSEB has appointed an advisory panel chaired by Jeremy Kilpatrick of the University of Georgia.

The purpose of the center is to establish a research base for the reform movement in school mathematics. According to Romberg, the center staff, which numbers about ten, will perform some of the research, but its main goal will be to serve in a coordinating role. The center will hold meetings, bring together research from various sources, and promote the use of the research.

The center is divided into two components. Instruction/Learning seeks to understand the relationship between student learning and classroom instruction. Romberg says that much of mathematics instruction does not take into account current knowledge about how students learn. The Curriculum/Assessment component examines how curricula are developed and methods of assessing students' abilities relative to those curricula.

Each component held a conference this year to promote collaborations between people who are working on various aspects of each area. A third conference, on the influence of computer technology on the curriculum, is scheduled for early November. In addition, the center is presently involved in three surveys, all investigating various aspects of the impact of mandated testing.

American Association for the Advancement of Science

MSEB has also had close contact with Project 2061, initiated in 1985 by the American Association for the Advancement of Science (AAAS). Project 2061 seeks to revamp the curricular structure and teaching methods in science and mathematics education. The number "2061" was chosen because Halley's Comet, the orbit of which approximates a human lifespan, appeared in 1985 and will next appear in 2061. AAAS has chosen Halley's Comet as a symbol of the future of scientific development.

Project 2061 has three phases. For the first phase, begun in 1985, "blue ribbon" panels were set up in the areas of biological and health sciences, mathematics, physical sciences and engineering, social and behavioral sciences, and technology. The co-chairs of the mathematics panel were Leon Henkin and David Blackwell, both of the Uni-
versity of California, Berkeley. The panels’ charge was to define a core of knowledge that should be included in the education of all youngsters. They were free to ignore traditional topical distinctions within their areas and the limitations of existing curricula. For example, instead of treating arithmetic, algebra, geometry, and trigonometry, the mathematics panel focused on such areas as shapes and patterns, relationships, probability, and logical reasoning. The panels’ reports are being put into final form and will be published near the end of the year.

The Phase 1 panels made recommendations about content without regard to how that content might be transmitted. Therefore the second phase of the project will involve the expertise of teachers and psychologists to examine the educational approaches necessary to achieve the goals set forth in Phase 1. Phase 2, which will take about four years, will develop recommendations that can be used to produce curricula, materials, teacher training programs, and educational research and development programs. Phase 3 will encourage the adoption of the goals and approaches set forth in the first two phases.

Programs Run by Mathematicians

Nationwide, there are few mathematicians who are seriously involved in educational activities apart from college teaching, but their number is increasing. While the various projects they are involved in may differ in approach or organization, these mathematicians have generally taken a content-oriented approach, carefully balanced with a focus on what works in the classroom. In addition to improvements in content, there have been psychological and administrative benefits, such as heightened teacher confidence, a stronger sense of teacher professionalism, and increased administrative support for innovative teaching ideas. The mathematicians’ contributions to these kinds of benefits usually came indirectly, as a result of the increased mathematical sophistication they brought, rather than as a result of their direct involvement in such matters.

Many of the more visible educational programs run by mathematicians focus on teacher development. Many mathematics teachers were trained years ago, so their knowledge of the field needs upgrading; in fact, because of acute shortages of school mathematics teachers in many areas of the country, teachers trained in other academic areas are now teaching mathematics. Working with the teachers creates important professional ties among the teachers and between the teachers and the mathematical community. In addition, the involvement of research mathematicians has the effect of legitimizing and increasing the prestige of the teaching profession.

Summer Training Institutes

In 1985, Harvey B. Keynes of the University of Minnesota launched a 3-year project involving secondary-school teachers from all over the state of Minnesota. The teachers attended 4-week summer institutes designed to upgrade their mathematical understanding through the use of a “semi-directed” approach to problem solving. In this approach, the learner gains expertise in a particular mathematical topic by working through a set of problems centered on that topic.

The teachers were divided into groups, each centered on a particular subject and led by the mathematics faculty member who designed the problem set. The teachers used what they learned in the courses to develop teaching modules suitable for use in their classes. During the academic year, they tested their materials and reconvened for seminars to share their experiences. The modules are currently being prepared for wider distribution in the state of Minnesota. In all, about seven college and university faculty and over 100 teachers participated in the project.

Keynes says that it was the focus on the mathematical content that sparked the interest of the faculty members, who were involved primarily in teaching and course development; very little administrative work was required of them. Furthermore, maintaining a focus on what is usable in the classroom was central to the success of the program. “Teachers are more craftsmen than artists. They are on a continuous quest for high quality teaching tools,” says Keynes. “This idea was brand new to all of us faculty members, who tended to put knowledge above pedagogy. It made us better teachers. It was a different kind of challenge for us.”

One of the biggest benefits of the project was the network that developed among the teachers. “What really impressed me was the isolation of these teachers,” remarks Keynes. By making contacts through the project, the teachers began to discover that other teachers are their best resource. In addition, Keynes says that the teachers also now regard the university faculty as a resource. “It took a long time to get over the ‘I’m professor—you’re teacher’ mentality,” says Keynes. “But now we have real friendships.” Such relationships also help the teachers to view themselves more as a professional community.

For their participation in the project, the teachers received stipends and graduate credit, and faculty received release time for coursework preparation during the school year and a month of summer salary. Providing stipends is one way of treating the teachers as the professionals, and faculty compensation prevents educational activities from being viewed in the mathematics department as “second class.” In addition, the mathematics department was compensated for commitment of resources to the
project, so that educational activities are not seen as a "drain" on research.

To some, large projects like Keynes' may seem rather formidable. Keynes suggests starting small—volunteering to provide enrichment in a local school or starting a program for mathematically talented youngsters. However, he points out that small projects tend to be very specific and are often not as flexible as larger projects. In addition, small projects can be less efficient: for example, it may take as much work to retrain five teachers as it does fifteen. "But getting involved in some way is the key," says Keynes. "What looks hard initially may be very do-able when interest grows in being more involved in precollege education."

**Teachers Training Teachers**

Another teacher renewal program, run by R. O. Wells, Jr. of Rice University, began in 1987. Called the Rice University School Mathematics Program, the 3-year project is similar in philosophy and purpose to Keynes', but differs in that it is based on a "teachers teaching teachers" approach. Senior mathematical scientists from Rice work with a team of four specially selected "master" teachers. These teachers spend the Spring studying a mathematical topic—such as number theory, statistics, or linear algebra—with their faculty advisors. The topics may not be ones that the teachers would present to a class as a regular full course of study, but nonetheless have intrinsic interest and provide a perspective on the field of mathematics.

Together with their faculty mentors, the master teachers develop a two-week workshop program dealing with the topic they studied and presenting methods for improved classroom teaching. During the following summer, 48 teachers chosen from Houston-area schools participate in the workshop program, in which the master teachers act as instructors. The faculty are available to answer questions and offer advice, but they have no formal teaching duties beyond giving colloquium lectures. The summer program also includes seminars on the use of the computer in mathematics instruction and preparation of teaching units for use in the classroom. The best half-dozen of the teaching units developed in the first year of the program are now being published and will be distributed in the Houston area.

There are a number of reasons for having the master teachers, rather than the faculty members, present the lectures in the workshops. For one thing, Wells says, the master teachers improve their self-confidence and understanding of the material by having to teach it. In addition, the "intimidation factor" is reduced. "The teachers may think, 'The professor can do this but I can't,'" says Wells. "But if it comes from their peers, they're more likely to think they can do it." Though this method may be less efficient, Wells believes the psychological improvement is worth it. "When the professors sit in the back row of the classroom listening to the teachers, it's a lot less intimidating. Besides, we're all colleagues," he says. "Breaking down the barriers is what we're trying to do."

In addition to the original $500,000, 3-year grant from the National Science Foundation, the program has received funding from private foundations and continues to expand. For example, this fall, there will be a symposium to lay plans for expanding the project to include the elementary level in the summer of 1989. In addition, there are plans to replicate the program in other communities in the state of Texas.

**A Curricular Philosophy**

Philip D. Wagreich of the University of Illinois at Chicago is co-director of a program entitled Teaching Integrated Mathematics and Science (TIMS), funded by two grants from the National Science Foundation (NSF) totaling about $1 million. Focusing on the elementary and middle school levels, TIMS differs from Keynes' and Wells' programs in that it utilizes a specific curriculum philosophy combining the teaching of mathematics and science. TIMS has an extensive teacher training program, and currently about 26 Chicago-area schools are participating.

Wagreich's involvement in education grew out of his dissatisfaction with mathematics and science education in the Chicago public schools. He says, "I would go into a sixth grade class and ask, 'What's area?' The students would say, 'It's length times width. Or is it two times length plus width? Or is it...?'." The students were completely stymied when confronted with the problem of finding the area of a leaf. Wagreich realized that the students had a superficial understanding of mathematical concepts because they were not making the connection with concrete experiences embodying those concepts. Wagreich found an Illinois colleague, physicist Howard Goldberg, who shared his views of mathematics and science education. Building on Goldberg's earlier work in science education, they formulated the conceptual basis for TIMS.

The TIMS curriculum concentrates on certain fundamental concepts central to all science. The children carry out a series of quantitative, hands-on experiments using a simplified version of the scientific method. Each experiment includes organization and presentation of data, manipulation and control of variables, techniques for finding patterns in data, and the logic necessary to think through a variety of conceptual situations.

For example, one experiment starts with measuring how high a tennis ball bounces when dropped from different heights. After observing that the graph of the
The speakers spent a great deal of time preparing slides and handouts for use in their presentations. Some of the speakers are personal friends of Haimo, but many were in discussions with the teachers afterward. The teachers had an enthusiastic response.

To obtain support from the school for participation in an elementary level, a mathematician's deep understanding helps.

Applications of Mathematics

Deborah T. Haimo of the University of Missouri at St. Louis has a 3-year grant from the NSF to run a teacher enhancement program focusing on the applications of mathematics. The program brings high school teachers into contact with people who use mathematics in their professions. "The objective is to get people to be motivated, aware, and interested in applications while keeping at the forefront the power of mathematics," she says. "The use of mathematics is the main thrust."

The program began last spring with four half-day refreshers for the teachers. At that point, each teacher had to make a commitment to stay in the program for the entire duration of ten months and to obtain support from the school for participation in the program. During the summer, the teachers attended presentations on the applications of mathematics by professionals in a wide variety of areas. For example, a representative from the U.S. Army Systems Command spoke on war gaming, a sociologist talked about the mathematics of surveys as applied to alcoholism, and a director of formulation of pet foods from Ralston-Purina gave a talk on least cost analysis. There were also speakers from political science, business, urology, and plastic surgery.

Although arranging such a diverse array of speakers may seem like an impossible task, Haimo says she received an enthusiastic response. She says many of the speakers spent a great deal of time preparing slides and handouts for use in their presentations and in discussions with the teachers afterward. Some of the speakers are personal friends of Haimo, but many were located by other means. For example, she called the public relations department at Monsanto Corporation and one of their biologists gave an excellent lecture about computer graphics.

During the summer, the teachers also worked on projects in applied mathematics to use in their classrooms. This fall, Richard Friedlander, co-principal investigator in the program, will visit the classrooms to see how the teachers are utilizing their projects and what they learned from the speakers. In December, there will be a workshop for teachers to discuss their experiences and to share ideas. At the final meeting, to be held in February, the teachers will conduct workshops, and other teachers not involved in the program, school principals, and other administrators will be invited. This cycle will continue over the next three years.

Haimo said that some of the teachers expected that she would provide them with lesson plans and other materials that they could take directly to the classroom. However, she says, much of the pedagogical adaptation was done by the teachers themselves, and this approach is appropriate to the purpose of the program. Says Haimo, "We want them to teach mathematics as a live, interesting subject, where the answers aren't always there for them."

Mathematics on Video

Tom M. Apostol of the California Institute of Technology is director of MATHEMATICS! (formerly called Project Mathematica), a project to produce a series of computer animated videotapes to aid in mathematics instruction. The well-known computer animator, James F. Blinn, who created the NASA planetary fly-by simulations, has recently moved from Jet Propulsion Laboratory to Caltech, where he will continue as animator for the project.

Apostol's involvement with science education videotapes began when he was a member of the team that produced "The Mechanical Universe," a highly praised physics series that has been broadcast on public television stations nationwide. MATHEMATICS! differs in that it will be geared toward use in classrooms, in learning resource centers, or by individuals. The programs will vary in length but will all use computer animation to facilitate learning mathematics. A guiding principle of the project is to use motion, color, and sound to put across mathematical concepts that are difficult to present at a chalkboard or in a textbook. Workbooks to accompany the tapes will be developed, and Apostol is also planning teacher training programs.

The first videotape, on the Pythagorean theorem, has already been produced. It begins by posing several practical problems that can be solved using the Pythagorean theorem, and then weaves a historical perspective to-
MATHEMATICS! videotapes on geometry and hopes to receive additional funds from private foundations and corporate sponsors. Together with a number of different proofs of the theorem. Algebraic manipulations are kept to a minimum as the animation effortlessly brings to life the geometric intuition underlying the proofs. Triangles and rectangles rearrange themselves to demonstrate when two areas are equal, and shapes expand and contract to illustrate the concept of similarity. Once the theorem is established, the program shows how to solve the problems posed at the beginning. It ends with an extension of the theorem to three dimensions and a dramatic view of why the theorem fails on the surface of a sphere.

The high cost of animation makes the project an ambitious one. "The Mechanical Universe" cost about $6 million to produce, and Apostol anticipates that $7 million to produce, and Apostol anticipates that MATHMATICS! will also cost several million dollars. "It's extremely expensive to do what we do," says Apostol. "It takes money and expertise, and that combination isn't easy to come by." To reduce costs, they plan to produce subsequent tapes on a network of personal computers, rather than using a VAX, as they did with the first tape on the Pythagorean theorem. Apostol has submitted a proposal to the National Science Foundation for $700,000 to produce four more computer animated videotapes on geometry and hopes to receive additional funds from private foundations and corporate sponsors.

The tapes and the accompanying workbooks will have a limited copyright, so that, for noncommercial use, they could be reproduced without cost. Apostol has set up a state consortium to insure widespread distribution of the tapes. The 34 consortium members have agreed to reproduce the tapes and workbooks and distribute them to teachers at no cost, and to help organize teacher training programs on the use of the tapes. In addition, the Mathematical Association of America and the NCTM have agreed to reproduce the materials and distribute them to their members on a nonprofit basis.

Apostol believes that the project will have an important impact by bringing a new dimension to mathematics instruction. He says, "This project is our attempt to use modern technology and the dazzle of television to show young people that learning mathematics can be visually exciting and intellectually rewarding."

A Massive Reform Project

The University of Chicago School Mathematics Project (UCSMP) is the country's largest mathematics education reform project. Though it focuses primarily on teacher training at the elementary level and curriculum development at the secondary level, this massive effort addresses all aspects of K-12 mathematics education. Paul J. Sally of the University of Chicago has been involved in the program since its inception in 1983 and served as director from that time until 1987. The present director is Zalman Usiskin, professor of education at the university.

The project got off to a healthy start, with a 6-year grant of about $7 million from Amoco Corporation. Concerned with mathematical proficiency in the workplace, Amoco was interested in funding a mathematics program for the average student. Izaak Wirszup of the University of Chicago, who had long been involved in mathematics education, with a particular emphasis on Russian achievements in this area, established initial contact with Amoco. The project was formulated as a collaboration between the department of mathematics and the department of education, which has a strong group in mathematics education.

The goal of UCSMP is to improve the mathematical awareness and skills of the majority of students, not just the brightest or the slowest. Indeed, a tenet of the project is that almost everyone can learn a significant amount of mathematics. "We would like to see mathematics move away from its role as a sorter and be treated more like reading and writing, which are seen as accessible and do-able by all," says Usiskin.

UCSMP has adopted a guiding philosophy that sets ambitious standards for mathematics education. Eliminating repetition and review, incorporating technology, and bringing out the real-world uses of mathematics are among the project's goals. In addition, UCSMP seeks to expand the scope of mathematics at all levels. "We view what we are doing as trying to do the first mathematical sciences curriculum, as opposed to mathematics curriculum," says Usiskin. He notes that high school students are considered well-prepared if they are prepared for calculus, but that there are many other topics in mathematics that they are likely to encounter in, for example, the areas of statistics and computer science.

"The curriculum should reflect changes in the discipline," he remarks. "The biggest changes are the explosion of applications and the implications of technology."

UCSMP has curriculum reform projects at every level of school mathematics, a teacher development program for the elementary level, and a program to train specialist mathematics teachers for grades 4-6. The kits for the kindergarten curriculum have been used by about 700 teachers, and about 500 teachers have been trained with the K-3 teacher training package, Math Tools for Teachers. The grades 4-6 specialist program is still in its infancy: UCSMP just graduated its first twelve specialists, who are currently teaching mathematics in six elementary schools on Chicago's south side. About 21,500 students are currently using the secondary materials. UCSMP also has an evaluation component to assess the effectiveness of the UCSMP programs and materials.

The Resource Development Component, run by Wirszup, provides a unique service by translating outstanding school mathematics publications from around the world and by monitoring the latest international literature on mathematics education. This year, UCSMP...
opened the International Mathematics Education Resource Center, which houses the translated texts as well as more than 500 original-language school mathematics textbooks.

Social Responsibility in Mathematics

Though he is no longer director of UCSMP, Sally continues to assist in the elementary teacher development component. In addition, he has just begun a new project with the assistance of NSF's Research Experiences for Undergraduates program. During the past summer, three undergraduate students did work in analytic number theory and served as counselors in a number theory course for 15 mathematically talented 6th, 7th, and 8th graders from the Chicago schools, a group that included several female and minority students. Sally plans to follow the students' progress through high school and to encourage their interest in mathematics by continuing the summer programs for the next five years and supplementing them with activities during the academic year. “We want to train these kids to be mathematicians and scientists,” he says. “The idea is to turn them on to the notion that these are viable careers for them.”

The undergraduates found the counseling aspect of the program especially rewarding. “These undergraduates were excited by the idea of studying some serious mathematics,” says Sally. “But by the end of the summer, they were saying, ‘We love the mathematics, but tutoring these kids was just fantastic.’” The educational part of the project also provides important experience for the undergraduates: “The idea of the program is to inject a sense of social responsibility into undergraduate training in mathematics,” says Sally.

Undergraduate Education

Because teaching is among the professional responsibilities of the great majority of mathematicians, most are aware of such problems as the need to update the calculus curriculum and the decreasing proportion of American Ph.D.'s in mathematics. Indeed, many perceive the problems of undergraduate mathematics education to be as pressing as problems at the precollege level, and a great deal of work is being done in this area. Two indications of the increased emphasis are the new initiative in undergraduate mathematics education at the NSF and a newsletter on collegiate mathematics education, which will begin in 1989 and which will be supported by the AMS, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics. The newsletter will be distributed to members of these organizations and others involved in collegiate mathematics education.

Minority Students' Achievement

Increasing the representation of Black and Hispanic students in mathematics and science is a prominent issue in undergraduate education. One of the most successful innovators in this area is Philip Uri Treisman, who runs the Professional Development Program at the University of California, Berkeley. Last year, Treisman received a $50,000 award from the Charles A. Dana Foundation for his work, and this year the foundation gave him $737,000 to establish a center to help colleges improve the performance of minority students in mathematics and science.

Working in an area that often becomes politically charged because of racial issues, Treisman has kept a steady focus on improving learning and teaching in mathematics while building a wide base of support for his program. In years past, it was personal conviction that led people to address the problems of low achievement among minority students, but today, he says, “institutional survival is at stake,” so the problems are receiving broader attention.

Treisman began investigating the Black students' difficulties in calculus at U.C. Berkeley about 10 years ago. At that time, he said, there had not been, in the previous decade, one year in which more than two black students received a B- or better, and 50% were failing the course. Treisman's program has had a dramatic effect: between 1979 and 1985, 55% of all Black students in his program received a B- or better, compared to 15% of those not in the program, and the failure rate has dropped to 4%. In addition, thirteen of the students from the program have gone on to graduate school in mathematics, and one is now a Rhodes scholar in materials science.

When he first began exploring the problems of Black students' performance in calculus, Treisman found that he had to drop the typical assumptions of poor academic preparation, lack of motivation, and difficult home lives. “These students were extraordinary and well-prepared, but they were failing out,” he says. “Their families were organized around helping these kids get to college.” Indeed, about 60% of the parents were teachers. “The stereotype of weak, low-income, ghetto families wasn't true.”

So why were the students doing so poorly in calculus? To answer this question, Treisman spent 18 months making detailed observations of the lives of a group of Black students and a group of Asian students. He found that many Black students put an emphasis on self-reliance which made them “real loners” and that they rigidly separated their social and academic lives. By contrast, the Asian students formed study groups that mixed social and academic life. They would generally study alone for a few hours, and then get help from the group on problems that had stumped them. The Asian
students saw others having difficulty, so "they got used to kicking problems around," says Treisman.

Treisman found the existing affirmative action program for mathematics tutoring to be less than ideal. "They're all in temporary buildings, in basements, completely separate from the rest of the campus," he says. "You never see any faculty there. In fact, the minority students aren't there; they only come in the day before a test." The program was designed to fill in the gaps in the students' knowledge, and although those running the program cared deeply about the students, this remedial aspect was hampering its effectiveness. "Anything to do with minorities was seen in this deficit way," he says.

Treisman decided to put together his own program using the Asian students' study groups as a model. He knew that, to get the broad support he needed, the program would have to improve the academic performance of all students, not just the minorities. Rather than constructing yet another remedial program, Treisman conceived an honors program in which faculty members and teaching assistants with a strong commitment to teaching could work with students in enriched and intensified sections. Though aimed at minority students, the sections are open to all students willing to commit the requisite 15-20 hours per week. The sections emphasize exploration of challenging mathematical problems, group effort, and broad involvement in departmental and campus life.

Treisman's program has been extended to several other universities in California, and he is currently working on a high school program for minority students in mathematics. He notes that one of the keys to helping minority students excel is to avoid polarizing problems along racial lines. In these kinds of programs, says Treisman, "it's best to de-emphasize ethnicity questions. Just put the students together, present them with beautiful mathematics, and encourage them all."

A Psychological Approach

Ed Dubinsky of Purdue University has for the past few years set aside his mathematical research to pursue a question that for him holds a deeper fascination: how people come to understand mathematical concepts. Most mathematicians who venture into education have taken a less theoretical approach than has Dubinsky, for his research focuses on an abstract understanding of the psychology of learning mathematics. Nonetheless, Dubinsky has consistently retained a view toward what works in the classroom and has developed and tested instructional materials based on his psychological theories.

Dubinsky's interest in learning stems directly from his teaching experience. He says that although he always took teaching very seriously and tried to be a "good" teacher, his students weren't learning. "Maybe they learned 5% better than with someone who didn't care at all about teaching," he says, but he was not satisfied. He tried all the usual strategies, such as having the students work in groups or at the blackboard, devising long-term projects, and formulating exciting ways to present the material. "I looked everywhere but at the students," he says. "Everything I tried had to do with what I was doing. I saw the students as objects, and that was a mistake. You have to try to understand what learning is to get the students to do the things they need to do in order to learn."

Dubinsky began studying Jean Piaget's theory of genetic epistemology, which considers questions of what knowledge is and how it is acquired. Dubinsky has interpreted Piaget's ideas to apply them to the process of learning mathematics. "Piaget knew no mathematics, but he understood what it meant to do mathematics," says Dubinsky. "I found much more in his ideas than the theories about children's developmental stages," for which Piaget is best known.

Dubinsky's theory is one of "genetic decomposition," in which the mental process of grasping a mathematical concept is broken down into a series of cognitive steps. Once a particular concept is analyzed in this way, the task is then to get the students to go through those steps. Dubinsky's method of constructing useful decompositions combines theoretical analysis with observations of students. When he noticed "striking structural similarities" between the cognitive steps in his theory and the mental processes involved in developing computer programs, he began to use the computer to "induce learning" by getting students to go through the steps.

Dubinsky has found this method to be far more effective than lecturing. "I almost never explain a mathematical idea to the students," he says. "Any time I do give an explanation, it means I am convinced that most of the students already understand it and I'm just focusing their attention on it and giving it a name." In addition, he says, "the motivation problem is much lessened" when he teaches this way. Students tend to discuss the mathematics among themselves and to think more deeply about the subject.

Dubinsky knows of no other mathematicians in this country who are doing similar research. His research differs from most work in mathematics education in that it centers on more advanced mathematical topics such as induction, quantification, and compactness.

Dubinsky has designed and taught a discrete mathematics course based on his theories, and a textbook and documentation for software is scheduled to appear this fall. Presently, he is working on applying his theories to calculus. In addition, together with his colleague Olaf Stackelberg, he is planning a teacher training program to begin in 1989 at Kent State University. The 2-summer program is to involve almost 200 high school teachers.
Geared toward the goals of the NCTM standards, the program will provide training in the teaching of computer science, in new mathematical topics, and in the use of the computer to teach mathematics. In addition, Dubinsky hopes the program will reflect to some extent his theories of teaching and learning.

Mathematics Networks

In recent years, a number of state and local organizations have sprung up to strengthen ties among mathematics teachers and to pool various resources to upgrade the teacher’s skills and sense of professionalism. These programs bring together teachers, college and university faculty, and professionals in industry to promote excellence in mathematics teaching at all levels, but especially at the school level.

Among the oldest and best known is the California Mathematics Project, a statewide, state-funded program of 16 regional teacher enhancement projects. One of these is the Bay Area Mathematics Project (BAMP), begun in 1983 on the initiative of Leon Henkin of the University of California, Berkeley. Through summer institutes and academic year activities, BAMP seeks to promote the exchange of ideas and information, provide personal and technical assistance, and build a sense of community among the teachers. Over the years, the more than 200 BAMP participants have in turn run workshops to further disseminate new ideas and teaching strategies, and many have become leaders in curricular reform efforts.

In 1985, the Ford Foundation began funding a number of Urban Mathematics Collaboratives, which are designed to improve mathematics education in inner-city schools and to support the professional needs of teachers. Today, with a total of 11 collaboratives, the Foundation has committed more than $2 million to the project. One of them, the Twin Cities Urban Mathematics Collaborative, is run by Keynes of the University of Minnesota as part of the Minnesota Mathematics Mobilization (M^3), a statewide effort to improve mathematics education. M^3 is now seeking funding for a project to replicate M^3 in several places across the country.

The American Mathematics Project (AMP), headed by Wells of Rice University, is an effort to replicate these kinds of mathematics networks on a national basis. Over a 3-year period, AMP will establish 20 more projects like BAMP and the Urban Mathematics Collaboratives. In a workshop to be held this month, AMP will bring together groups of 4-6 individuals who are interested in initiating a local mathematics project. In the two-year period following the workshop, the AMP staff will provide assistance to these groups as they organize their projects. In this way, AMP will be able to provide several models of how such projects get off the ground and how they operate.

Wagreich of the University of Illinois and Keynes have initiated another kind of network—one intended to link college and university mathematicians who have become interested in education. They organized a workshop entitled “Mathematicians and Education Reform,” held last July. Sponsored by the NSF, the workshop brought together a number of mathematicians who have successfully led educational programs with those who are seeking greater involvement in education. Originally Wagreich and Keynes envisioned the workshop as a one-time conference, but now they want to hold two each year; they are planning another one for the spring of 1989.

The Numbers are Small

Although the number of mathematicians who have become seriously involved in education is growing, their number is still small, for the split between mathematics research and education persists. Says Sally of the University of Chicago, “It’s viewed as a stigma if research mathematicians get involved in mathematics education. Their colleagues ask, ‘Have you given up on research?’” Saying that “precollege education is almost totally isolated from the research community,” Sally believes that mathematicians have a responsibility to contribute to education. “There is no necessity to give up a strong research career to be involved in education,” he says. “The balance is hard to achieve, but that does not dilute the responsibility.” To those who fear involvement in education will jeopardize their research careers, Sally has a simple solution: “Get tenure first, then cut back on your sleep and do it.”

Allyn Jackson
Staff Writer
Inside the AMS

Support of Conferences

There is a brief paragraph in the Notices of July/August 1988 concerned with various conferences sponsored by the Society. It occurs just below the middle of the second column on page 782. It elicited an objection from a funding agency to the effect that the account is misleading in implying that the activities are supported by Society funds. The intent of this article is to describe the components of support of conferences.

The Society operates a variety of conference series, including the following:

- **Summer Institute**: A research conference with invited and contributed lectures on a single topic in core mathematics, usually of three weeks duration.
- **Summer Seminar**: A research and instructional conference with invited and contributed lectures in a single topic in applied mathematics, usually of two weeks duration.
- **Summer Research Conferences**: A set of up to ten research conferences of invited and contributed lectures on topics in pure and applied mathematics and statistics, usually each of one week duration.
- **Symposium in Pure Mathematics**: A set of invited lectures on a single topic, from two to five days duration and sometimes held in conjunction with a general Society meeting.
- **Symposium on Some Mathematical Questions in Biology**: A set of invited lectures on a single topic, usually of two days duration and held in conjunction with a meeting, most recently of a society in quantitative biology.
- **Anniversary Conferences**: A set of lectures, invited and contributed, tied to the commemoration of an occasion such as a one hundredth birthday of a distinguished mathematician, of two to five days duration, and frequently taking the place of a symposium in pure mathematics.

Some of these are intended to be annual events and others biennial, save for the fact that the anniversary conferences are dependent on the occurrence of suitable occasions.

There are three components of support of a successful conference: financial, administrative, and scientific.

The financial support of the conferences operated by the Society comes from several kinds of sources. For most conferences, and certainly for the larger ones, there is a grant. Granting agencies have included the National Science Foundation (NSF), the Army Research Office, the Office of Naval Research, the Air Force Office of Scientific Research, the Atomic Energy Commission, the Department of Energy, the Institute for Defense Analyses, and the National Institutes of Health. Foundations providing grants have included the Sloan Foundation, the Vaughn Foundation, the IBM Foundation, and the Exxon Foundation. Historically, the largest grantor has been the NSF.

Organizations joining with the Society in cosponsoring the conferences include the Society for Industrial and Applied Mathematics, the Institute for Mathematical Statistics, the Association for Symbolic Logic, Society for Mathematical Biology and various universities. They have provided financial support in kind, such as administrative support and publicity, but are not at risk. (In other contexts, these organizations conduct conferences as principals and may be at risk.)

The Society itself supplies financial support in several ways, such as the cost of preparation of grant proposals, a variety of unrecovered overhead, and some direct outlays, including partial support of conferences with partial grant support and even the full financial support of an occasional smaller conference.

There is a great deal of indirect financial support, for instance by speakers and participants, part or all of whose expenses may be borne by the individual or the employing institution. Individuals pay nominal registration fees as part of their expenses. Of course the cost of preparation of lectures is borne by the employing institution of the speaker or by a research grant if the speaker is so supported.
Grants, when available, are used to pay expenses of principal speakers, partial expenses of some of the participants, and administrative costs such as staff time, space charges and clerical costs.

A substantial administrative framework is needed to insure effective operation of a conference. This comes mostly from employed staff persons, although volunteers and staff of supporting institutions figure also.

Scientific support of a conference begins with a selection committee which reviews proposals for conference topics put forth by various interested groups of mathematicians. This is volunteer work, whose cost is part of the overhead of an intellectual community and is borne by the employing institutions. Individuals are appointed to the selection committees by the president of AMS and the presidents of any cosponsoring societies. The proposers of the selected topic form an organizing committee for the conference which then selects speakers and plans the program. The efforts of the organizing committee constitute a considerable contribution of time and effort in support of the conference and, as in the case of the selection committee, the cost is borne by the employing institution.

It must be recognized that grant support of a conference does not always meet the cash costs immediately attributable to the conference, although without it conferences would not flourish. Fortunately there is a compensating factor. A conference frequently generates proceedings and these are an essential intellectual component. They are published by the Society. Proceedings call for initial capital investment but can be priced so as to recover capital and sometimes generate a surplus that compensates for any deficit in the operation of the conference.

One should keep in mind that the benefits to research in mathematics from a conference are not limited to the participants. A conference helps the spread of ideas in the mathematical community as these ideas are organized and promulgated and subsequently used. It is for this reason that it is fair that a modest fraction of the costs are sometimes borne by the community through membership in the Society.

Everett Pitcher
Secretary

METHODS AND APPLICATIONS OF MATHEMATICAL LOGIC
Walter A. Carnielli and Luiz Paulo de Alcantara, Editors
(Contemporary Mathematics, Volume 69)

This volume constitutes the proceedings of the Seventh Latin American Symposium on Mathematical Logic, held July 29–August 2, 1985, at the University of Campinas in Brazil. Striking a balance between breadth of scope and depth of results, the papers in this collection range over a variety of topics in classical and non-classical logics. The book provides readers with an introduction to the active lines of research in mathematical logic and particularly emphasizes the connections to other fields, especially philosophy, computer science, and probability theory. The potential applicability of the mathematical methods studied in logic has become important because various areas—such as software engineering, mathematical biology, physics, and linguistics—now appear to need mathematical methods of the kind studied in logic.

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Computers and Mathematics

Edited by Jon Barwise

Editorial Notes

How to Computerize a Math Department

The featured articles this month are a review by D. F. Holt of the program CAYLEY, a program designed to be an aid to research in modern algebra, and an article by Richard Palais on various aspects of computer communication having to do with networking and electronic bulletin board systems.

Programs like CAYLEY (and others reviewed last month) are rapidly altering what it means to be a well trained mathematician. And they have changed what it means to give students an adequate mathematical education. And the existence of computer networks and electronic bulletin board systems are drastically changing the way information is transferred from one person to another. These facts, which are rapidly being recognized around the country, give rise to a serious challenge: that of providing adequate computational resources to mathematicians and their students.

What computational resources should a school provide? Lab experience for math courses? Email? Mathematical text processing? Intensive symbolic computation? High power number crunching? What kinds of machines are needed: mainframes, workstations, personal computers, or some combination? What make? How will the facilities be networked together? Will they be able to communicate with the outside world?

What commercial software will be purchased? Who will be able to use it? Where will the resources be housed? Offices or common space? Will they be available in the classroom itself? Who will provide the technical support to maintain them (both hardware and software)? Faculty, staff, or student help? How much will such a facility cost, to purchase, install, and (above all) to maintain annually? And who will bear the cost?

These are difficult questions, questions which are currently being answered in an uncoordinated fashion. And they are questions whose answers depend very much on the character of the department in question. Research departments at large universities probably have different needs that a department of six in a good liberal arts college. But in the very near run, all these departments are going to have to become computerized, if they haven’t already.

This column can provide a place to exchange information about these problems. We hope to publish a series of short pieces by people who have been involved in establishing computational facilities mathematics departments of various sorts. The second article this month, "Academic computing and..."
networking,” by Richard Palais, addresses two of these questions. Palais explains the importance of networking, some of the kinds of networks that exist, and how they are used. He concludes with a discussion of electronic bulletin boards and a possible Mathematical Bulletin Board that the AMS is exploring.

As you will see, there are many aspects of the general problem still to be discussed. For this, we need volunteers. If you have had experience helping to computerize your department, please write a short piece detailing your answers to the questions raised above, and describing how well your department’s current facility is serving the needs of the department. What will you do differently in the future?

A Conference:
“Computers & Mathematics”
What promises to be an exciting meeting on all facets of computers and mathematics is being planned for next June. The program consists of tutorial minicourses, invited sessions, and contributed sessions. The conference will heavily emphasize the use of computer graphics and computer algebra as research tools in mathematics. Topics covered include: computers and combinitorics, mathematics and computer graphics, computers as a research tool, computers as a teaching tool, computers and physics, mathematics and supercomputing, computation number theory, computational geometry, computer algebra methods, discrete computational mathematics, parallel computation, and equational theorem proving.

The current list of invited speakers is:
Computers as a teaching tool, Juda Schwartz (Harvard), Dennis Stanton (Minnesota)

1. What is CAYLEY?
CAYLEY is not a computer algebra package in the sense that MACSYMA or REDUCE are, and it is certainly not just another alternative to these systems. They are really directed towards the solution of problems in analysis, rather than algebra in the modern sense of the word, whereas CAYLEY is aimed at discrete mathematics, with a strong emphasis on group theory and related algebraic structures. On the other hand, it is not a general purpose symbolic algebra package that allows the user to define arbitrary algebraic structures. Such systems often turn out to be prohibitively slow when it comes to solving large scale problems in specific areas. CAYLEY, on the other hand, by restricting its domain of application, aims to allow the user convenient access to the most efficient implementations available of a wide variety of particular algorithms. Since it is a complete program-
ming language, these algorithms can be combined together in almost unlimited fashion, thereby greatly enhancing their range of applicability.

It has made significant contributions to the solution of problems in many areas of mathematics. A few such examples are Numerical Analysis [17], Galois Theory [16], Topology [8], Geometry [2] and Graph Theory [1], as well as Group Theory itself. Furthermore, since it can perform arithmetical operations on arbitrarily large integers, and its data-types include many rings and fields as well as groups, it is being used most unlimited fashion, thereby increasing computing power and abilities in Computational Group Theory, which is its principal domain of application.

Calculations in group theory have always had a tendency to become lengthy and repetitive, and attempts to invoke the assistance of machines date back to the early 1950s. The development and implementation of efficient algorithms for the mechanical computation of virtually any property of a group that the reader can imagine has kept pace with the ever increasing computing power which is likely to be available. CAYLEY is therefore in a state of continuous growth and development, since its design philosophy is always to incorporate new algorithms and improvements to the old as soon as possible.

Although there are surprisingly few natural questions relating to groups that CAYLEY does not purport to be able to answer, some problems will clearly require much more time and space than others. Unfortunately, it will not always be clear to the inexperienced user exactly which questions are likely to be answered almost immediately, and which will take a long time. (For example, computing the normalizer of a subgroup of a group is often very time consuming, and sometimes effectively impossible.) Although I can only hope to cover a small sample of the available functions here, I shall attempt to provide some information on this matter and, where appropriate, to suggest ways of avoiding the more time-consuming operations.

2. Easy Examples

It is a surprising fact that the majority of CAYLEY users are not themselves specialists in group theory. This results from the fact that CAYLEY requires no prerequisites from the user. As the examples in this section show, it can answer straightforward requests without further ado. Suppose that we want the character table of the alternating group of degree 6. We simply type:

```
>PRINT CHARACTER TABLE (ALTERNATING(6));
```

(>’ is the CAYLEY prompt sign.) After a few seconds, the answer appears:

```
CHARACTER TABLE
CLASS 1 2 3 4 5 6 7
CONJG 1 90 45 72 72 40 40
ORDER 1 4 2 5 5 3 3
X.1 1 1 1 1 1
X.2 5 -1 1 0 0 -2
X.3 5 -1 1 0 0 -2
X.4 8 0 0 Z1 Z2 -1 -1
X.5 8 0 0 Z2 Z1 -1 -1
X.6 9 1 1 -1 -1 0 0
X.7 10 0 -2 0 0 1 1
```

SYMBOL TABLE

```
Z1=1+W+2W^3 WHERE W=EXP(2*I*PI/5)
Z2=1+W+2W^4 WHERE W=EXP(2*I*PI/5)
```

(All of the examples in this article were done on a VAX/780 machine running under VMS.)

If you wish to do several calculations with the same group, then the sensible thing is to make an assignment, as in any other programming language.

```
>g=Dihedral (8);
>PRINT g;
GROUP G OF ORDER
16 = 2^4
GENERATORS:
(1,2,3,4,5,6,7,8)
(1,8) (2,7) (3,6) (4,5)
```

Notice that the elements of the group are stored as permutations on the eight points 1, 2, ..., 8, and the elements are printed in cyclic form. It is possible to see the complete set of elements, and even the complete multiplication table by typing:

```
>PRINT ELEMENTS (g);
>PRINT MULTIPLICATION TABLE (g);
```

We won’t waste space by printing the answers here. Such functions are only really applicable to fairly small groups, but they can be very useful if CAYLEY is being used as a teaching aid for elementary group theory courses. Similarly, the complete lattice of subgroups can be computed with the SUBGROUP LATTICE function. These computations take virtually no time with such a small group. Of course, with larger groups you must expect a longer wait. If you can afford ten minutes or so of cpu-time, then you might expect to be able to compute a character table of a group of order up to a million, or a complete subgroup lattice or automorphism group of a group of order up to a few hundred. (This depends a great deal on the individual group.)
3. Groups Defined by a Finite Presentation

As we saw above, CAYLEY already knows the definitions of some common classes of groups like cyclic, dihedral, symmetric, alternating, and many others. This might suffice for many users, but there will obviously be times when one wishes to define groups for oneself. There are a number of ways of achieving this, and we shall look at these in this and the following two sections.

Perhaps the most frequently used method is to define the group by means of a finite presentation. This is illustrated by the following easy example. First, we define a free group on the generators that we intend to use, and then we type in the defining relations.

\[ \text{G:FREE (X,Y);} \]
\[ \text{G.RELATIONS: X^4 = Y^2, Y^{-1}*X*Y = X^{-1}*X;} \]
\[ \text{PRINT ORDER (G);} \]
\[ \text{SAVE 'G48';} \]

The last command saves the complete state of the program on a disk-file named 'G48'. There are several good reasons for doing this at frequent intervals, even when one is not quitting. It is so easy to do something silly and ruin the fruits of a long session, or the machine might crash with the same result. Another reason, which was mentioned in Section 1, is that one often has no idea how long a particular command is going to take to execute, and it is very easy to misguidedly issue a command that would take many hours (or even years) to complete. Since it is not usually possible to interrupt individual commands, the only recourse is to interrupt the session and restart CAYLEY. The saved state can then be immediately read back in with the RESTORE command.

CAYLEY uses Todd-Coxeter coset enumeration to compute the order of a finitely presented group. This is the oldest and most basic group-theoretical algorithm, and it dates back to the 1930s. It will of course fail, usually after wasting a great deal of time, if the group is infinite or very large. In such cases, it may still be possible to use it to find the index of a subgroup. In the following example, G is infinite, but the subgroup H has index 7. Note that relators can be input as an alternative to relations.

\[ \text{G:FREE (X,Y);} \]
\[ \text{G.RELATIONS: X^2, Y^3,} \]
\[ (X*Y)^7; \]
\[ H = \text{< Y, X*Y*X*Y^{-1}*X,} \]
\[ (X*Y)^{-1}*X*Y*X*(Y*X)>;} \]
\[ \text{PRINT TODCOX (G,H);} \]
\[ 7 \]

(The '^^' operation on group elements is conjugation.) It is also possible to compute the permutation representation of the group on the cosets of the subgroup, and then the permutation group algorithms (which will be surveyed in the following section) can be applied. Coset enumeration will normally work fairly easily for subgroup indices up to about 10,000. If there is plenty of space available and there are not too many generators, it may work up to index 100,000 or even more.

It may even be possible to use CAYLEY to prove that a group is infinite. There are a number of tricks that one can apply to this end. The easiest case is when the abelianized group \( G/[G,G] \) is infinite. The function ABELIAN QUOTIENT INVARIANTS (or AQINVARIANTS for short) prints out the orders of the cyclic factors of \( G/[G,G] \), and a zero indicates an infinite group. Even if this fails, \( G \) may have a subgroup \( H \) of small index with \( H/[H,H] \) infinite. The following example, due to Mike Slattery, illustrates this point. This resolved a query published in the AMS Notices [12].

\[ \text{G:FREE (X,Z);} \]
\[ \text{G.RELATIONS: Z^3*X=Z^5*X^2*Z^2*X^2, X^{-4};} \]
\[ \text{PRINT AQINVARIANTS (G);} \]
\[ \text{SEQ(4);} \]

Unfortunately \( G/[G,G] \) is finite of order 4. The next command is to find at most 30 subgroups of \( G \), of index at most 30, and to store them in a sequence called LIS.

\[ \text{LIS} = \text{LOW INDEX SUBGROUPS (G,0,30; LIMIT=30);} \]
\[ \text{FOR EACH GP IN LIS DO} \]
\[ \text{FOR=PRINT AQINVARIANTS (GP);} \]
\[ \text{FOR>END;} \]

The invariants for each of the 30 subgroups were then printed, and the 24th of these read: SEQ (2, 2, 2, 4, 0). This particular group is therefore infinite, and so \( G \) is also.

This example illustrates the use of the FOR statement and the data-type SEQUENCE. CAYLEY is a full programming language, with control structures modeled on PASCAL. Its data-types include integer, set, sequence and mapping, as well as algebraic objects such as group, field, matrix ring, vector space and KG-module. Another instance of the application of finitely-presented group methods can be found in [9], for example.

4. Permutation and Matrix Groups

Structural computations within a finite group can be carried out
most efficiently if a reasonably small-degree permutation representation of the group can be found. Powerful algorithms using the concepts of base and strong generating sets have been devised to cope with this situation. The example below is the group generated by the two types of perfect shuffle on a deck of 24 cards. (This problem aroused considerable interest a few years ago, and it was eventually solved completely for decks of arbitrary size. See [7] or [10]. The deck-size 24 turned out to be an interesting case.) The usual convention is to input permutations in cyclic form.

```
> G: PERMUTATION GROUP (24);
> A = (2,3,5,9,17,10,19,14,4,7,13) (6,11,21,18,12,23,22,20,16,8,15);
> B = (1,2,4,8,16,7,14,3,6,12,24,23,21,17,9,18,11,22,19,13) (5,10,20,15);
> G.GENERATORS: A, B;
> PRINT ORDER (G), FORDER (G);
194641920
SEQ(2, 17, 3, 3, 5, 1, 11, 1)

The second item (FORDER = factorized order) means that |G| = 2^{17} \cdot 3^5 \cdot 5.11. Since G fairly obviously acts transitively, we do not need to compute its orbits, but we can test for primitivity.

```

```
> BL = BLOCK SYSTEMS (G);
> PRINT LENGTH(BL), BL[1];
  1 [1 24]
> K = BLOCKS IMAGE (G, BL[1]);
> PRINT ORDER (K);
95040

BL is a sequence containing one element. This means that there is a single system of blocks of imprimitivity. BL[1] is one of the blocks in this system, and as it has size 2 there are 12 blocks. We have computed the induced action K on the blocks. I now suspect that K is the simple Mathieu Group M_{12}.

```

```
> PRINT SIMPLE(K), PERFECT (G);
TRUE TRUE
> PRINT COMPOSITION FACTORS (G);
COMPOSITION FACTORS OF GROUP G
CYCLIC(2) APPEARS 11 TIMES
M_{12} APPEARS ONCE
```

Matrix group computations are less efficient, and not so completely implemented in CAYLEY, but they can still be useful when the group has a natural description as a matrix group, such as the following example G = GL(3,8).

```
> G = GENERAL LINEAR (3, FIELD(8));
> Z = CENTRE(G);
> PRINT ORDER(G), FORDER(G), ORDER(Z);
115379712
SEQ(2, 9, 3, 2, 7, 2, 73, 1)
(The spelling 'CENTER' will also work!)

Suppose that we wanted the Sylow 7-normalizer in this group. Since normalizers cannot be computed directly in matrix groups at present, the easiest method is to use a homomorphism onto a permutation group. The degree 73 representation on the one-dimensional subspaces is the most convenient. This is not faithful, but as the kernel is the centre, we can still compute the required normalizer as an inverse image. Since we need to refer to a vector, we need a name for the underlying vector space of G.

```
> V = VECTOR SPACE(G);
> V1 = VECTOR(1, 0, 0) OF V;
> M, IM, KER = MATACT HOMOMORPHISM(G, V1, TRUE);
> PRINT DEGREE(IM), FORDER(IM);
73
SEQ(2, 9, 3, 2, 7, 2, 73, 1)
```

N is the homomorphism, and IM and KER are the image and kernel. TRUE here means find representation on subspaces rather than on vectors. We can now do the required computation.

```
> S = SYLOW(G, 7);
> INS = M(S);
> IMM = NORMALIZER(IM, INS);
> N = M@ (IMN);
> PRINT N;
GROUP N OF ORDER 2058 = 2 \cdot 3 \cdot 7^3 IS A SUBGROUP OF G
```

M@ (IMN) means inverse image of IMM under the map M. The group N is the required normalizer in G. The generators of N were also printed out as matrices.

The computation that we have described in this section took virtually no cpu-time, with the exception of the NORMALIZER computation, which took about 4 minutes. For larger groups, finding Sylow subgroups can also be time consuming. Centralizers (of elements or subgroups) can usually be found fairly quickly, however. Basic operations on permutation groups, such as finding the order, are now reasonably practical for degrees up to about 10,000.

5. Groups of Prime Power Order and Finite Solvable Groups

Algorithms for computing within finite p-groups (that is, groups whose order is a power of a
6. Further Features

As we have already seen, CAYLEY has a full collection of control-flow statements. These can enable the user to try the same computation many times on different data, and they are particularly useful for carrying out systematic searches for elements or subgroups satisfying certain prescribed properties. Procedures with input and output parameters can also be written in the language. These can be convenient if a lengthy computation is being submitted as a batch job. They are also extremely useful for the development and testing of new algorithms.

Procedures and other sequences of commands can be stored in a library file, which CAYLEY can read in. In fact, it is advisable to prepare such a file in advance with a text editor whenever there is a long sequence of commands to be typed in, particularly if technical data is involved. Although some of the most recent releases of CAYLEY for particular machines do incorporate some command-line editing facilities, it is extremely frustrating, particularly to the inexperienced user, to be forced to retype a complete command as a result of a small error. A number of standard library files are provided with the package. These include definitions for many familiar groups (primitive permutation groups up to degree 50, simple groups up to order a million, 2-groups up to order 128, etc.), and also some useful procedures that have not yet been incorporated into the language itself.

A related concept is a problem file, which is used when CAYLEY is being used for teaching purposes. It has been successfully used in conjunction with undergraduate and postgraduate courses in Group Theory, Ring Theory, and Number Theory, for example, in a number of Universities. Problem files contain statements which guide the student through the solution of an exercise, with the option of providing hints.

At present CAYLEY is acquiring more and more facilities in the areas of Representation Theory (including modular representations) and Character Theory. Examples of such applications can be found in [11],[14] and [15]. More detailed surveys of its facilities can be found in [5] and [6].

7. Conclusion

As a group-theorist who frequently needs to carry out technical computations, I find CAYLEY an indispensable tool, and its usefulness grows rapidly with experience. As we saw in Section 2, it can also provide valuable assistance to the non-specialist, even if only a small fraction of its capabilities are being applied. There are, however, a number of pitfalls that the beginner is likely to fall into. Throughout this survey, I have attempted to point some of these out, and to provide guidance on avoiding them. This is all a result of my own personal experience, and they are all difficulties that I have encountered and been frustrated by myself. The most immediate of these is the frequent necessity to retype commands that contain syntax errors. Of course, one makes less errors with experience, but the best solution is to make a library file in advance; this is particularly necessary if, for example, some lengthy permutations need to be entered. Another danger is to issue a command that will take most of eternity to execute. Although there is no way of avoiding this completely, one learns with experience to look for and find more efficient ways of achieving the same end. To avoid losing previous work, use the SAVE command frequently. Many group-theoretical computations are by their very nature time-consuming, whereas others are awaiting more efficient implementations. Operations with sets and sequences are currently a bit too slow, which is a nuisance if one is testing a complicated procedure.

The policy of the developers of incorporating new algorithms as quickly as possible is in general very helpful to the user; in fact, it often results in CAYLEY being more up-to-date than the mathematical literature. Of course, this also often results in bugs arising, usually in the new algorithms or in their interface to the old. The experienced user has to learn ways of avoiding potential bug-situations! Another resulting inconvenience is that the manual now has at least two major updates, and so it is not always easy to look things up.
CAYLEY is currently maintained and distributed by John Cannon at the University of Sydney. Recent versions are written mainly in 'C', but older versions are in FORTRAN. It can be run comfortably on Mainframes and Minis, Workstations, and even on some larger PCs.

References

Academic Computing and Networking

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Academic Computing and Networking

This has been called the “Information Age”, for in many aspects of modern life it has become axiomatic that continual and instantaneous access to information, together with an ability to process and exploit the information rapidly, is a prerequisite to success. As a consequence we have seen the rapid development of a whole new technology for managing the creation, processing, storage, retrieval, and flow of vast amounts of data. Central to this technology are “computers”, which are in reality general information processing devices, useful in a given enterprise to the extent that enterprise is involved with the generation and transformation of data.

One tends to think of business, finance, and government as the primary beneficiaries of this “computer revolution”. But this is mainly a reflection of the high cost of early computing equipment; at first only the government bureaucracy and large corporations could afford the entry price. The computer I first used, in 1973, filled a whole room and cost more than three-quarters of a million 1973 dollars. It had a quarter megabyte of fast memory (RAM), and ran at one-half million instructions per second (MIPS). The memory and computing cycles were such a scarce and expensive resource that
they had to be time-shared among thirty users, all of whom gave their instructions and received their results on teletypes that cluttered away at a maddeningly slow thirty characters per second. To examine complex results meant printing out huge tables of data on a line printer, for the machine had no graphical output display capability.

In the past decade a vast increase in the power and sophistication of computing systems has gone hand in hand with a remarkable miniaturization of components. Coupled with this has been a spectacular drop in price that has all but eliminated cost as a limiting factor in the use of computers, and we have all watched with amazement as ever smaller computing devices have come to pervade our lives. I am writing this at home on a desktop computer. Though its cost is less than one percent of that 1973 machine, both the hardware and the software are far more powerful and easier to use. It runs at one MIPS, has five megabytes of RAM and forty megabytes of disk storage. Its results are presented graphically in color on a high resolution monitor, and it silently outputs five pages per minute with typeset quality on a laser printer.

Now perhaps no aspect of modern life surpasses the academic world in its degree of involvement with various aspects of information; and so it seems inevitable that computers will insinuate themselves more and more into our daily activities. Many mathematicians look with some apprehension at this prospect; we all cherish the image of the lone mathematician thinking quietly in his or her study, pencil in hand, pitting intellect against stubborn complexity. No, a computer does not fit well into that picture, but on the other hand there are many calls on our time that compete with research, and most of us must fight for opportunities to get away to the ivory tower. And this is precisely where the computer comes in, used wisely it has the potential to increase efficiency and productivity, allowing us to complete academic chores sooner and have more time for creative research.

My wife and I are both academic mathematicians. At home we share two offices. Upstairs is a large, quiet room lined with bookcases. It contains only our desks, some file cabinets, and comfortable chairs for reading. Downstairs is our small “high tech” room, with its two computers, two disk drives, a copier, laser printer, and modem. Upstairs we read, think, and write lecture notes and early drafts of papers. And downstairs? Recently I have been keeping a log of my computer usage, and I also looked carefully through the directory of files on my hard disk, so it is in fact quite easy for me to reconstruct the ways in which I use this downstairs office.

- Word processing. Writing letters, books and articles, reviews, recommendations, referee reports, grant proposals, exercise sets.
- Record keeping. Maintaining my appointment calendar, “to do” list, grade sheets, curriculum vitae, preprint mailing lists, subject oriented bibliographies, research notebook.
- Administration. Maintaining files related to work on university committees, AMS committees, and journal editorial duties.
- Accessing information. Consulting the university library card catalogue and the Mathematical Reviews database.
- Personal file maintenance. Keeping banking and other financial records, income and expense reports, and preparing income tax returns. Maintaining telephone and address “rolodex” file.
- Programming.
- Communications. Sending and receiving Email (electronic mail), accessing electronic bulletin boards.

I am sure many who look at this list will say to themselves, “But he has only made more work for himself! He has taken on a lot of the work that should be left to a secretary.” There is a certain amount of truth in this observation. Setting up an integrated system of computer files takes some initial effort, and maintaining it properly not only takes a little retraining and discipline, but also requires some ongoing effort that might otherwise be handed off to a secretary. But the many compensating advantages are so great that there is a noticeable net saving in time. In addition one has a hard to quantify sense of being better organized and having firmer control over one’s affairs. Let me describe just a few features that I find advantageous:

- The majority of my letters go to frequent correspondents. I can open an old letter, file “Jones.12/11/87” and save a copy as “Jones.4/22/88”. I replace the body of the letter with my new message, leaving the address and other boilerplate the same, and print out the new letter and envelope. It takes less time than would dictating the letter or writing a handwritten draft for a secretary, and there is no need to proofread and make corrections.
Each academic year I spend considerable effort making small updates and revisions to documents that already exist; e.g., my CV and list of published papers, research reports, academic activity reports, recommendations for former students, and exercise sets. In the past I felt I was wasting a lot of time recopying the old material (usually introducing a few errors in the process). Now I just edit in the required changes.

References in my research tend to come from a reasonably small and slowly changing list of papers and monographs. When I finished a paper or book I used to dread the boring task of creating the bibliography. Now I keep my standard references in a database. When a paper is done it is a simple task to add a few more articles and books to this database and then go through it selecting the appropriate records. It was easy to create a short report writing macro that formats these references as a \TeX{} input file.

But the question of whether it is easier to handle such tasks oneself, with a personal computer, or leave the work to a secretary may soon become moot. For as we shall see below, it is possible for both you and your secretary to easily access and work on the same files, sharing the work in an almost traditional way. This brings us to the main topic of this article, the development of computer networking in the academic environment, for this is the means to having our cake and eating it.

Computer networking refers to the interconnecting of computing devices, perhaps even geographically widely separated ones, allowing them to communicate with each other and thereby to access and work with the same data. Many who have analyzed the rapidly evolving system of computer networks have concluded that it has an even greater potential to change the way we work than did the advent of the individual computer. Let's see why.

From the beginning, modern electronic computing systems have been comprised of two basic kinds of hardware. On the one hand there are the logical devices that store and transform data, and on the other hand there are the communication channels that move data from one location to another, either to or from storage or to serve as operands for one of the logical devices. In the primitive early machines the only communication was internal communication on the so-called data-bus. Data could only be read in by setting mechanical switches and read out from control panel lights. This was of course a maximally user-unfriendly environment, so very soon computer designers began attaching various kinds of input and output devices to their machines; teletypes, tape and card readers, line printers, disks and drums. These were attached to their host computers with communication lines, and they also required some of their own internal logical hardware in order to respond properly to requests from the host to transmit and receive information. In some sense networking had arrived, but these networks were mere passive roadways between active elements, a pale precursor of what was to come.

One of the main driving forces in the development of more sophisticated computer networks was the need to solve what might be called the "Tower of Babel Problem". When a design team creates a new computer and its operating system, they make many arbitrary but interrelated choices involving the manner in which information is coded and stored internally, and the precise format and structure of the way files of data are stored externally on mass storage devices. As long as information moves within a given machine or between two machines of the same basic design these choices give reliable results. But if one tries to move data directly from one machine to another of a different type, say by carrying it on a magnetic tape, one has no end of problems; even if the systems write their bits at the same place on the tape, these bits mean completely different things to the two machines. Of course one could write a couple of translation programs for any pair of machines, but if one is trying to design a system that allows say a hundred different computer systems around the world to all intercommunicate, one is faced with the daunting task of writing ninety-nine hundred programs, plus another couple of hundred when the next new system comes on line. Of course there is a better way. One can never hope to get computer designers to agree on a standard internal data structure for their machines, and anyway that would stifle progress. But since it is in everyone's interest to be able to intercommunicate between machines one can get agreement on a "standard interface" for communicating between machines; that is on a set of hardware and software protocols for any device to communicate information to and from some standard device. Since these protocols are completely public and well documented, any hardware design team that wants its latest widget to be compatible with this standard has only to write one program to communicate with that standard device and create one cable to at-
tach to it. Such a standard device, or really the set of hardware and software protocols that define it, is what one now usually means when one refers to a computer network. Of course there is not really a single universal such standard but rather several. Some of the better known are EtherNet, AppleTalk, and IBM’s Token Ring. But, as a special case of the above general principal, it is a relatively simple matter to design so-called “bridge” or “gateway” devices to interconnect different networks.

Let’s first consider so-called “local area networks” or LAN’s. In order to keep costs low these usually have hardware and software limitations that keep them small in two senses. First, they are limited to interconnecting a small number of devices: perhaps a few dozen, but rarely more than several hundred. And, as the name suggests, they are geographically localized. Typically they interconnect computers, memory storage devices, and output devices in a small office complex consisting of one or several rooms in the same building, but the more powerful LAN’s can cover a whole university campus. Of course the basic reason for setting up a LAN is usually to make it possible to communicate and to share important data and expensive hardware resources. Here are some examples.

The smallest LAN’s usually connect work groups, that is a small number of people sharing a common task. This past year I co-authored a book with my wife, Chuu-Lian Terg. Very early in the project we purchased a LaserWriter and connected it to our two computers with an AppleTalk network. At first this connectivity was for mere convenience; it avoided having to continually switch the printer cable from one computer to the other. But we soon discovered a much more crucial use for our tiny LAN. We each took primary responsibility for certain chapters of the book, but we proof-read and often made extensive revisions and additions to one another’s chapters. Each chapter was maintained as a single file, and at first we stored a complete set of these files on both of our hard disks. After one of us finished an edit of a chapter we would update the other’s disk by copying the new version to a floppy disk and carrying it to the other machine. We soon discovered the hard way that this is a no-no! Often the process of editing a chapter went on for several work sessions that lasted many hours. Inevitably it finally happened that we both decided to work on the same version of a chapter simultaneously, without either of us mentioning it to the other. One of us finished while the other was away from their computer, walked over with the floppy and wiped out hours of the other’s work! The next day we got two copies of a program named TOPS for our computers. TOPS is what is called a “distributed file server”; it can make any hard disk attached to a computer of an AppleTalk network appear as if it were also attached to all the others computers on the same network. Thereafter we each kept only our “own” chapters on our hard disk and if we had to edit one of the other chapters we accessed it through TOPS. Of course TOPS would not let both computers access the same chapter simultaneously, and in fact all the problems that go along with having multiple versions of the same file immediately disappeared. By the way, TOPS solves another knotty problem. Just a couple of years ago a lot of people were tearing their hair in frustration trying to transfer data between Macintosh computers and IBM-PCs. Since both of these, as well as many other types of computers, can not only attach to an AppleTalk network but also run TOPS, such data transfers have now become routine.

University departments are a natural candidate for the next step up in the scale of LAN integration. Many departments have long had their own departmental minicomputer systems and, particularly in fields such as Engineering, Applied Mathematics, and Computer Science, there are also powerful workstations in many faculty offices. Indeed many universities administrators have taken the next logical step, and decided to put computers on every faculty desktop, and this will no doubt rapidly become the norm throughout the university community. There are some obvious advantages to connecting these office workstations to the departmental mini. It permits department members to share the expensive output devices attached to the departmental computer and to access and use from their office, data files and computer programs of common interest that reside on the mini. In addition the mini can act as a file server for the desktop machines, allowing department members to store or back up their important files on its large and dependable disk system.

But there are also uses for this kind of LAN that go beyond simple resource sharing and into the realm of communications. For example, it is easy to set up an electronic mailbox system that permits department members to send electronic messages and memoranda to one or more colleagues. A recipient who is currently logged on to the system is immediately notified that new mail has arrived, otherwise notification takes place at the next logging in. It is sim-
ple and convenient to read and reply to the mail on the computer screen and then either archive or delete the message. This is a primitive form of what is called Email (electronic mail), about which we will have more to say below. Of course it is important to have the office staff also tied into the departmental LAN. Not only does this permit the staff to transmit messages to specific faculty and to circulate department-wide memoranda, it also permits a convenient mode of interaction between faculty members and their secretarial help. A department member can put a draft of a letter in an electronic “in-box", and it is then easy for a secretary to format it, print it on departmental letterhead, and archive it in the sender's personal letter file. And when a graduate student needs one more letter of recommendation sent, a secretary can find the letter in the professor's recommendations file and mail it off.

It is possible to set up an inexpensive yet effective LAN for a small or medium size department using a low bandwidth system such as AppleTalk. The physical layer of the AppleTalk network protocols can be implemented with ordinary telephone wires (“twisted pairs"), and it is often possible to use wiring already available in the walls. (It is normal practice to wire even a private home with two twisted pairs, a red-green pair for the basic telephone service and a yellow-black pair for a possible second line. And if this second pair is not in use it makes a convenient, cost-free backbone for a small LAN). Even a large department can be connected with this technology by splitting it into zones. Each zone is a normal, fully connected LAN, and the different zones can intercommunicate on demand through a bridge device.

Campus wide local area networks are orders of magnitude more complex and more expensive than such departmental LAN’s. Since they interconnect many hundreds of diverse devices, all of them competing for network resources, they require high bandwidth systems such as EtherNet that use more costly coaxial cable. Nevertheless, both the immediate and the long-term payoffs promised by setting up such networks are great enough that university administrations are currently spending the millions of dollars required to rewire their campuses. The design of such networks is an evolving art, and each is a custom job, so it is not easy to say what a typical university-wide network looks like. It even took some effort for me to find out much detail about the network that has been set up recently at my own university, Brandeis. Let me describe some of the features of this network, not because I feel it has any universality, but just to give some idea of the scale of a campus-wide LAN for a relatively small university (approximately 3000 students and 350 faculty).

A couple of years ago the whole campus was wired with coaxial cable, and connection boxes were placed in every office. Attaching a new device or “node" to the campus network is usually no harder than plugging the appropriate cable into a socket. The main computing nodes on the network are three general purpose VAX computers and an Evans and Sutherland PS300 graphics processor. Of course each of these has its complement of peripheral devices (disk drives, printers, plotters, etc.) indirectly available to the network. Other computational resources are available on departmental LAN’s that are bridged to the main campus network. A recent addition is LOIS, the Library Online Information Service. This is a database running on a small, dedicated computer that contains the bibliographic records for the combined Brandeis libraries. Users can locate references almost instantaneously, using author, title, subject, or key-word searches. I find it faster and easier to use than the card catalogue, but until it was attached to the net, one had to go to the library to access it. Now faculty and students can use it from their offices or even by dial-up line from home. There are altogether about eight hundred nodes on the network. The great majority of these are ostensibly “terminals", used to communicate with the VAX nodes or LOIS, but actually many of these so-called terminals are in reality powerful desktop computers or workstations running terminal software. For example, it is common for a Sun Workstation to have one window always running as a terminal and logged onto one of the VAX’s so that it can receive Email. Many of these workstations can also serve as host computers for other terminals on the net. Finally there are a number of modems attached to the network. These are the devices that permit computers to communicate digital data over telephone lines, and they make it possible to dial up and attach to the network from a computer or terminal at home, and then connect to various network resources.

The use of campus LAN’s is bound to grow enormously in the near future. A few years ago I could impress my students by handing out weekly exercise sheets typeset with TeX; now I regularly get typeset answers back from students. Within a few years I expect that it will be routine for faculty to post exercise sets on electronic bul-
letin boards set up for each course, and for students to submit course work the same way. The category of software called “courseware” is bound to grow rapidly. This consists of interactive programs designed to accompany and elucidate lecture material and test the student’s understanding. Creating or customizing good courseware is a demanding task, and I expect that upperclass undergraduate experts will cooperate with faculty over the network to develop and maintain these programs. And students will be able to access the courseware by logging into the network from their dorm rooms.

As is probably clear by now, it is natural to configure computer networks in a hierarchy. In the academic world, a campus-wide network may be the top of the local area heirarchy, but these university LAN’s are themselves usually nodes on one or more of several national and international networks. Some of these wide area networks (such as NSFNET or EDU, the educational network that split off from the old ARPA- NET) are very high bandwidth packet-switched systems that permit remote logins to computers halfway around the world, but these are expensive systems and are not generally available to faculty at all institutions. Of course, for some, the ability to log in remotely to a supercomputer is of vital importance to their research, but for most academics it is the communications capabilities of these networks that are desired, the ability to send messages and computer files expeditiously to colleagues at other institutions, perhaps in different countries. To meet these needs the universities themselves have set up a remarkable wide area network called BITNET (Because It’s Time). I am told that, including foreign affiliates, there are now over 2500 nodes on BITNET. I regularly exchange messages and manuscripts with colleagues in Canada, France, Switzerland, and Australia. Usually a message or file arrives a few minutes, or at most a few hours, after it is sent, yet the system is inexpensive enough that almost any college or university can afford to put one of its computers on BITNET. Here is how it works. When a university decides to make one of its computers a BITNET node, it finds a nearby institution that already has a node, and leases a 9600 baud telephone line to establish a modem connection between their two machines, and it also agrees to be at the receiving end of such a connection to some later prospective node. (A 9600 baud line has the capacity of four ordinary voice telephone lines, and can handle about a page of text per second.) This is the secret to BITNET’s low cost; the two 9600 baud modems and the leased line are the major expense for implementing a new node. Of course this simple network structure mandates the fairly low-tech message sending protocol used by BITNET, the slow but reliable “store and forward” method. A message is sent from node A to node B by traversing a sequence of adjacent nodes. When a message is received for transmission (or relay) by the BITNET program at a particular node, receipt is acknowledged to the sending program, a line is added to the message header recording its receipt by that node, and it is put in temporary storage. The BITNET software (which knows the current structure of the network) then picks a node adjacent to it that is on a shortest path to the final destination node. If that adjacent node is “up”, the message is relayed to it immediately. If not the software keeps waiting and trying again until the relay finally does succeed and it gets an acknowledgement from the next node that it has received the message, at which point it deletes its temporary copy. You may wonder what happens if you want to send a message to a recipient who is not on BITNET but rather one of the other major networks (ARPANET, NSFNET, CSNET, UUNET). As you’ve probably guessed by now, the answer is that there are gateway nodes that interconnect these networks. But mailing between networks can be a difficult and daunting task! The reason for the complexity would probably have amused Confucius, who always stressed the importance of calling things by their correct names. Of course on a computer network each node must have a unique name to make it possible for one node to know how to address another. But the naming conventions and protocols on the different networks often seem a hopelessly confusing and contradictory morass. Let me give you just one illustration. Two of the Brandeis VAX’s are on BITNET. Their names on the internal Brandeis LAN are BINAH and LOGOS. These would not be very mnemonic names for external use, and anyway there are probably a dozen other nodes on BITNET with the internal name LOGOS. So, on BITNET, BINAH is known as BRANDEIS, and LOGOS is known as BRANDLOG. But LOGOS is also the Brandeis Computer Science Department node on CSNET, where it is known as BRANDEIS. I am told that there are in fact two individuals at Brandeis (let us call them John Jones and Sarah Jones), one with an account on BINAH and one with an account on LOGOS, and both use the same login name Jones. Now mail to someone with login...
name “user” on a network node with the name “node” is traditionally sent by giving an address of the form user@node. But you can see that if someone on the ARPANET sends a message addressed simply to Jones@BRANDEIS, it would reach a different person depending on whether it came through the BITNET or CSNET gateway. One cure is to use a more complicated form of address, such as user@node.BITNET or BITNET@user@node. The problem is that both of these conventions (and many more besides) are in use by different mailing programs and it is a nightmare trying to remember when upper or lower case is significant, when you must enclose parts of the address in double quotes, and where other end. Let me mention just one academic application of this technology. The number of scholarly journals has become so great in recent years that it is beyond the means of any but the largest university libraries to subscribe to them all. To meet this problem many universities are joining in consortia that share journal subscriptions. Only one university in an area need subscribe to each esoteric journal in order for it to be available to them all. But it often takes several days to photocopy a journal article at one university and have it delivered to another. While this may be acceptable in general, in many circumstances even tomorrow is too long to wait, and the Boston Area Library Consortium has started experimenting with Telefax delivery in such cases.

I would like to conclude with a discussion of another networking application of the telephone system; to create what are known as electronic bulletin board systems (or BBS for short). An early BBS was literally a public bulletin board. Someone would attach their personal computer to a telephone line with a modem set in auto-answer mode, and run a simple program that permitted callers to post messages and read those posted by others. Then this someone, who became known as the system operator or “sysop”, would spread the word (perhaps on an already established BBS) that he had a new BBS open for use at such and such a number. Messages would run the gamut of buy and sell advertisements, personals, movie reviews, political and religious messages, etc. But since those calling an early BBS were of necessity members of the then small band of personal computer users, many messages tended to be about computing: the advantages and disadvantages of certain hardware and software, the problems people had encountered with these, and how they had overcome these problems. People would also upload computer programs they had developed, for others to use, test, and modify. In effect these early BBS often developed into small ad hoc computer user groups. And conversely, many computer user groups soon discovered that setting up a BBS was an ideal way to interchange information and programs. Of course information about or programs for one type of computer system is of little value to users of another type, so gradually two kinds of BBS developed. Some BBS became oriented towards trading technical information and software, and these usually remained small and local, and specialized in a single type of personal computer (usually that of the sysop). But as the ownership of personal computers gradually spread into the general population, other BBS developed a system of “sub-boards”, each of which specialized either in some hobby, some social or professional interest, the use of some computer system, or perhaps gave access to some generally useful database. Eventually some of these general boards became large commercial ventures (e.g., CompuServe, Delphi, Genie, The Source) with thousands of users, many logged on simultaneously from all over the country.
Although using a BBS is easy, getting started can be somewhat intimidating, so let me explain a little about how one goes about it by describing a more or less typical BBS. Of course you should realize that all real boards will differ in detail from this board and from each other. I will assume that you have learned the basics of using a modem and a terminal program, and in particular that you know how to dial up the bulletin board and set your communication parameters to match those of the board. If not, you should get a knowledgeable friend to help.

When you first dial up the board gives an identifying sign-on message and then asks you to type in your name. It will look up this name in its file of validated users and, if it finds it, it will ask you to type in your password. If not it will ask you to choose a password and will then start a “validation dialogue” with you, asking for your address and phone number and perhaps some other basic personal information. (If it is a BBS only open to members of some organization it will probably ask your membership number. If it is a commercially operated board it will ask for credit information.) Then the BBS will usually state its rules of operation and ask if you are willing to abide by them. If you assent you will be told to call back again in a day or so, when your validation should have been completed by the sysop. Assuming that you are validated, the next time you call in and complete the logging in process by giving your correct password, you will be presented with a “main menu” of BBS functions to choose from. Each menu item will usually have a letter or number associated to it, and you select from the menu by typing that letter or number. On our typical board the main menu might look like:

| A | Leave a message for the sysop. |
| B | Change password. |
| C | Conferences. |
| D | Messages. |
| E | File transfers. |

If, for example, you now type an “M”, you will go to the public message section of the bulletin board. Here you will be presented with another menu, the “message menu”, giving you a choice of leaving a new message, reading messages, or returning to the main menu. If you decide to leave a message you will be given brief instructions on how to proceed and when you have finished you will return to the message menu. If you choose to read messages you will be asked to check off a list of subject categories you are interested in. Having made this choice you will then go to still another menu, asking you whether you wish to read messages only if they are “new” (since you last were on the system) or according to some other criterion. This complicated hierarchy of menus may sound confusing at first, but several things make navigating it easier than it might at first seem. First, you quickly get used to them, secondly if you get lost or confused you can almost always jump back either one level or all the way to the main menu, and finally if like most users you pretty much always do the same thing, there are ways to automate the whole process.

Let’s look at some of the other BBS functions on the main menu of our hypothetical BBS. If you choose “File transfers” you will be given the option of either uploading a file to the bulletin board, looking at a catalogue of files that the BBS has available (with thumbnail descriptions), or downloading one of these available files. If you choose “Email” you will go to the private message section, where you can exchange messages with other validated users. Finally, if you choose “Conferences” from the main menu you will be presented with a list of currently active conferences and asked if you want to join one or start a new one. What is a conference? It is a small and perhaps temporary sub-board, devoted to a specialized subject that is deemed not of sufficient interest to the general user of the BBS to warrant being a topic in the public message section. If, for example, the sysop notices that a small group of users is having an increasingly esoteric discussion on some topic, he may ask them to move it to a conference. Normally message exchanging in a conference works just as with the public message section. You log in and read the new messages when you have time, log out and think about them, then log in again to respond. But in some of the large boards that permit many users to log in simultaneously, one can arrange what is called “real-time conferencing”, which works pretty much like a conference call.

“Fine”, you say, “very interesting, but why is this appearing in the Notices? What has it got to do with Mathematics?” Perhaps a lot. Let me explain.

In certain academic fields, Computer Science and Physics in particular, there are subfields in which the majority of workers spend much of their time at a workstation and are connected to each other on the same network. It has become common in these fields to set up so called “mailing lists” on the network, consisting of small groups of people with common research interests. When a member of such a group finishes a paper that he feels may be...
of interest to others in the group, he can send it to this mailing list, and everyone on the list automatically receives it almost immediately. There is anecdotal evidence that this is also beginning to happen now in mathematics. What should be recognized is that this is a new form of “publishing” research. While there is surely nothing inherently wrong with this electronic publication, it does have some inherent dangers. You see, if an author is lazy, such a “paper” need never appear as real ink on real paper until a copy is finally sent off to a journal some weeks later. These papers are often written in \TeX{} or troff or some other technical word processing system and may be “printed” only on the computer screens of the author and others on the mailing list. Even if the author is conscientious and sends the paper out eventually as a conventional paper preprint, it is clear that the electronic mailing list is an “in” group with considerable time advantage over outside researchers. We have always taken it as axiomatic that openness of the research literature was one of the foundations of the academic enterprise, and these developments make many people a little nervous.

There is a solution to this potential problem that has occurred to a number of people. It preserves the speed and simplicity of electronic publication, but it also preserves the principle of openness. Let me refer to it here as The Mathematical BBS. The idea is to set up an electronic bulletin board, open to the whole mathematical community and devoted to its interests. Without trying to describe all the features that such a BBS might have, one central function would be to support a system of ongoing, specialized electronic research conferences. Anyone doing research in the area of one of these conferences would be eligible to take part in it and submit questions, open problems, papers, abstracts, and comments on papers.

If such a BBS is to be set up there would be some obvious advantages to having it sponsored and maintained under the auspices of the AMS. At the recommendation of the ECBT (Executive Committee of the Council and the Board of Trustees), president G. D. Mostow has recently appointed a Committee on the Electronic Exchange of Information (CEEI) to advise the Society on whether it should sponsor an electronic bulletin board system and, if so, how it should be organized, financed, etc. The committee consists of professors Joe P. Buhler, Marie M. Klawe, Richard G. Larson, Dr. Andrew Odlyzko, and the author of this article as chairman. The committee would be happy to hear comments and opinions from members of the AMS, either addressed directly to it or as Letters to the Editor of the Notices.
Each fall official Washington comes alive again after a summer slowdown. The out-of-state buses which a few short weeks earlier had been crammed with children are replaced with ones holding senior citizens. The wave of tourists in shorts, armed with cameras and maps, recedes to expose people in suits and dresses scurrying to work or between government buildings. They are part of unofficial Washington, the small army of government workers and staff members who did not go away during the summer, but worked to put in place plans for the year, plans which officials will implement as they return.

The small platoon which works in Washington on behalf of the mathematics community has also been planning over the summer. The plans, which deal largely with improving communication with members of the community, will be discussed in future columns in this space, after they have been approved by the Joint Policy Board for Mathematics.

People who are generally aware of Bill LeVeque's work on our behalf correctly point to his accomplishments in the heart of what we do: publication and dissemination of the results of mathematical research. Growing out of his years as Executive Editor of Mathematical Reviews and extending through his term as Executive Director is a string of innovations which reveals creativity together with a deep commitment to mathematics and to quality. His accomplishments cover a broad spectrum from the use of modern printing technology to the establishment of the new Journal of the AMS.

Bill's contributions at the interface between mathematicians and the outside world deserve wider recognition. During his time as Executive Director he worked steadily to expand our horizons, to encourage us to convey mathematics and its needs to other sciences, to government and to the general public. The pattern of his activities is impressive, as a diverse sample will show: He was one of the first chairmen of the AMS Science Policy Committee; he pressed to have the Notices reformatted, to make it more accessible and readable; he built a case for having a science writer in the Providence office, which is why the aforementioned Allyn Jackson is with us; he developed and put forward the idea of the new Collegiate Mathematics Education Newsletter that will begin publication in 1989.

There is a bigger job Bill did, one requiring years of effort. Starting with his term as chairman of the Conference Board of the Mathematical Sciences in 1973-1975, Bill was one of the small group of people who argued consistently for developing greater unity of purpose and action across the mathematical sciences community. Because of their efforts the Joint Concerns Committee of AMS-MAA-SIAM was transformed into the Joint Policy Board for Mathematics (JPBM) in 1983, and in 1984,
it began to create a stronger Wash­
ington presence for our commu­
nity. All those who have been di­
rectly connected with the JPBM
during its five years of existence
would on reflection acknowledge
that Bill has been the main pil­
lar of this effort of the three
societies—pushing the agenda for­
ward, helping us over the bumpy
spots, supplying the glue to hold
the enterprise together.

Bill LeVeque is not a quiet
man. But his work over the years
in strengthening communication
with our several publics was done
quietly, steadily, and effectively.
The consistency of it reveals that
it was also done with vision.

Merci! M. LeVeque. The good
deeds, the commitment, the sup­
port, and the skill are appreciated
by a good many of us.

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Introduction by
Anthony J. Tromba

The term “global analysis” refers to the
general area of analysis on manifolds, in
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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
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Executive Director
The Mathematical Association of America

The Mathematical Association of America seeks an Executive Director to succeed Alfred B. Willcox on his retirement in September 1990 after twenty-two years of service. (An interim plan will be considered for someone prepared to begin earlier.) The Association, with 26,000 members, is dedicated to the advancement of mathematics, particularly at the collegiate level. Its activities include national and regional meetings, publication of journals and books, visiting lecturer programs, and mathematical competitions for high school and college students. In addition, the Association (in cooperation with other mathematical organizations) is active in publicizing and explaining, to the public and the government, the importance of mathematics in meeting the needs of the country.

The Executive Director is the Chief Executive Officer of the Association, working under the immediate direction of the Executive and Finance Committees of the Board of Governors, and assisted by associate directors. The Executive Director attends meetings of these committees and of the Board.

The Executive Director has ultimate responsibility for all programmatic and administrative activities of the Association, including supervision of the headquarters staff of twenty-five; serves as the staff officer in charge of development; and, along with the elected officers, represents the Association in professional, governmental, and public affairs as an advocate in behalf of collegiate mathematics, as a fund raiser, and as a liaison with other organizations.

Candidates who hold a Ph.D. in the mathematical sciences and have substantial experience as professional mathematicians and educators are encouraged to apply, particularly if they also have administrative and managerial experience equivalent to that of department chair or higher, experience in fund raising and dealing with foundations, and a history of activity in the Association. Helpful attributes would be some familiarity with publishing and with the use of computers in publishing as well as data processing.

The Executive Director is based at the headquarters of the Association, a historic townhouse complex in downtown Washington. The appointment is for an indefinitely renewable five-year term. Candidates should have in mind a (nonbinding) commitment of at least two terms. The salary will be competitive, and fringe benefits are liberal.

Send applications (with vitae and names of three references) and nominations to:

Professor Deborah Tepper Haimo, Chair
Executive Director Search Committee
Department of Mathematics and Computer Science
University of Missouri–St. Louis
St. Louis, MO 63121

The selection committee will begin to review applications on December 15.

The Mathematical Association of America is an Affirmative Action, Equal-Opportunity Employer
News and Announcements

Hans Lewy
1904-1988

Hans Lewy, Professor Emeritus of mathematics at the University of California, Berkeley, died of leukemia on August 23, 1988, at the age of 83. He was best known for his influential work in the areas of the calculus of variations, partial differential equations, and hydrodynamics.

Professor Lewy was born on October 20, 1904, in Breslau, Germany. He received his Ph.D. in mathematics from the University of Göttingen in 1926 and was Privatdozent there from 1927 until the Nazis came to power in 1933. At that point, he came to Brown University, where he was an associate until 1935. In 1936, he moved to the University of California, Berkeley and advanced from lecturer to professor. He became Professor Emeritus in 1972 and continued to lecture until two months before his death.

Professor Lewy held Rockefeller Foundation Fellowships at the University of Rome (1929-1930) and the University of Paris (1930-1931). He was a member of the Mathematics Section of the National Academy of Sciences and of the Accademia dei Lincei in Rome. He presented AMS invited addresses at AMS meetings in Pasadena in 1945 and in Berkeley in 1954. In 1950, he presented an invited lecture at the International Congress of Mathematicians.

In 1979, Professor Lewy received the Society’s Steele Prize for three influential papers, one on holomorphy and the other two on linear differential equations. It was in one of these papers that he presented the famous example of a smooth linear partial differential equation having no solution. The Wolf Foundation awarded Lewy its mathematics prize in 1985 for “initiating many developments, now classic and essential, in partial differential equations.”

In 1950, Professor Lewy, together with several other tenured professors at Berkeley, refused to sign a loyalty oath required by the university’s board of trustees. Professor Lewy was discharged, but later reinstated when the courts ruled that the oath violated the professors’ civil rights.

A member of the Society since 1934, Professor Lewy served on the AMS Subcommittee on Preparation for Research of the War Preparedness Committee (1941-1942) and was an AMS representative to the Division of Physical Sciences (1964-1967) and to the Division of Mathematics (1965-1967) at the National Research Council. He was on the editorial boards of The Indiana University Mathematical Journal and of Annali della Scuola Normale di Pisa.

Gerald Alexanderson
New MAA Secretary

The Board of Governors of the Mathematical Association of America (MAA) has elected Gerald L. Alexanderson of Santa Clara University as secretary. His five-year term will begin in January 1990. The Board also elected the present secretary, Kenneth A. Ross of the University of Oregon, to a new position as associate secretary.

A change in the MAA bylaws made it possible to divide the present position of secretary into two positions. As secretary, Alexanderson will attend to such duties as assisting the president, the Board, and the Executive and Finance Committees and will be involved with policymaking. Ross’ new position as associate secretary entails planning MAA meetings.

Alexanderson has been chairman of the mathematics department at Santa Clara University since 1967. He is on numerous MAA committees, including the Executive Committee and the Committee on Publications. He is editor of the MAA’s Mathematics Magazine and an associate editor of The College Mathematics Journal. He was also first vice president of the MAA from 1984 to 1986, and has served as associate director of the William Lowell Putnam Mathematics Competition since 1975.

In addition to his MAA service, Alexanderson also served as President of the Fibonacci Association from 1980 to 1984. He has been division director of the Division of Mathematical and Natural Sciences at Santa Clara University since 1981. Together with Donald Albers, Alexanderson edited the book Mathematical People, a collection of interviews with prominent mathematicians.
**News and Announcements**

**Pi Mu Epsilon Celebrates its 75th**

Pi Mu Epsilon, Inc., the national honorary mathematical society founded in 1914 at Syracuse University, will celebrate its 75th anniversary at the Summer Joint Mathematics Meetings in Boulder Colorado, August 7-10, 1989. Pi Mu Epsilon has more than 250 chapters at colleges and universities around the country and encourages institutions to send student speakers and delegates to its Diamond Jubilee. Travel grants will be available for student participants. For further information, please contact Eileen Poiani, Department of Mathematics, St. Peter's College, Jersey City, NJ 07306 or Robert Woodside, Department of Mathematics, East Carolina University, Greenville, NC 27858.

**BMS Reports**

The Board on Mathematical Sciences at the National Research Council recently published four reports on the mathematical sciences.

- Statistical Models and Analysis in Auditing and Discriminant Analysis and Clustering were prepared by the Board's Committee on Applied and Theoretical Statistics, chaired by Morris DeGroot of Carnegie-Mellon University. Copies of these reports have been sent to U.S. Ph.D.-granting statistics and biostatistics departments.

- Report of the Advisory Panel to the Mathematical and Information Sciences Directorate, Air Force Office of Scientific Research is an example of the advisory services the Board provides to federal agencies (a similar report was issued to the Office of Naval Research last year). Wendell Fleming of Brown University chairs the AFSOR panel.

- Mathematical Sciences: Some Research Trends is the Board's major report after its first two years in operation. This report contains separate sections on research activity and trends in applied mathematics, core mathematics, and statistical sciences, plus eight vignettes highlighting specific areas of recent intense and important activity. The Research Trends report is intended to be broadly useful to mathematical scientists, consumers of the yield of mathematical sciences research, and professional societies. Copies of the Research Trends report have been sent to U.S. Ph.D.-granting mathematics and statistics departments. Phillip Griffiths of Duke University chairs the Board.

Although copies of the Research Trends report can be made widely available, supplies of the other reports are almost depleted. However, the Board will attempt to honor all requests for copies of the reports, and will consider a second printing if demand warrants. Those interested should send a postcard indicating the report(s) of interest to: Board on Mathematical Sciences, National Research Council, Room 312, 2101 Constitution Avenue NW, Washington, DC 20418.

**NRC Offers Ford Foundation Fellowships for Minorities**

The National Research Council will administer Ford Foundation Fellowships for minorities at the doctoral and postdoctoral levels. To be eligible, an applicant must be a U.S. citizen and a member of one of the following minority groups: Native American Indians, Alaskan Natives (Eskimo or Aleut), Black Americans, Mexican Americans/Chicanos, Native Pacific Islanders (Polynesians or Micronesians), and Puerto Ricans. The fellowships will be awarded in the behavioral and social sciences, humanities, engineering, mathematics, physical sciences, and biological sciences, or for interdisciplinary programs comprised of two or more eligible disciplines.

The Predoctoral and Dissertation Fellowships will be tenable at any accredited nonprofit U.S. institution of higher education offering Ph.D.s or Sc.D.s in the eligible fields. Each predoctoral fellowship will include an annual stipend of $10,350 to the Fellow and an annual institutional grant of $6,000 to the fellowship institution in lieu of tuition and fees. Dissertation Fellows will receive a stipend of $18,000 for the twelve-month tenure with no institutional grant. There will be approximately 55 three-year predoctoral awards and 20 one-year dissertation awards. The deadline for applications is November 14, 1988.

The Postdoctoral Fellowships are open to those who are preparing for or already engaged in college or university teaching, and who hold the Ph.D. or Sc.D. The fellowship provides a postdoctoral research experience at a not-for-profit institution of higher learning or research institution of the Fellow's choice. Appropriate institutions include universities, museums, libraries, government or national laboratories, privately sponsored not-for-profit institutes, government chartered not-for-profit organizations, and centers for advanced study. There will be approximately 25 one-year awards. The deadline for submission of applications is January 13, 1989.

All inquiries concerning application materials and program administration should be addressed to the Fellowship Office, GR420A, National Research Council, 2101 Constitution Avenue, Washington, DC 20418.

**Fulbright Collaborative Research and Travel Grants**

Fulbright Collaborative Research and Travel Grants are available from the Institute of International Education (IIE). These grants support research in foreign countries by U.S. graduate students and recent postdoctoral researchers.

Fulbright Collaborative Research Grants will be available to teams of two or three graduate students or recent postgraduate researchers for
six to ten months to most countries of the world (except most East European countries, the U.S.S.R., and Indochina). There are no restrictions on fields of study. It is preferable that applications be endorsed by and submitted through a U.S. academic institution of professional entity sponsoring the research. Applications must include evidence of affiliation with a host country institution or ongoing project that will oversee the collaborative research.

The grant benefits include a base sum and fixed sum monthly payments to each team member to cover the cost of round-trip international travel and maintenance during the tenure of the award. Basic health and accident insurance is also provided.

Fulbright Travel Grants for individual graduate students (postgraduate researchers are not eligible) are available to Belgium, Finland, France, Germany, Italy, Korea, and New Zealand. The grants must be used to supplement maintenance and/or tuitions scholarships and cannot be used to supplement personal funds. They provide roundtrip international transportation, health and accident insurance, and the cost of an orientation course abroad, if applicable.

All applicants for the both programs must be U.S. citizens at the time of application and must hold a bachelor's degree or its equivalent before the beginning of the grant. For Collaborative Research Grants, candidates may not have obtained the Ph.D. earlier than June 1986. Applicants must also have sufficient proficiency in the written and spoken language of the host country to carry out the proposed study or research.

Applications forms and further information may be obtained from the U.S. Student Programs Division at the IIE's New York City headquarters or one of its regional offices in Atlanta, Chicago, Denver, Houston, or San Francisco. Or contact Walter Jackson, U.S. Student Programs Division, 212-984-5327; address: Institute of International Education, 809 United Nations Plaza, New York, NY 10017.

AAAS Meeting Features Mathematics Symposia

The American Association for the Advancement of Science (AAAS) is a broadly based organization devoted to promoting research and education in all areas of science. Recently the Society has begun efforts to strengthen its ties with AAAS and has formed an AMS-AAAS Liaison Committee.

The 1989 Annual Meeting of the AAAS will be held January 14-19, 1989, in San Francisco. Section A of AAAS, which is concerned with mathematics, is sponsoring several outstanding expository talks by prominent mathematicians, including the following 3-hour symposia:

- Chaos and Dynamical Systems, organized by Jerrold E. Marsden. Speakers are Robert Devaney, Philip Holmes, Stephen Smale, James Yorke.
- Monte Carlo Methods, Statistical Mechanics, and Combinatorial Optimization, organized by Nicholas C. Metropolis and Lawrence Goldstein. Speakers are J. D. Doll, Stewart Geman, Lawrence Goldstein, G. S. Gurlani, Brols Hasslacher.
- The Next Generation of Neural Nets, organized by David H. Sharp. Speakers are Dana Ballard, John S. Denker, David Haussler, Eric Mjolsness, David H. Rumelhart.
- Logic Today, organized by Harvey Friedman. Speakers are H. J. Keisler, Kenneth McAloon, Kenneth Manders, Dana Scott, Stephen Simpson.
- The Scientist's Role in Developing Minority Students, organized by Leon Henkin. Speakers are Mindy Thompson Fullilov, Ray Landes, Frederick Reif, Frank Talamantes, Uri Treisman.

In addition, the mathematics lecture in the Frontiers in Physical Sciences series will be presented by Michael H. Freedman.

The meeting will be held in conjunction with the Joint Annual Meeting of the American Association of Physics Teachers and the American Physical Society. The AAAS program will also feature various symposia honoring the sesquicentennial of the American Statistical Association. Section A of AAAS is also cosponsoring various symposia that will be of interest to mathematicians and mathematics educators. Some of these are listed below.

- Chaos in Neural Networks
- Chaos in Biological Systems: Physiology, Medicine, and Ecology
- Chaos in Physical Systems: Studies of Turbulence
- Chaos in Physical Systems: Studies of Quantum Systems
- Chaos in Physical Systems: Astronomy and Celestial Mechanics
- Chaos in Global Affairs: Economics and the Arms Race
- Spatial Statistics
- Federal Funding of the Academic Physical Sciences
- Looking into Windows: Qualitative Research in Math and Science Education
- Perspectives and Emerging Approaches for Assessing Higher Order Thinking in Mathematics

These activities are just a few of the 150 or so AAAS program offerings that span all of science and that can enhance and broaden the perspectives of students and professionals alike.

"In presenting mathematics to the AAAS Program Committee, I have found that committee to be genuinely interested in more symposia
on mathematical topics of current interest," says Warren Page, Secretary of Section A. "Providing this may not be easy, but the outstanding success of the mathematics symposia at last year's AAAS Annual Meeting in Boston proved that effort and inspiration can accomplish wonders. That meeting's mathematics program showed that first rate mathematical researchers can also communicate effectively to a broad audience of scientists."

Section A of AAAS knows that increasing representation and participation of mathematicians at AAAS meetings are important ways to increase public awareness of mathematics and how it affects science and society. Section A invites those interested in stimulating activities in the mathematical sciences within AAAS to attend the Section A Committee Meeting (6-8pm, January 15, 1988, Walnut B Room of the San Francisco Hilton).

In addition, Section A welcomes suggestions from the mathematical community for symposia topics and individuals who might be able to serve as organizers. To make suggestions, contact: Warren Page, Secretary (Section A), New York City Technical College, CUNY, 300 Jay Street, Brooklyn, NY 11201.

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

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

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

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

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

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

Third Annual Conference on Undergraduate Research

Plans are underway for the Third Annual National Conference on Undergraduate Research to be held April 27–29, 1989, at Trinity University in San Antonio, Texas. The conference, which focuses solely on undergraduate research, will have as its 1989 theme "Excellence in Undergraduate Research: Experience, Knowledge and Achievement" (EUREKA). Last year's conference was held in Asheville, North Carolina and was attended by approximately 1000 participants.

The conference program will be open to all academic disciplines including the natural and physical sciences, mathematical sciences, engineering, social sciences, arts, humanities, and business. The conference will include formal student research presentations, a large exhibit of poster presentation displays of research approaches, methods and findings, and expositions/performances appropriate to the arts. Special sessions are planned to promote student-faculty interaction. In addition, the conference will provide opportunities for students to share their work with each other and for faculty from the various colleges and universities to exchange ideas, explore the methodology of undergraduate research, and discuss the role of research in the undergraduate curriculum.

Additional information about the Third Annual Conference on Undergraduate Research, including the formal call for papers and abstracts (mid-February abstract deadline), may be obtained from EUREKA, Trinity University, Holt Center, 106 Oakmont, San Antonio, TX 78212.
Congress Passes NSF Budget

The House-Senate conference bill containing the fiscal year 1989 budget for the NSF was passed early last month. The overall increase of 9.8% to $1.885 billion is a far cry from the 19% hike the President had requested. However, the $1.583 million appropriated for the “Research and Related Activities” category represents an increase of 8.9% over FY88, close to the 10% increase the President had requested. The big winner was Science and Engineering Education, which will grow to $171 million; this boost is almost double the 12% increase the Administration had requested.

At the time of this writing, it was not known what the budget would be for the Division of Mathematical Sciences (DMS), or even for the Directorate of Mathematical and Physical Sciences, the larger organizational structure containing the DMS. Aside from research and education, the only other component of the budget that has been determined at this time is the Antarctic Program, which will increase by 5% to $131 million. The exact amounts to be allocated to the DMS and the other disciplinary divisions will be worked out by the NSF this month when it develops its “Current Plan” budget for FY89.

It is also uncertain how the NSF’s Science and Technology Centers (STCs) program will fare. The STCs will be large-scale, collaborative efforts that will combine basic research, education, and outreach programs. The STC program has generated controversy because some are concerned it will decrease funds available for individual research.

Partly to allay such concerns, NSF Director Erich Bloch requested a separate appropriation of $150 million to provide complete funding for 10-15 STCs for five years. Congress rejected this funding method, but allowed the NSF to proceed with a limited number of the centers, funded out of the research budget.

There are several stipulations within the budget categories that Congress dealt with. For example, the Congressional conferees accepted the House’s earmarks of $900,000 for the International Institute for Systems Analysis, $200,000 for the Cajon Pass drilling project, and $1.5 million for access to supercomputing resources not available at the NSF’s supercomputer centers.

In addition, the conferees stipulated that the $15 million provided to education above the President’s request be used in a specific way. Ten million is to go to precollege teacher training, and the remaining funds are to be used at the NSF’s discretion and may be used for undergraduate programs. In addition, Congress earmarked $1 million for competitive curriculum development activities for grades K-9 by ongoing nonprofit organizations.

The appropriations bill also contained language that puts a cap of $95,000 on principal investigator salaries. The bill says, “none of the funds appropriated in this Act may be used to pay the salary of any individual functioning as a federal employee, or any other individual, through a grant or grants at a rate in excess of $95,000 per year.”

It is not entirely clear how this cap will be interpreted. It may be that an investigator’s salary plus two-ninths of his or her academic year salary cannot exceed $95,000, in which case those with academic year salaries greater than about $78,000 would be affected. Or, the cap may be interpreted to mean that no monthly salary rate may exceed one-twelfth of $95,000, or about $8,000; in that case, those with an academic year salary of more than $72,000 would be affected. It should be emphasized that these details must still be worked out between Congressional staff and the NSF.

New NSFNET Backbone Goes On Line

The new NSFNET backbone network, almost 30 times faster than the old network, went into operation on July 27. Transmitting information at the rate of 1.5 billion bits per second, the new backbone is the country’s fastest nonprivate computer network.

The NSFNET backbone uses MCI’s digital and fiber optic circuit network and IBM hardware and software to route data and manage data traffic. The combination of packet-switching and circuit-switching technologies makes it one of the world’s
largest implementations of an Internet-protocol based network.

Really a “network of networks,” NSFNET connects researchers at over 190 U.S. campuses and government research centers to state-of-the-art computing facilities throughout the nation. In addition, it provides access to other research-supported networks, including ARPANET and the NASA Space Science Network. The NSFNET backbone provides large-scale, trans-continental connections for NSFNET.

The new NSFNET backbone has 13 nodes, while the old one had only six; in addition to the NSF supercomputer centers, the new backbone connects seven other sites that serve as entry points to regional networks across the country. Between one and four circuits connect each of the 13 sites to MCI “Points of Presence” (POPs). In the center of this configuration are two interconnected rings that use a combination of high quality digital radio and optical fiber for the transport of digital data between POPs. Located along the rings are Digital Cross Connects (DXCs) which enable circuit switching to reroute data (see accompanying figure).

Establishment of the new NSFNET backbone follows a solicitation for bids by NSF in August of last year. The Merit Computer Network, a consortium of eight state-supported universities in Michigan, was awarded a $14 million, five-year grant to re-engineer and manage NSFNET. The state of Michigan contributed $5 million for the new network, and IBM and MCI are providing architecture, services, and equipment.

SCREMS (Scientific Computing Research Equipment for the Mathematical Sciences), a program in the Division of Mathematical Sciences, will make a limited number of awards for the purchase of scientific computing equipment. SCREMS is designed to provide for the kind of equipment that is required by several (two to five) research projects and that would be difficult to justify for a single project.

Eligible institutions include U.S. graduate institutions with departments or research programs in mathematics, applied mathematics, or statistics. Proposals involving more than one institution or department are welcome. Significant cost-sharing on the part of the institution(s) is expected.

The deadline for proposals for SCREMS is December 5, 1988. For further information, contact Elbert Walker, Program Director for Special Projects, Division of Mathematical Sciences, Room 339, National Science Foundation, 1800 G Street, NW, Washington, DC 20550; telephone 202-357-9764.

Mathematical Sciences Postdoctoral Research Fellowships

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

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

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

The deadline for applications is November 15, 1988.

New Japan Initiative

In an effort to increase the number of U.S. investigators in Japan, the NSF is implementing a “Japan Initiative,” beginning in 1988, which seeks to increase the number of scientists and engineers in the U.S. who can operate with ease in Japan's research community and follow developments in the Japanese science and engineering literature. The initiative is designed to increase American recognition of the potential benefits of cooperative research with Japanese institutions and build relations between the U.S. and Japanese research communities.

There are several different activities under the sponsorship of the initiative:

- **Support for research visits to Japan.** Open to both established researchers and recent doctoral degree recipients, the program will support visits to research or development laboratories for 6 to 18 months. Grantees will receive a monthly stipend, roundtrip airfare (for themselves and up to three accompanying dependents) to Japan, and a modest housing allowance. Applicants should begin correspondence with their prospective Japanese hosts well before submitting a proposal. Applications may be submitted at any time and require 6 months for processing. Request document number NSF88-51 (see address below).

- **Fellowships.** Open to scientists and engineers at the graduate, postgraduate, and senior levels, these fellowships support study of the Japanese language, but not travel to Japan. Deadlines are May 15, October 15, and December 15. For more details, see Notices, July/August 1988, page 816, or request document number NSF88-10. In addition, the NSF will accept proposals to develop improved course materials for teaching technical Japanese.

- **Opportunities for American researchers.** The NSF will assist U.S. researchers in arranging long-term stays at Japanese laboratories. The NSF office in Tokyo will continue to elicit commitments from Japanese companies to accept qualified American researchers. The office can also contact Japanese laboratories, both national and private, to facilitate replies to applications from U.S. scientists and engineers.

- **Research at AIST institutes.** This program will support U.S. scientists and engineers to conduct research at the Agency of Industrial Science and Technology (AIST) institutes. Beginning in 1988, AIST will annually receive up to thirty U.S. visitors selected by the NSF. The program provides a stipend, costs for travel to and from the AIST host institute, and reasonable living expenses in Japan for the applicant and family. Visits will normally last from 6 months to 1 year. Request document number 88-22.

For more information on these programs, contact: Japan Initiative, Room 1208, Division of International Programs, National Science Foundation, 1800 G Street NW, Washington, DC 20550; telephone: 202-357-9558; electronic mail: cwallace@note.nsf.gov. To request program announcements for the individual programs, request the appropriate document from Forms and Publications at the NSF's street address above; telephone 202-357-7861.
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 50,000 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.

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1988 AMS Elections

### Candidates

**OFFICERS**

- **Vice President** (one to be elected)
  - Sun-Yung Alice Chang
  - Melvin Hochster

- **Secretary***
  - Robert M. Fossum

- **Associate Secretaries***
  - Joseph A. Cima (South East)
  - W. Wistar Comfort (East)

- **Treasurer***
  - Franklin P. Peterson

- **Associate Treasurer***
  - Steve Armentrout

**Member-at-Large of the Council** (five to be elected)

- Jonathan L. Alperin
- Melvyn S. Berger
- Fan R. K. Chung
- Lawrence J. Corwin
- James H. Curry

**Board of Trustees** (one to be elected)

- Edwin E. Floyd
- Paul J. Sally, Jr.

**EDITORIAL AND COMMUNICATION COMMITTEES**

- **Committee to Monitor Problems in Communication***
  - Arthur M. Jaffe
  - Paul Nevai

### Publication Committees***

- **American Journal of Mathematics**
  - David Gieseker

- **Bulletin**
  - Murray H. Protter

- **Colloquium**
  - Charles L. Fefferman

- **Mathematical Reviews**
  - Leonard D. Berkovitz
  - John L. Selfridge

- **Mathematical Surveys and Monographs**
  - David Kinderlehrer

- **Mathematics of Computation**
  - Andrew M. Odlyzko

- **Proceedings**
  - William W. Adams
  - J. Marshall Ash
  - Maurice Auslander
  - Andreas R. Blass
  - Clifford J. Earle, Jr.
  - Palle E. T. Jorgensen

- **Transactions and Memoirs**
  - Eugene B. Fabes

### NOMINATING COMMITTEE FOR 1989

(Preferential Ballot, four to be elected)

- Joan S. Birman
- John B. Garnett
- James E. Humphreys
- Victor Klee

- Ray A. Kunze
- Andy Roy Magid
- James D. Stasheff
- Alan D. Weinstein

*Uncontested offices*
**Election Information**

The ballots for election of members of the Council and Board of Trustees of the Society for 1989 will be mailed on or shortly after September 10, in order for members to receive their ballots well in advance of the November 10 deadline. Prior to casting their ballots members are urged to consult the following articles and sections of the Bylaws of the Society: article I, section 1; article II, sections 1, 2; article III, sections 1, 2, 3; article IV, sections 1, 2, 4; article VII, sections 1, 2, 5. The complete text of the Bylaws appears on pages 1155-1160 of the November 1987 issue of Notices. A list of the members of the Council and Board of Trustees serving terms during 1988 appears in the AMS Reports and Communications section of this issue.

**SUGGESTIONS FOR 1989 NOMINATIONS**

Each year the members of the Society are given the opportunity to propose for nomination the names of those individuals they deem both qualified and responsive to their views and needs as part of the mathematical community. Candidates will be nominated by the Council to fill positions on the Council and Board of Trustees to replace those whose terms expire December 31, 1989. See the AMS Reports and Communications section of this issue for the list of current members of the Council and Board of Trustees. Members are requested to write their suggestions for such candidates in the appropriate spaces on the form in the next column.

**REPLACEMENT BALLOTS**

This year ballots for the AMS election will be mailed September 10, 1988, or within a day or two thereafter. The deadline for receipt of ballots in Providence is November 10, 1988.

There has been a small but recurring and distressing problem concerning members who state that they have not received ballots in the annual election. It occurs for several reasons, including failure of local delivery systems on university or corporate properties, failure of members to give timely notice of changes of address to the Providence office, failures of postal services, and other human errors.

To help alleviate this problem, the following replacement procedure has been devised: A member who has not received a ballot by October 10, 1988, or who has received a ballot but has accidentally spoiled it, may write after that date to the Secretary of the AMS, Post Office Box 6248, Providence, RI 02940, asking for a second ballot. The request should include the individual's member code and the address to which the replacement ballot should be sent. Immediately upon receipt of the request in the Providence office, a second ballot, which will be indistinguishable from the original, will be sent by first class or air mail. It must be returned in an inner envelope, which will be supplied, on the outside of which is the following statement to be signed by the member:

The ballot in this envelope is the only ballot that I am submitting in this election. I understand that if this statement is not correct then no ballot of mine will be counted.

signature

Although a second ballot will be supplied on request and will be sent by first class or air mail, the deadline for receipt of ballots will not be extended to accommodate these special cases.

### SUGGESTIONS FOR 1989 NOMINATIONS

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<tr>
<th>Council and Board of Trustees</th>
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<tr>
<td>Vice President (2)</td>
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<td>Associate Secretaries (2)</td>
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<td>Member of the Bulletin Editorial Committee (1)</td>
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<td>Member of the Colloquium Editorial Committee (1)</td>
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<td>Member of the Mathematical Reviews Editorial Committee (1)</td>
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<td>Member of the Mathematical Surveys Editorial Committee (1)</td>
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<td>Members of the Mathematics of Computation Editorial Committee (2)</td>
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<td>Members of the Proceedings Editorial Committee (3)</td>
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<td>Member of the Transactions and Memoirs Editorial Committee (1)</td>
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<td>Members of the Committee to Monitor Problems in Communication (2)</td>
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<td>Members-at-large of the Council (5)</td>
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<td>Member of the Board of Trustees (1)</td>
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The completed form should be addressed to AMS Nominating Committee, Post Office Box 6248, Providence, RI 02940, to arrive no later than November 10, 1988.
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
  - Zoll Surfaces, by Victor Guillemin, Code VIDGUILLEMIN
  - Matrices I Have Met, by Paul R. Halmos, Code VIDHALMOS
  - How Computers Have Changed the Way I Teach, by John G. Kemeny, Code VIDKEMENY
  - Oscar Zariski and His Work, by David Mumford, Code VIDMUMFORD

**ICM-86 Plenary Addresses**
- VHS Format, approx. one hour, Price $49 each
  - Geometry of four-manifolds, by Simon K. Donaldson, Code VIDDONALDSON
  - Underlying concepts in the proof of the Bieberbach conjecture, by Louis de Branges, Code VIDDEBRANGES
  - Recent progress in arithmetic algebraic geometry, by Gerd Faltings, Code VIDFALTINGS
  - Soft and hard symplectic geometry by Mikhael Gromov, Code VIDGROMOV
  - Efficient algorithms in number theory, by Hendrik W. Lenstra, Code VIDLENSTRA
  - Classifying general classes, by Saharon Shelah, Code VIDSHELAH
  - Complexity aspects of numerical analysis, by Stephen Smale, Code VIDSMALE
  - Problems in harmonic analysis related to oscillatory integrals and curvature, by Elias M. Stein, Code VIDSTEIN
  - Representations of reductive Lie groups, by David A. Vogan, Jr., Code VIDVOGAN
  - String theory and geometry, by Edward Witten, Code VIDWITTEN
  - On the work of Simon K. Donaldson, Fields Medalist, by Michael F. Atiyah; On some of the mathematical contributions of Gerd Faltings, Fields Medalist, by Barry Mazur; On the work of Michael Freedman, Fields Medalist, by John W. Milnor; On the work of Leslie G. Valiant, Nevanlinna Prize Winner, by Volker Strassen

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

PREPAYMENT REQUIRED. Order from American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-9930 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.
Meetings and Conferences of the AMS

FUTURE MEETINGS

- Lawrence, Kansas
  October 28–30
  Page 1165

- Claremont, California
  November 12–13
  Page 1181

- Phoenix, January 11–14
  Page 1191

Mathematical Sciences Employment Register
  Page 1228

Invited Speakers and Special Sessions
  Page 1236
Coming Events

The first announcement of the Phoenix Meetings appears in this issue, along with the Preregistration/Housing Form. Make sure you rush your form in to the Mathematics Meetings Housing Bureau by October 31 in order to be eligible for the drawing for free sleeping rooms. A special hike in the Sonoran Desert has been arranged by the Local Arrangements Committee for Friday the 13th! (Hmmm.)

The meetings in Boulder next summer will observe the 75th anniversary of the founding of Pi Mu Epsilon. A news item elsewhere in this issue gives more details.

Several new meetings are being announced in the calendar for the first time. Annual meetings are now planned for San Francisco in 1991, Baltimore in 1992, and Cincinnati in 1994. Summer meetings are planned at Ohio State University in 1990 and the University of Maine in 1991. The former will showcase the 75th Anniversary Celebration of the Mathematical Association of America. MAA was founded on the Ohio State campus during a meeting of the American Association for the Advancement of Science in 1915, and a special plaque will be dedicated at the building where this important event took place. This is only one of many very special events the Association is planning for this occasion.
Program

The eight-hundred-and-forty-fifth meeting of the American Mathematical Society will be held at the University of Kansas in Lawrence, Kansas on Friday, October 28, and Saturday, October 29, 1988.

Invited Addresses

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

BJÖRN DAHLBERG, Washington University, Elliptic boundary value problems in non-smooth domains.

STEVEN E. HURDER, University of Illinois at Chicago, Geometry and the index theory of foliations.

PETER SCOTT, University of Michigan, Ann Arbor, Least area surfaces in 3-manifolds.

SIDNEY M. WEBSTER, University of Minnesota, Minneapolis, The integrability problems of complex analysis.

Special Sessions

By invitation of the same committee, there will be twelve special sessions of selected twenty-minute papers. Topics and the names and affiliations of the organizers and a list of tentative speakers, when available, follow.


Control theory, TYRONE DUNCAN, University of Kansas. Speakers include: Thomasz Bielecki, William M. Boothby, Richard Datko, Tyrone Duncan, David L. Elliott, Kurt Helmes, P. S. Krishnaprasad, P. R. Kumar, Irena Lasiecka, Lawrence Markus, Clyde F. Martin, Bozena Pasik-Duncan, Raymond Rishel, Roberto Triggiani, and F. S. Van Vleck.

Applications of set theory, WILLIAM FLEISSNER, University of Kansas. Speakers include Zoltan Balogh, Paul Bankston, Dennis Burke, Paul Corazza, Peg Daniels, S. W. Davis, Alan Dow, Gary Gruenhage, Winifred Just, John Kulesza, Withold Marciszewski, Arnold W. Miller, Peter J. Nyikos, Jack R. Porter, Karel Prikry, Judy Roitman, Mary Ellen Rudin, Charles Schindwein, and Franklin D. Tall.

Meetings

Map of Lawrence and the campus of the University of Kansas

DENOTES TRAFFIC SIGNAL

NORTH
WEST
EAST
SOUTH

KANSAS TURNPIKE

U.S. 40 EAST

KOA Camp ground

I-70 EAST

I-70 WEST

1-70 WEST

SUPER 8

HOLIDAY INN

PARK INN

HALLMARK INN

TRAVELODGE

HALCYON HOUSE

ELDRIDGE HOTEL

GSP HALL

ALUMNI CENTER

MELTHAM BLDG

UNION BLDG

CAMPU'S AREA

ADAMS DR

SUNNYSIDE DR

SOUTH CAMPUS DR

PARKING

11TH ST

11TH ST

11TH ST

11TH ST

11TH ST

18TH ST

15TH ST

13TH ST

10TH ST

9TH ST

8TH ST

7TH ST

6TH ST

5TH ST

4TH ST

3RD ST

2ND ST

1ST ST

K-10 (TO K.C.)
Meetings

Flat bundles and geometric structures, William Mark Goldman, University of Maryland. Speakers are Daniel M. Burns, Jr., James A. Carlson, Suh Young Choi, Sidney Frankel, Daniel Gallo, Richard Hain, Yoshinobu Kamishima, Ravi S. Kulkarni, Karl Luttinger, Larry Lok, and J. Millson.


Contributed Papers

There will also be sessions for contributed ten-minute papers.

Social Event

A social hour with a cash bar will be held on Friday evening, October 28, from 5:30 p.m. to 7:00 p.m. at the Adams Alumni Center located on the corner of 13th and Oread Streets.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Atlanta meeting announcement on page 68 of the January issue of Notices.

Accommodations

Blocks of rooms are being held at the lodging establishments listed below. Participants should make their own reservations directly with the hotel of their choice and be sure to identify themselves with the AMS meeting at the university. Please make reservations by October 12, 1988. After that date, reservations will be accepted on a space available basis only. Prices listed below are subject to change and do not include applicable taxes of 8 percent.

Westminster Inn
W. 6th Street
Telephone: 913-841-8410
Single $24 Double $32

Virginia Inn
W. 6th Street
Telephone: 913-843-6611
Single $24 Double $33

Park Inn
W. 6th Street
Telephone: 913-842-7030
Single $29 Double $37

All Seasons
Iowa Street
Telephone: 913-843-9100
Single $28 Double $33

Best Western
Iowa Street
Telephone: 913-841-6500
Single $28 Double $36

Registration

The registration desk will be located in the Level 4 Lobby of the Kansas Union and will be open on Friday, October 28, from 8:00 a.m. to 3:00 p.m., and Saturday, October 29 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.

To reach the registration area from Parking Lot 91, enter and walk through the understreet tunnel located at the southeast corner of Lot 91. When you enter the Kansas Union building, take the elevators on the south side of the stairwell to the Level 4 Lobby area.
Rooms have not been blocked at the following locations but are included for informational purposes only.

**Holiday Inn**
- McDonald Drive
- Telephone: 800-238-8000 or 913-841-7077
- Single $44 Double $50

**Eldridge Hotel**
- Massachusetts Street
- Telephone: 913-749-5011
- Single $61 Double $68

**Food Service**
Most local lodging establishments have restaurants for breakfast, lunch, and dinner. The Kansas Union building houses several food service facilities ranging from salad bar to deli to traditional meals. Additionally, Lawrence has a variety of fine restaurants, such as the Eldridge Hotel; Arthur Porters, 1511 W. 23rd Street; and Costello's Greenhouse restaurant, 3400 W. 6th Street. Fast food restaurants can be found throughout Lawrence. Information on area eating establishments will be included in your registration packet and will also be available at the registration area.

**Travel**
The University of Kansas main campus is located in Lawrence, about forty miles west of Kansas City International Airport which is served by most major airlines. Lawrence is also accessible by Greyhound bus lines.

For those driving or renting cars at the airport, Lawrence can be reached by taking I-29 south (from the airport) to I-635 south to I-70 west. There are two exits for Lawrence: the East exit leads to the downtown area; the West exit leads to the campus and lodging establishments listed above.

Public limousine service to and from Kansas City International Airport is available from Corporate Coach, 913-841-5466, four times daily. Advance reservations are required and must be made 24 hours in advance.

**Parking and Local Travel**
Courtey visitor parking permits are available through the mathematics department at the university. Please send your written request to: The Department of Mathematics, University of Kansas, Strong Hall, Lawrence, KS 66045 not later than October 1, 1988.

Metered visitor parking at the University of Kansas is available in Lot 91 located just behind the Kansas Union. Visitors must park at metered spaces. The current rate is 25 cents per hour to a maximum of ten hours. Meters accommodate nickels, dimes and quarters. Visitors parking in nonmetered spaces will be ticketed. Lawrence has local taxicab service information available at local motels and hotels.
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 October 1988 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.

Friday, October 28

AMS Special Session on Applications of Set Theory, I

8:30 a.m.–10:50 a.m. Walnut Room, Kansas Union

8:30 a.m. Elementarily tolerant compact Hausdorff spaces.
(1) Paul Bankston, Marquette University (845-93-14)
9:00 a.m. Set theoretic properties of Loeb measure. Preliminary report.
(2) Arnold W. Miller, University of Wisconsin, Madison (845-04-201)
9:30 a.m. Countably compact spaces, the core model, and
(3) Chang Conjecture variants. Preliminary report.
Peter J. Nyikos, University of South Carolina, Columbia (845-54-103)
10:00 a.m. On a classification of pointwise compact sets of the
(4) first Baire class functions.
Witold Marciszewski, University of Kansas (845-54-191) (Sponsored by Jack R. Porter)
10:30 a.m. Three set theoretic problems in generalized metric
(5) spaces.
S. W. Davis, Miami University, Oxford (845-54-143)

AMS Special Session on Geometry and Mathematical Physics, I

9:00 a.m.–10:50 a.m. Jayhawk Room, Kansas Union

9:00 a.m. Non-abelian cohomology for many-body physics.
(6) Brian de Facio, University of Missouri, Columbia (845-53-198) (Sponsored by John K. Beem)
9:30 a.m. Properties and applications of the GGV
(7) representations of gauge groups. Preliminary report.
F. R. Miller*, Kansas State University, and H. R.
Fischer, University of Massachusetts, Amherst (845-58-24)
10:00 a.m. The trousers problem.
(8) Corinne A. Manogue* and Tevian Drey, Oregon State University (845-81-35)

10:30 a.m. Topology of the universe.
(9) Adrian L. Melott, University of Kansas (845-85-02)
(Sponsored by Phillip E. Parker)

AMS Special Session on Control Theory, I

9:00 a.m.–10:50 a.m. International Room, Kansas Union

9:00 a.m. Boundary control of vibrating systems requires some
(10) internal stability.
Richard Datko, Georgetown University (845-93-08)
(Sponsored by Tyrone Duncan)
9:30 a.m. On the control of rods. Preliminary report.
(11) P. S. Krishnaprasad, University of Maryland, College Park (845-93-49)
10:00 a.m. Exponential stabilizability of nonlinearly perturbed
wave equation with Neumann boundary conditions.
Irena Lasiecka, University of Virginia (845-49-70)
10:30 a.m. Uniform stabilization for Euler-Bernoulli equation.
(12) Roberto Triggiani, University of Virginia (845-35-104)
(Sponsored by Tyrone Duncan)

AMS Special Session on Commutative Algebra, I

9:00 a.m.–10:50 a.m. Pine Room, Kansas Union

9:00 a.m. Pseudo-Dedekind domains and divisorial ideals in
(14) R[X].
D. D. Anderson*, University of Iowa, and B. G. Kang
Pohang Institute of Science and Technology, Korea (845-13-39)
9:30 a.m. Integral domains that lose ideals in overrings.
(15) Preliminary report.
William Heinzer, Purdue University, West Lafayette, and
David Lantz*, Colgate University (845-13-48)
10:00 a.m. Two asymptotic functions.
(16) Daniel Katz, University of Kansas, and Stephen
McAdam*, University of Texas at Austin (845-13-37)
10:30 a.m. Generators of residual intersections. Preliminary
(17) report.
Matthew Miller* and Andrew Kustin, University of
South Carolina, and Bernd Ulrich, Michigan State
University (845-13-56)
**Program of the Sessions**

**Friday, October 28** (cont'd)

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<td>9:00 a.m.</td>
<td>AMS Special Session on 3-Manifolds, I</td>
<td>Parlor A, Kansas Union</td>
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<td>9:00 a.m.</td>
<td>Covers of Dehn fillings on once punctured torus bundles.</td>
<td>(18) Mark D. Baker, Vanderbilt University (845-57-138)</td>
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<tr>
<td>9:30 a.m.</td>
<td>Lattices on trees, and automorphisms of graphs, free groups and surfaces.</td>
<td>(19) Ravi S. Kulkarni, Queens College, City University of New York (845-57-108)</td>
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<td>10:00 a.m.</td>
<td>Braid groups and differential geometry. Preliminary report.</td>
<td>(20) D. D. Long, University of California, Santa Barbara (845-57-45)</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>A generalization of a theorem of R H Bing.</td>
<td>(21) Joel Hass and Abigail Thompson*, University of California, Davis (845-57-127)</td>
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<td>10:00 a.m.</td>
<td>AMS Special Session on Algebraic Geometry, I</td>
<td>Summerfield, Alumni Center</td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>On a class of rational surfaces.</td>
<td>(22) Anthony V. Geramita*, Queen's University, and Alessandro Gimigliano, Universita di Roma, Italy (845-14-200)</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Schubert's coincidence formulas for line complexes and the contribution of embedded plane pencils.</td>
<td>(23) Susan Jane Colley, Oberlin College (845-14-84)</td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>AMS Special Session on Operator Theory and Applications to Geometry, I</td>
<td>Bruckmiller, Alumni Center</td>
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<tr>
<td>10:00 a.m.</td>
<td>Trace formulas and spectral asymptotics for Hamiltonians associated to representations of nilpotent Lie groups.</td>
<td>(24) Palg Jorgensen, University of Iowa (845-47-15)</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Automorphisms of Toeplitz C*-algebras.</td>
<td>(25) Paul S. Muhly*, University of Iowa, and Jingbo Xia, State University of New York, Buffalo (845-47-89)</td>
</tr>
<tr>
<td>11:00 a.m.</td>
<td>Least area surfaces in 3-manifolds.</td>
<td>Woodruff Auditorium, Kansas Union</td>
</tr>
<tr>
<td>11:00 a.m.</td>
<td>AMS Invited Address</td>
<td>(26) Peter Scott, University of Michigan, Ann Arbor (845-57-98)</td>
</tr>
<tr>
<td>1:30 p.m.</td>
<td>Geometry and the index theory of foliations.</td>
<td>Woodruff Auditorium, Kansas Union</td>
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<tr>
<td>3:00 p.m.</td>
<td>AMS Special Session on Partial Differential Equations–Geometric Theory, I</td>
<td>Bruckmiller, Alumni Center</td>
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<tr>
<td>3:00 p.m.</td>
<td>On the convexity and nonconvexity of solutions in a free-boundary problem in fluid dynamics.</td>
<td>(28) Andrew F. Acker, Wichita State University (845-35-182)</td>
</tr>
<tr>
<td>3:30 p.m.</td>
<td>A construction of a Bernstein function using the Gauss map.</td>
<td>(29) Alan Elcrat* and Kirk Lancaster, Wichita State University (845-35-181) (Sponsored by Kirk Lancaster)</td>
</tr>
<tr>
<td>4:00 p.m.</td>
<td>Computation of vortex flows past obstacles with circulation.</td>
<td>(30) Alan Elcrat and Kenneth Miller*, Wichita State University (845-76-187)</td>
</tr>
<tr>
<td>4:30 p.m.</td>
<td>Inverse conductivity problem.</td>
<td>(31) Victor Isakov, Wichita State University (845-35-180)</td>
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<td>3:00 p.m.</td>
<td>AMS Special Session on Algebraic Geometry, II</td>
<td>Walnut Room, Kansas Union</td>
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<td>3:00 p.m.</td>
<td>Rational elliptic surfaces with Mordei-Weil group isomorphic to Z. Preliminary report.</td>
<td>(32) Eileen Alvarez, Colorado State University (845-14-116)</td>
</tr>
<tr>
<td>3:30 p.m.</td>
<td>Mixed Hodge theory with local coefficients.</td>
<td>(33) Donu Arapura, Purdue University, West Lafayette (845-14-95)</td>
</tr>
<tr>
<td>4:00 p.m.</td>
<td>Hypersurface variations are maximal.</td>
<td>(34) James A. Carlson, University of Utah (845-14-78)</td>
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<tr>
<td>4:30 p.m.</td>
<td>Compositions of smooth blow-ups. Preliminary report.</td>
<td>(35) Bruce Crauder, Oklahoma State University, Stillwater, and University of North Carolina, Chapel Hill (845-14-170)</td>
</tr>
<tr>
<td>5:00 p.m.</td>
<td>Algebraic cycles in the cohomology of a Kuga variety.</td>
<td>(36) B. Brent Gordon, University of Oklahoma (845-14-113)</td>
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<tr>
<td>3:00 p.m.</td>
<td>AMS Special Session on Real Analysis, I</td>
<td>Jayhawk Room, Kansas Union</td>
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<tr>
<td>3:00 p.m.</td>
<td>Independent random variables on the unit interval.</td>
<td>(37) James Foran* and Lee Hart, University of Missouri, Kansas City (845-26-149)</td>
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<td>Some consequences of an integral representation of the Cesaro kernel.</td>
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<td>Edward M. Arnold, Eastern Montana State College (845-42-120)</td>
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<tr>
<td>3:00 p.m.</td>
<td>The integrability of Riemann summable trigonometric series.</td>
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<td>P. S. Bullen*, University of British Columbia, and S. N. Mukhopadhyay, University of Burdwan, India (845-42-13)</td>
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<td>3:30 p.m.</td>
<td>On weighted Lipschitz spaces. Preliminary report.</td>
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<td>Gerald S. De Souza*, Auburn University at Auburn, and Steven Bloom, Siena College (845-26-118) (Sponsored by Gary Sampson)</td>
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<td>5:00 p.m.</td>
<td>Fourier series on Vilenkin groups, differentiation of integrals.</td>
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<td>Daniel Waterman*, Syracuse University, and David Dezern, University of North Carolina, Asheville (845-26-163)</td>
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<td>5:30 p.m.</td>
<td>A selection theorem for certain subsets of ( I \times I ).</td>
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<td>B. D. Garrett, Tennessee State University (845-26-162)</td>
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<td>6:00 p.m.</td>
<td>A transcients set. Preliminary report.</td>
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<td>Henry Fast, Wayne State University (845-18-175) (Sponsored by James Foran)</td>
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<td>6:30 p.m.</td>
<td>Informal Discussion</td>
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<td>3:00 p.m.</td>
<td>A canonical metric on M&quot;obius structures and applications.</td>
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<td>Ravi S. Kulkarni, Queens College, City University of New York (845-53-109)</td>
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<td>3:30 p.m.</td>
<td>Fill-ins and developing maps of spherical CR-structures. Preliminary report.</td>
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<td>Daniel M. Burns, Jr., University of Michigan, Ann Arbor (845-32-80)</td>
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<td>3:00 p.m.</td>
<td>F-regularity and splitting of finite maps for Gorenstein rings. Preliminary report.</td>
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<td>Craig Huneke*, Purdue University, West Lafayette, and Mel Hochster, University of Michigan, Ann Arbor (845-13-102)</td>
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<tr>
<td>3:30 p.m.</td>
<td>Phantom intersection theorems. Preliminary report.</td>
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<td>Melvin Hochster*, University of Michigan, Ann Arbor, and Craig Huneke, Purdue University, West Lafayette (845-13-171)</td>
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<td>4:00 p.m.</td>
<td>Parafactoriality and small divisor class groups.</td>
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<td>Bernd Ulrich, Michigan State University (845-13-12)</td>
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<td>4:30 p.m.</td>
<td>Normal surfaces with infinitely many singularities.</td>
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<td>Preliminary report.</td>
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<td>Shreeram S. Abhyankar* and William J. Heinzer, Purdue University, West Lafayette (845-13-119)</td>
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<td>5:00 p.m.</td>
<td>On the vanishing of local cohomology modules.</td>
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<td>Craig Huneke, Purdue University, West Lafayette, and Gennady Lyubeznik*, University of Chicago (845-13-194)</td>
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<td>5:30 p.m.</td>
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### AMS Special Session on Potential Theory and Partial Differential Equations in Nonsmooth Domains, I

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<td>Harmonic Bergman spaces on non-smooth domains.</td>
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<td>Properties of derivatives of solutions of ( Au = f ).</td>
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<td>3:00 p.m.</td>
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<td>Essential laminations in 3-manifolds.</td>
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<td>David Gabai*, California Institute of Technology, and Ulrich Oertel, Rutgers University, Newark (845-57-73)</td>
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<td>Affine laminations and their stretch factors.</td>
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<td>Ulrich Oertel, Rutgers University, Newark (845-57-59)</td>
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</tbody>
</table>
### Program of the Sessions

**Friday, October 28 (cont'd)**

#### AMS Session for Contributed Papers, I

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>3:00 p.m.</td>
<td>International Room, Kansas Union</td>
<td></td>
</tr>
<tr>
<td>3:00 p.m.</td>
<td>Two generalized well orderings of $0^n$.</td>
<td>(60) S. M. Kim, Yonsei University, Korea (845-04-01)</td>
</tr>
<tr>
<td>3:40 p.m.</td>
<td>Discussion</td>
<td></td>
</tr>
</tbody>
</table>

#### AMS Special Session on Geometry-Physics, II

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:30 p.m.</td>
<td>Quantum manifolds in curved spacetimes. Preliminary report.</td>
<td>(82) David G. Retzloff, University of Missouri, Columbia (845-83-61)</td>
</tr>
<tr>
<td>4:00 p.m.</td>
<td>Mass zero questions in fundamental physics. Preliminary report.</td>
<td>(63) Justin C. Huang* and Tsung-Cheng Shen, University of Missouri, Columbia (845-82-93) (Sponsored by John K. Beem)</td>
</tr>
<tr>
<td>4:30 p.m.</td>
<td>Glueing spacetimes together.</td>
<td>(64) Tevian Dray, Oregon State University (845-83-43)</td>
</tr>
<tr>
<td>5:00 p.m.</td>
<td>Topology of static space-times with and without blackholes. Preliminary report.</td>
<td>(65) Gregory J. Galloway, University of Florida (845-83-146)</td>
</tr>
<tr>
<td>5:30 p.m.</td>
<td>Complete spacelike immersions with topology.</td>
<td>(66) Steven G. Harris, Oregon State University (845-53-10)</td>
</tr>
</tbody>
</table>

#### AMS Special Session on Numerical Linear Algebra, I

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>3:30 p.m.</td>
<td>Hybrid schemes for computing the singular value decomposition on a hierarchical memory architecture.</td>
<td>(67) Michael Berry, University of Illinois, Urbana-Champaign (845-68-202) (Sponsored by Ralph Byers)</td>
</tr>
<tr>
<td>4:00 p.m.</td>
<td>Incremental condition estimation and an application in a local pivoting scheme.</td>
<td>(68) Christian H. Bischof, Argonne National Laboratories, Argonne, Illinois (845-65-23) (Sponsored by Ralph Byers)</td>
</tr>
<tr>
<td>4:30 p.m.</td>
<td>Using the block Lanczos method for parallel optimization.</td>
<td>(69) Stephen G. Nash, George Mason University (845-65-28)</td>
</tr>
</tbody>
</table>

#### AMS Special Session on Control Theory, II

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:30 p.m.</td>
<td>Orbital stability of difference equations. Preliminary report.</td>
<td>(72) David L. Elliott, Washington University (845-93-41)</td>
</tr>
<tr>
<td>4:00 p.m.</td>
<td>Control of Nahm’s nonlinear dynamical system. Preliminary report.</td>
<td>(73) Lawrence Markus, University of Minnesota, Minneapolis (845-93-36)</td>
</tr>
<tr>
<td>4:30 p.m.</td>
<td>Observability, identification and the classical moment problem. Preliminary report.</td>
<td>(74) Clyde F. Martin, Texas Tech University (845-93-17)</td>
</tr>
<tr>
<td>5:00 p.m.</td>
<td>Positive cone controllability for linear control systems with delays. Preliminary report.</td>
<td>(75) M. El-Hodiri and F. S. Van Vleck*, University of Kansas (845-93-58)</td>
</tr>
</tbody>
</table>

#### AMS Special Session on Applications of Set Theory, II

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:30 p.m.</td>
<td>The combinatorics of constructing normal not collectionwise normal manifolds.</td>
<td>(76) Mary Ellen Rudin, University of Wisconsin, Madison (845-04-06)</td>
</tr>
<tr>
<td>4:00 p.m.</td>
<td>Topological applications of reflection. Preliminary report.</td>
<td>(77) Franklin D. Tall, University of Toronto (845-54-67)</td>
</tr>
<tr>
<td>4:30 p.m.</td>
<td>Separation under PMEA.</td>
<td>(78) Peg Daniels, Auburn University at Auburn (845-54-110)</td>
</tr>
<tr>
<td>5:00 p.m.</td>
<td>Combinatorial conditions and collectionwise separation. Preliminary report.</td>
<td>(79) Dennis Burke, Miami University, Oxford (845-54-144)</td>
</tr>
<tr>
<td>5:30 p.m.</td>
<td>Metrizable spaces where the inductive dimensions disagree.</td>
<td>(80) John Kulesza, George Mason University (845-54-105)</td>
</tr>
</tbody>
</table>
### Program of the Sessions

#### AMS Special Session on Operator Theory, II

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:30 p.m.</td>
<td>Tori of divisors and Hardy spaces on multiply connected planar domains</td>
<td>206 Smith Hall</td>
</tr>
<tr>
<td>3:30 p.m.</td>
<td>Kevin F. Clancey, University of Georgia (845-47-86)</td>
<td></td>
</tr>
<tr>
<td>4:00 p.m.</td>
<td>Asymptotic pseudo-differential operators. Preliminary report.</td>
<td></td>
</tr>
<tr>
<td>4:00 p.m.</td>
<td>Jonathan Block, Massachusetts Institute of Technology, and Jeffrey Fox*, University of Colorado, Boulder (845-58-177)</td>
<td></td>
</tr>
<tr>
<td>4:30 p.m.</td>
<td>The Lefschetz theorem for foliated manifolds.</td>
<td></td>
</tr>
<tr>
<td>4:30 p.m.</td>
<td>James L. Heitsch, University of Illinois, Chicago (845-47-100)</td>
<td></td>
</tr>
<tr>
<td>5:00 p.m.</td>
<td>Twistor and Gauss lifts of surfaces in four-manifolds.</td>
<td></td>
</tr>
<tr>
<td>5:00 p.m.</td>
<td>Gary R. Jensen*, Washington University, and Marco Rigoli, I.C.T.P., Miramare-Trieste, Italy (845-53-27)</td>
<td></td>
</tr>
<tr>
<td>5:30 p.m.</td>
<td>Vanishing theorems and index formulas for transversal Dirac operators.</td>
<td></td>
</tr>
<tr>
<td>5:30 p.m.</td>
<td>Jochen Bruening, University of Augsburg, Federal Republic of Germany, and Franz W. Kamber*, University of Illinois, Urbana-Champaign (845-58-178)</td>
<td></td>
</tr>
</tbody>
</table>

#### Saturday, October 29

### AMS Special Session on Numerical Linear Algebra, II

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 a.m.</td>
<td>Rank detection methods in sparse weighted and equality constrained least squares problems.</td>
<td>107 Smith Hall</td>
</tr>
<tr>
<td>8:00 a.m.</td>
<td>Jesse L. Barlow, Pennsylvania State University, University Park (845-65-54) (Sponsored by Ralph Byers)</td>
<td></td>
</tr>
<tr>
<td>8:30 a.m.</td>
<td>Low rank modifications of the spectral factorization.</td>
<td></td>
</tr>
<tr>
<td>8:30 a.m.</td>
<td>Christopher Beattie, Virginia Polytechnic Institute and State University (845-65-22)</td>
<td></td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>The unsymmetric eigenvalue problem: Can HQR be beat?</td>
<td></td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>G. A. Geist, Oak Ridge National Laboratory, Oak Ridge, Tennessee (845-65-38) (Sponsored by Ralph Byers)</td>
<td></td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>Large growth factors in Gaussian elimination with pivoting.</td>
<td></td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>Nicholas J. Higham*, Cornell University, and Desmond J. Higham, University of Toronto (845-65-11) (Sponsored by Ralph Byers)</td>
<td></td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>On the orthogonality of eigenvectors computed by a divide and conquer method.</td>
<td></td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>D. C. Sorensen* and P. T. Tang, Argonne National Laboratory, Argonne, Illinois (845-85-152) (Sponsored by Ralph Byers)</td>
<td></td>
</tr>
</tbody>
</table>

#### AMS Special Session on Geometry-Physics, III

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:30 a.m.</td>
<td>Improving the accuracy of inverse iteration.</td>
<td></td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>E. R. Jessup, Yale University (845-15-42) (Sponsored by Martin Schutz)</td>
<td></td>
</tr>
</tbody>
</table>

#### AMS Special Session on Algebraic Geometry, III

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30 a.m.</td>
<td>Automorphisms of K3-like surfaces with a cuspidal anticanonical curve.</td>
<td>107 Fraser Hall</td>
</tr>
<tr>
<td>8:30 a.m.</td>
<td>Brian Harbourne, University of Nebraska, Lincoln (845-14-18)</td>
<td></td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>Small resolutions of Gorenstein threefold singularities.</td>
<td></td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>Sheldon Katz, Oklahoma State University, Stillwater (845-14-71)</td>
<td></td>
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<tr>
<td>9:30 a.m.</td>
<td>Flatness of tangent cones of a family of varieties.</td>
<td></td>
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<tr>
<td>9:30 a.m.</td>
<td>Gary Kennedy, Oberlin College (845-14-122)</td>
<td></td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>Extremal rational elliptic surfaces in characteristic p.</td>
<td></td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>William E. Lang, Brigham Young University and University of Minnesota, Minneapolis (845-14-114)</td>
<td></td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>On the vanishing of local cohomological modules.</td>
<td></td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Craig Huneke, Purdue University, West Lafayette, and Gennady Lyubeznik*, University of Chicago (845-14-130)</td>
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</tr>
</tbody>
</table>

#### AMS Special Session on Applications of Set Theory, III

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>8:30 a.m.</td>
<td>Measureable graphs.</td>
<td>Pine Room, Kansas Union</td>
</tr>
<tr>
<td>8:30 a.m.</td>
<td>Karel Prikry, University of Minnesota, Minneapolis (845-04-140)</td>
<td></td>
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</tbody>
</table>
### Saturday, October 29 (cont’d)

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 a.m.</td>
<td>Classifying sets of measure zero with respect to their open covers. Winfried Just (*) and Claude Laflamme, University of Toronto (845-04-64)</td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>Preliminary report. Ramsey sets, the Ramsey ideal, and other classes over R. Paul Corazza, University of Wisconsin, Madison (845-03-192)</td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>Atomic Boolean algebras with restricted endomorphisms. Judy Roitman, University of Kansas (845-03-69)</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Some more applications of proper forcing. Preliminary report. Zoltan Balogh, Miami University, Oxford (845-54-145)</td>
</tr>
</tbody>
</table>

**AMS Special Session on Flat Bundles and Geometric Structures, II**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>8:30 a.m.–10:50 a.m.</td>
<td>113 Fraser Hall</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30 a.m.</td>
<td>Real projective surfaces. Preliminary report. Suhyoung Choi, University of Illinois, Urbana-Champaign (845-51-87)</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>Affine geometry and several complex variables. Sidney Frankel, Columbia University (845-32-153) (Sponsored by W. Goldman)</td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>Projective structures with prescribed holonomy. Preliminary report. Daniel Gallo, St. John’s University (845-51-169) (Sponsored by Mark Goldman)</td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>On the local structure of flat bundles over a smooth variety near a variation of Hodge structure. Preliminary report. Richard Hain, University of Washington (845-32-72)</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Spherical CR-structures and their automorphism groups. Preliminary report. Yoshinobu Kamishima, Hokkaido University, Japan (845-57-133)</td>
</tr>
</tbody>
</table>

**AMS Special Session on Operator Theory, III**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>8:30 a.m.–10:50 a.m.</td>
<td>206 Smith Hall</td>
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<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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</thead>
<tbody>
<tr>
<td>8:30 a.m.</td>
<td>Homotopy invariance properties of secondary invariants of certain elliptic operators. Jerome Kaminker, Indiana University-Purdue University, Indianapolis (845-47-197)</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>Analytic isomorphisms of transformation group C*-algebras. Preliminary report. Michael Lamoureux, Dalhousie University (845-47-112)</td>
</tr>
</tbody>
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**AMS Special Session on Commutative Algebra, III**

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>8:30 a.m.–10:50 a.m.</td>
<td>106 Fraser Hall</td>
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<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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</thead>
<tbody>
<tr>
<td>8:30 a.m.</td>
<td>Parametric blowing-up of finite local cohomology rings. Preliminary report. Bernard Johnston (*), University of Utah, and Les Reid, Southwest Missouri State University (845-13-132)</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>On the resolution of singularities. Preliminary report. T. T. Moh, Purdue University, West Lafayette (845-13-03)</td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>The Picard group of the ring of integer-valued polynomials. Preliminary report. Robert Gilmer, Florida State University, William Heinzer (*), Purdue University, West Lafayette, David Lantz, Colgate University, and William Smith, University of North Carolina, Chapel Hill (845-13-57)</td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>Prime ideals in two-dimensional polynomial rings. Preliminary report. William Heinzer, Purdue University, West Lafayette, and Sylvia Wiegand (*), University of Nebraska, Lincoln (845-13-148)</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Generalization of Horrocks’s conjecture for multigraded modules. Hara Chalambous, University of Illinois, Urbana-Champaign (845-13-135)</td>
</tr>
</tbody>
</table>

**AMS Special Session on Potential Theory, II**

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>8:30 a.m.–10:50 a.m.</td>
<td>111 Fraser Hall</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
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</thead>
<tbody>
<tr>
<td>8:30 a.m.</td>
<td>Parabolic measure and the Dirichlet problem for the heat equation in two dimensions. John L. Lewis (*) and Judith A. Silver, University of Kentucky (845-35-129)</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>The Dirac operator and Hardy spaces of Clifford analytic functions on Lipschitz domains. Preliminary report. John E. Gilbert, University of Texas at Austin, and Margaret A. M. Murray (*), Virginia Polytechnic Institute and State University, and University of Minnesota, Minneapolis (845-35-154)</td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>A maximum principle for biharmonic functions. Preliminary report. Jill Pipher, University of Chicago, and Gregory Verchota (*), University of Kentucky (845-35-156)</td>
</tr>
<tr>
<td>Time</td>
<td>Session</td>
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<tr>
<td>10:00 a.m.</td>
<td>Area integral estimates for biharmonic functions.</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Boundary value problems for the parabolic systems ( \mu \Delta u + (\lambda + \mu) \nabla (\nabla u) = \partial u/\partial t ) in Lipschitz cylinders. Preliminary report.</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>AMS Special Session on PDE-Geometric Theory, II</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>Nonlinear boundary value problems of capillary type in corners.</td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>A strong minimizing property of stable extremal hypersurfaces.</td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>An example of nonhomotopic solutions to the Dirichlet problem for harmonic maps in two dimensions.</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Convergence of an approximation scheme for a grad variational problem.</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>AMS Special Session on Control Theory, III</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>Some solvable stochastic control problems in symmetric spaces. Preliminary report.</td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>An example of non-existence of strict sense optimal controls.</td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>Adaptive control of stochastic systems. Preliminary report.</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Analysis of simulated annealing type Markov chains via the orders of recurrence. Preliminary report.</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>AMS Special Session on Real Analysis, II</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>Marczewski sets.</td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>General Cantor set criteria for which ( \sigma )-porous implies porous.</td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>Hausdorff measures and Packing measures.</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Some covering theorems. Preliminary report.</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>AMS Special Session on 3-manifolds, III</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>Knots are determined by their complements.</td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>On contractible open 3-manifolds with periodic ends.</td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>Arithmeticity of knot complements.</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Informal Discussion</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>AMS Session for Contributed Papers, II</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>Three analogs of the Frattini subgroup of a finite group.</td>
</tr>
<tr>
<td>9:20 a.m.</td>
<td>A characterization of the algebras for a locally compact group. Preliminary report.</td>
</tr>
<tr>
<td>9:40 a.m.</td>
<td>Prolongation of differential systems and applications to CR geometry.</td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>Tau numbers, natural density, and Hardy and Wright's Theorem 437.</td>
</tr>
<tr>
<td>11:00 a.m.</td>
<td>AMS Invited Address</td>
</tr>
<tr>
<td>11:00 a.m.</td>
<td>The integrability problems of complex analysis.</td>
</tr>
</tbody>
</table>
### AMS Special Session on Linear Algebra, III

<table>
<thead>
<tr>
<th>Time</th>
<th>Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:30 p.m.</td>
<td>Arnoldi methods for large Sylvester-like observer matrix equation and partial pole placement. Biswa Nath Datta*, Northern Illinois University, and Youcef Saad, University of Illinois, Urbana-Champaign (845-65-74)</td>
</tr>
<tr>
<td>4:00 p.m.</td>
<td>Convergence of block and nested iterative methods for linear systems. Daniel B. Szyld, Duke University (845-15-53)</td>
</tr>
<tr>
<td>4:30 p.m.</td>
<td>Storage schemes for parallel implementations of eigenvalue problem solvers. Robert A. van de Geijn, University of Texas at Austin (845-65-20)</td>
</tr>
<tr>
<td>5:00 p.m.</td>
<td>The unitary eigenproblem. William B. Gragg, Naval Postgraduate School, Monterey, California (845-65-196)</td>
</tr>
</tbody>
</table>

### AMS Special Session on Algebraic Geometry, IV

<table>
<thead>
<tr>
<th>Time</th>
<th>Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:00 p.m.</td>
<td>The structure of an even liaison class. Giorgio Bolondi, Università di Camerino, Italy, and Juan C. Migliore*, Drew University (845-14-97)</td>
</tr>
<tr>
<td>3:30 p.m.</td>
<td>Ghost terms in minimal monads. Preliminary report. A. P. Rao, Northeastern University (845-14-83)</td>
</tr>
<tr>
<td>4:00 p.m.</td>
<td>On theta-divisors with large singular locus. Preliminary report. Roy Smith* and Robert Varley, University of Georgia (845-14-190) (Sponsored by Sheldon Katz)</td>
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<td>4:30 p.m.</td>
<td>The Gauss map on a genus 3 theta divisor. Preliminary report. Robert Varley*, Clint McCrory and Theodore Shifrin, University of Georgia (845-14-189)</td>
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<td>5:00 p.m.</td>
<td>Informal Discussion</td>
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### AMS Special Session on Control Theory, IV

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<tr>
<td>3:00 p.m.</td>
<td>Feedback stabilization of nonlinear, planar control systems. William M. Boothby*, Washington University, and Riccardo Marino, University of Rome II, Italy (845-93-139)</td>
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<td>3:30 p.m.</td>
<td>Predicted miss is optimal: The case of Poisson point observations. Kurt Helmes, University of Kentucky (845-93-193) (Sponsored by T. Duncan)</td>
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<td>Time</td>
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<tr>
<td>4:00 p.m.</td>
<td>Some recent results on controlled Markov processes with singularly perturbed generators. Preliminary report.</td>
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<td>Tomasz Bielecki, University of Kansas (845-93-33)</td>
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<td>(Sponsored by Bozena Pasik-Duncan)</td>
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### AMS Special Session on Applications of Set Theory, IV

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<td>3:00 p.m.</td>
<td>Lattices of compactifications. Preliminary report.</td>
<td>Pine Room, Kansas Union</td>
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<td>Jack R. Porter*, University of Kansas, and R. Grant Woods, University of Manitoba (845-54-99)</td>
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<td>3:30 p.m.</td>
<td>Two non-metric Peano continua.</td>
<td>Pine Room, Kansas Union</td>
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<td>Gary Gruenhage, Auburn University at Auburn (845-54-142)</td>
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<td>4:00 p.m.</td>
<td>Tree-supported iterations.</td>
<td>Pine Room, Kansas Union</td>
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<td>Chaz Schindwein, University of Kansas (845-03-117)</td>
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<td>4:30 p.m.</td>
<td>On countably tight countably compact spaces.</td>
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<td>Alan Dow, York University (845-54-141)</td>
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<td>5:00 p.m.</td>
<td>Informal Discussion</td>
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<td>3:00 p.m.</td>
<td>Differentiable restrictions.</td>
<td>208 Smith Hall</td>
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<td>Jack B. Brown, Auburn University at Auburn (845-26-151)</td>
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<td>3:30 p.m.</td>
<td>Darboux functions with a perfect road.</td>
<td>208 Smith Hall</td>
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<td>Richard G. Gibson, Columbus College (845-26-125)</td>
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<td>4:00 p.m.</td>
<td>Weighted integral inequalities of exponential type.</td>
<td>208 Smith Hall</td>
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<td>Hans P. Heinig, McMaster University (845-44-77)</td>
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<td>4:30 p.m.</td>
<td>Iterates and compositions of almost continuous functions.</td>
<td>208 Smith Hall</td>
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<td>Kenneth R. Kellum, San Jose State University (845-26-150)</td>
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<td>5:00 p.m.</td>
<td>The structure of density continuous functions.</td>
<td>208 Smith Hall</td>
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<td>Preliminary report.</td>
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<td>Krzysztof Ciesielski, Lee Larson and Krzysztof Ostaszewski*, University of Louisville (845-26-04)</td>
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<td>5:30 p.m.</td>
<td>Separately continuous real-valued functions--open questions.</td>
<td>113 Fraser Hall</td>
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<td>Z. Piotrowski, Youngstown State University (845-26-56)</td>
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<td>6:00 p.m.</td>
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### AMS Special Session on Flat Bundles and Geometric Structures, III

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<td>3:00 p.m.</td>
<td>Degenerations of local symmetric structures.</td>
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<td>Preliminary report.</td>
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<td>Karl Luttinian, Stanford University (845-53-63)</td>
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<td>3:30 p.m.</td>
<td>A conjecture concerning discrete groups of Euclidean motions.</td>
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<td>Preliminary report.</td>
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<td>Larry Lok, University of Southern Mississippi (845-51-111)</td>
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<td>4:00 p.m.</td>
<td>New results on harmonic mappings from a compact Kahler manifold to a locally symmetric space.</td>
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<td>James A. Carlson* and Domingo Toledo, University of Utah (845-53-79)</td>
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<td>4:30 p.m.</td>
<td>Informal Discussion</td>
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### AMS Special Session on Operator Theory, IV

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<td>Heat equation and comparison theorems for Riemannian foliations.</td>
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<td>Preliminary report.</td>
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<td>Ernst A. Ruh, Ohio State University, Columbus, and University of Basel, Switzerland, and Philippe Tondeur*, University of Illinois, Urbana-Champaign (845-58-29)</td>
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<td>3:30 p.m.</td>
<td>Toeplitz operators on pseudo-convex domains and foliation C*-algebras.</td>
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<td>Norberto Salinas, Albert J. L. Sheu* and Harald Upmeier, University of Kansas (845-46-90)</td>
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<td>4:00 p.m.</td>
<td>Berger Shaw theorem on algebraic curve.</td>
<td>206 Smith Hall</td>
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<td>Ronald G. Douglas, State University of New York, Stony Brook, and Keren Yan*, University of Iowa (845-47-134)</td>
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<td>4:30 p.m.</td>
<td>Holomorphic Besov spaces and Toeplitz operators.</td>
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<td>Kehe Zhu, University of Waterloo (845-30-09)</td>
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### AMS Special Session on Commutative Algebra, IV

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<td>3:00 p.m.</td>
<td>Betti numbers and the integral closure of ideals.</td>
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<td>Sangki Choi, Purdue University, West Lafayette (845-13-126)</td>
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<td>3:30 p.m.</td>
<td>Multiplicities of adjacent integrally closed ideals in a 2-dimensional RLR. Preliminary report.</td>
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<td>Sunsook Noh, Purdue University, West Lafayette (845-13-88)</td>
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<td>4:00 p.m.</td>
<td>Picard groups of singular affine curves over a perfect field.</td>
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<td>Roger Wiegand, University of Nebraska, Lincoln (845-13-85)</td>
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Program of the Sessions

Saturday, October 29 (cont'd)

4:30 p.m. Partially split double complexes. Preliminary report. 

(189) John A. Eagon, University of Minnesota, Minneapolis 

(845-13-147) (Sponsored by K. K. Tilak A. DeAlwis)

5:00 p.m. Informal Discussion

AMS Special Session on Potential Theory, III

3:00 p.m.–5:20 p.m. 111 Fraser Hall

3:00 p.m. Lp estimates for elliptic p.d.e. Preliminary report. 

(190) Carlos E. Kenig, University of Chicago (845-35-158)

3:20 p.m. Parabolic measure and the Dirichlet problem for the 

heat equation. 

Jang-Mei Wu, University of Illinois, Urbana-Champaign (845-35-47)

4:00 p.m. Harmonic measure and arclength. 

(191) Christopher J. Bishop*, University of California, Los 

Angeles, and Peter W. Jones, Yale University 

(845-31-92)

4:30 p.m. Sharp good->. inequalities for area functions and 

maximal functions. 

Rodrigo Bañuelos, Purdue University, West 

Lafayette, and Charles Moore*, Washington 

University (845-42-165)

5:00 p.m. Informal Discussion

AMS Special Session on 3-manifolds, IV

3:00 p.m.–5:00 p.m. 112 Fraser Hall

3:00 p.m. Producing reducible 3-manifolds by surgery on a knot. 

(194) Martin Scharlemann, University of California, Santa 

Barbara (845-57-91)

3:30 p.m. Involutions on non-irreducible 3-manifolds. 

(195) John Kalliongis, Saint Louis University (845-57-58)

4:00 p.m. 3-manifolds as branched covers of S3 branched over 

the figure eight knot. 

John Hempel, Rice University (845-57-176)

4:30 p.m. Problem Session

AMS Session for Contributed Papers, III

3:00 p.m.–4:40 p.m. Parlor A, Kansas Union

3:00 p.m. A player's chances of winning a tennis game and its 

expected length. 

Curtis N. Cooper* and Robert E. Kennedy, Central 

Missouri State University (845-60-124)

3:20 p.m. The character curve of a two-bridge knot. 

(196) David C. Boyles, St. Louis University (845-57-160)

3:40 p.m. Affine geometry and the Lorentz Force Law. 

(197) Geoffrey Martin, North Dakota State University, 

Fargo (845-83-161)

4:00 p.m. Canonical invariants for corresponding residue 

systems in p-adic fields. 

Steven R. Benson, St. Olaf College (845-12-172)

4:20 p.m. Determining vanishing k-fold products on closed 

braids. 

Stefanos Giatamas, University of Wisconsin, 

Oshkosh (845-55-188)

Andy Roy Magid 

Associate Secretary 

Norman, Oklahoma
Presenters of Papers

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

- AMS Invited Lecturer
- Special Session Speaker

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Can you identify these prominent members of the mathematical community? Learn their identities in
I HAVE A PHOTOGRAPHIC MEMORY
by Paul R. Halmos

He knows about cohomology groups of algebras

An algebraist and number theorist with more than one name

Paul R. Halmos, eminent mathematician and brilliant expositor, is also a snapshot addict. For the past 45 years, Halmos has snapped mathematicians, their spouses, their brothers and sisters and other relatives, their offices, their dogs, and their carillon towers.

From 6000 or so photographs, Halmos has chosen about 600 for this book. The pictures are candid shots showing mathematicians just being themselves, and the accompanying captions, in addition to identifying the subjects, include anecdotes and bits of history that reveal Halmos' inimitable wit, charm, and insight. This delightful collection of mathematical memorabilia is certain to become a favorite browsing book as well as a valuable historical record.
Claremont, California
Claremont McKenna College
November 12–13

Program

The eight-hundred-and-forty-sixth meeting of the American Mathematical Society will be held at Claremont McKenna College, Claremont, California, on Saturday and Sunday, November 12 and 13, 1988.

Invited Addresses

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, there will be three invited one-hour addresses. The speakers, their affiliations, and titles follow:

- **WILLIAM JACOB**, Oregon State University, Galois cohomology and K-theory: Applications to division algebras and quadratic forms.
- **FRANCIS BONAHON**, University of Southern California, Riemann surfaces and measured laminations.

Special Sessions

By invitation of the same committee, there will be five special sessions of selected twenty-minute papers. The topics, names and affiliations of the organizers and a list of tentative speakers are:

- **Low dimensional geometry**, FRANCIS BONAHON and DAVID GABAI, California Institute of Technology. Speakers include: David M. Austin, Peter J. Braam, Daryl Cooper, David Gabai, Joel Hass, Steven Kerckhoff, Eric Klassen, D. D. Long, Darryl McCullough, R. C. Penner, Martin Scharlemann, Ron Stern, and Shicheng Wang.
- **Computers and software in mathematical research**, ROBERT BORRELLI, Harvey Mudd College, and COURTNEY S. COLEMAN, Harvey Mudd College. Speakers are Frederick Dashiell, Jr., David C. Fisher, Ned Freed, Alfred Inselberg, Charles Lawson, and Robert Valenza.


Division rings, WILLIAM JACOB and ADRIAN WADSWORTH, University of California, San Diego. Speakers include Altha Blanchet, Thomas Craven, Frank DeMeyer, Dennis R. Estes, Burton Fein, Larry J. Gerstein, Darrell Haile, T.-Y. Lam, Jan Minac, Patrick J. Morandi, Alex Rosenberg, David J. Saltman, Murray Schacher, Olga Taussky-Todd, Roger Ware, and Sergey Yuzvinsky.

Contributed Papers

There will also be sessions for contributed ten-minute papers.

Activities of Other Organizations

The Southern California section of the Mathematical Association of America will meet on Saturday, November 12. An AMS-MAA Joint Invited Addresses will be delivered by LEONARD GILLMAN, University of Texas, Austin, and President of MAA at 1:45 p.m titled Mathematics and the public. MAA Invited Addresses will include REUBEN HERSH, University of New Mexico, Mathematics and ethics, 9:00 a.m., and MARVIN MARCUS, University of California at Santa Barbara, The Numerical Range, at 1:00 p.m. There will be a luncheon at noon in the Athaeneum; the cost is $8. SOLOMON GOLOMB, University of Southern California, will speak on Reflections of a mathematician. Tickets are to be purchased in advance from John Ferling of Claremont McKenna College.
Meetings

There will be two sessions for MAA Contributed Papers titled *Mathematical notes and classroom capsules* and *Mathematics as a humanistic discipline* from 10:00 a.m.-11:50 a.m.

Registration

The meeting registration desk will be located in the lobby of Bauer Center. The desk will be open from 8:30 a.m. to 2:00 p.m. on both Saturday and Sunday, November 12 and 13. The registration fees are $30 for both days for members of the AMS, $45 for nonmembers, and $10 for students and unemployed mathematicians. There is a special one-day fee for MAA members on Saturday only of $15.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Atlanta meeting announcement on page 68 of the January issue of *Notices*.

Accommodations

Rooms have been blocked at the following hotels and motels. Participants should make their own reservations directly with the hotel of their choice, identifying themselves as attending the American Mathematical Society’s meeting at Claremont McKenna College. Rates quoted do not include applicable taxes and are subject to change.

Shuttle service from and to Ontario International Airport is provided free of charge. The driving time is 15 to 20 minutes.

Griswold’s Inn (walking distance)

555 West Foothill Boulevard
(Corner of Indian Hill Boulevard)
Claremont, CA 91711
Telephone: 800-854-5733 (except California), 800-821-0341 (in California) or 714-626-2411

Rooms (1-4 persons): $60 plus tax

Rooms must be reserved before October 21.

Ramada Inn (2.5 miles)

840 South Indian Hill Boulevard
(Next to San Bernadino Freeway-Interstate 10)
Claremont, CA 91711
Telephone: 800-228-2828 or 714-621-4831

Rooms (1-2 guests): $49 plus tax
Additional person: $6 per night

Food Service

The hotels listed above have their own restaurants. In addition, there are many good restaurants in Claremont and the surrounding area. A list will be provided at the meeting.

Travel

Claremont is located 35 miles east of Los Angeles. Most major airlines serve Ontario International Airport (California). The drive from LAX is slow on Friday afternoons, but not as slow on Saturdays and Sundays.

To get to the Bauer Center of Claremont McKenna College where registration and meetings will be held, you should head west on 9th Street from Claremont Boulevard. Please refer to the accompanying map.

Parking

Parking is available in the lots on the south side of 9th Street on the Claremont McKenna College campus.
NOW AVAILABLE

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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 approximately 9,600 pages, it is an important addition to any mathematics library.

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- locate, under each subject index heading, all items having this classification as either a primary or a secondary classification

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## 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 October 1988 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.

ALL SESSIONS WILL BE HELD IN BAUER CENTER.

### Saturday, November 12

**AMS Special Session on Low Dimensional Geometry, I**

<table>
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<th>Time</th>
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<th>Room</th>
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<tr>
<td>8:30 a.m.</td>
<td>Transverse recurrence of train tracks.</td>
<td>R. C. Penner, University of Southern California</td>
<td>(846-57-44)</td>
<td>23</td>
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<tr>
<td>9:00 a.m.</td>
<td>Representations in SU(2) of fundamental groups of doubled knots.</td>
<td>Eric Klassen, California Institute of Technology</td>
<td>(846-57-48)</td>
<td>23</td>
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<tr>
<td>9:30 a.m.</td>
<td>Z/pZ invariant instantons on S^4.</td>
<td>David M. Austin, University of Utah</td>
<td>(846-53-20)</td>
<td>23</td>
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**AMS Special Session on Differential and Difference Equations, I**

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<th>Room</th>
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<tr>
<td>8:30 a.m.</td>
<td>Monotone flows generated by non-quasimonotone systems of delay equations.</td>
<td>Hal L. Smith* and H. Thieme, Arizona State University</td>
<td>(846-34-17)</td>
<td>23</td>
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<tr>
<td>9:00 a.m.</td>
<td>Hopf bifurcation for a 2-delay linear differential equation.</td>
<td>Joseph M. Mahaffy, San Diego State University</td>
<td>(846-38-61)</td>
<td>23</td>
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<tr>
<td>9:30 a.m.</td>
<td>An epidemiological model with time delay.</td>
<td>P. Van Den Driessche, University of Victoria</td>
<td>(846-34-16)</td>
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**AMS Special Session on Division Rings, I**

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<tr>
<td>8:30 a.m.</td>
<td>Function fields of generalized Brauer-Severi varieties.</td>
<td>Altha Blanchet, University of Texas at Austin</td>
<td>(846-16-18)</td>
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**AMS Special Session on Low Dimensional Geometry, II**

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<tr>
<td>8:30 a.m.</td>
<td>Minimal embeddings of central simple algebras.</td>
<td>Burt Fein, Oregon State University, David Saltman,</td>
<td>(846-16-77)</td>
<td>22</td>
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<tr>
<td>9:00 a.m.</td>
<td>The Witt ring of Q.</td>
<td>Frank DeMeyer*, Colorado State University, and David Harrison, University of Oregon</td>
<td>(846-12-08)</td>
<td>22</td>
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**MAA Invited Address**

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<td>9:00 a.m.</td>
<td>Mathematics and ethics.</td>
<td>Reuben Hersh, University of New Mexico</td>
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**AMS Invited Address**

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<td>10:00 a.m.</td>
<td>Riemann surfaces and measured laminations.</td>
<td>Francis Bonahon, University of Southern California</td>
<td>(846-57-06)</td>
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**AMS Invited Address**

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<td>11:00 a.m.</td>
<td>Galois cohomology and K-theory; applications to division algebras and quadratic forms.</td>
<td>Bill Jacob, Oregon State University</td>
<td>(846-12-38)</td>
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**AMS-MAA Invited Address**

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<td>1:45 p.m.</td>
<td>Mathematics and the public.</td>
<td>Leonard Gillman, University of Texas at Austin</td>
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## Saturday, November 12 (cont'd)

### MAA Invited Address

**2:45 p.m.–3:35 p.m.** Bauer Lecture Hall

- **2:45 p.m.** The numerical range.
  - **(14)** Marvin Marcus, University of California, Santa Barbara

### AMS Special Session on Low Dimensional Geometry, II

**2:45 p.m.–5:05 p.m.** Room 23

- **2:45 p.m.** The geometry of magnetic monopoles.
  - **(15)** Peter J. Braam, University of Utah (846-58-55)
- **3:15 p.m.** Instanton polynomials of homology three spheres.
  - **(16)** Preliminary report. Ronald J. Stern*, University of Utah, and Ronald Fintushel, Michigan State University (846-57-76)
- **3:45 p.m.** Discussion
- **4:15 p.m.** Representation spaces and low-dimensional topology.
  - **(17)** Preliminary report. Steven Kerckhoff, Stanford University (846-57-62)
- **4:45 p.m.** Discussion

### AMS Special Session on the Spectrum of the Laplacian, I

**2:45 p.m.–5:05 p.m.** Room 25

- **2:45 p.m.** A compactness theorem for conformal metrics on 3-manifolds and application to isospectral metrics.
- **3:15 p.m.** Isospectral higher rank locally symmetric spaces.
- **3:45 p.m.** Twisted trace formulas. Preliminary report.
- **4:15 p.m.** The scattering matrix and the Selberg zeta function for a Kleinian group. Preliminary report.
  - **(27)** Peter Perry, University of Kentucky (846-53-57)
- **4:45 p.m.** Independent paths in expanding graphs. Preliminary report.

### AMS Special Session on Differential and Difference Equations, II

**2:45 p.m.–6:35 p.m.** Forum

- **2:45 p.m.** Some stability results for systems of advection-diffusion equations.
  - **(29)** F. A. Howes, University of California, Davis (846-35-05)
- **3:10 p.m.** Blow up for the diffusion-advection equation.
  - **(30)** Nicholas D. Alikakos, University of Tennessee, Knoxville (846-35-10) (Sponsored by Stavros N. Busenberg)
- **3:35 p.m.** Free boundary problems arising from stress-driven diffusion in polymers.
  - **(31)** Donald S. Cohen, California Institute of Technology (846-35-13)
- **4:00 p.m.** Quasilinear systems of reaction diffusion equations.
  - **(32)** Preliminary report. W. E. Fitzgibbon*, University of Houston, University Park, J. J. Morgan, Texas A & M University, College Station, and S. J. Waggner, Furman University (846-35-04)
- **4:25 p.m.** Lipschitz perturbations of non-densely defined generators. Preliminary report.
  - **(33)** Horst R. Thieme, Arizona State University (846-35-02) (Sponsored by Stavros N. Busenberg)
- **4:45 p.m.** Discussion
- **5:00 p.m.** Discontinuous solutions of singularly perturbed systems.
  - **(34)** Jane Cronin Scanlon, Rutgers University, New Brunswick (846-34-21)
- **5:25 p.m.** Conjugate points of generalized fourth order differential equations.
  - **(35)** Kurt Kreith, University of California, Davis (846-34-07)
### Program of the Sessions

<table>
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| 5:50 p.m.  | An ergodic theorem for a class of nonlinear matrix difference equations. Preliminary report.  
J. M. Cushing, University of Arizona (846-92-26) |
| 6:15 p.m.  | Periodic solutions of a nonlinear resonance problem whose nonlinearities have linear growth. Preliminary report.  
Edward M. Landesman*, University of California, Santa Cruz, and Victor L. Shapiro, University of California, Riverside (846-34-37) |
| 2:45 p.m.-4:35 p.m. | **AMS Special Session on Division Rings, II** |
| 2:45 p.m.  | A generalization of Q-admissibility. Preliminary report.  
Burton Fein*, Oregon State University, and Murray Schacher, University of California, Los Angeles (846-20-34) |
| 3:15 p.m.  | Value functions and Dubrovin valuation rings on central simple algebras.  
Patrick J. Morandi, University of Texas at Austin (846-16-29) |
| 3:45 p.m.  | Division algebras over Henselian surfaces. Preliminary report.  
Tim Ford, Florida Atlantic University, and David J. Saltman*, University of Texas at Austin (846-16-47) |
| 4:15 p.m.  | Clifford algebras and conjugate splittings.  
Darrell Haile, Indiana University (846-16-51) |
| 2:45 p.m.-4:10 p.m. | **AMS Session on Contributed Papers** |
| 2:45 p.m.  | Free products of finite groups as automorphisms of a subshift of finite type. Preliminary report.  
Roger C. Alperin, San Jose State University (846-20-85) |
| 3:00 p.m.  | Unified signal algebras for algebraic coding.  
C. R. Giardina, College of Staten Island, City University of New York, the Electronic System and Data Communication Corporation (846-34-33) |
| 3:15 p.m.  | Covering a closed curve with a given total curvature. Preliminary report.  
Mostafa Ghanehari, Naval Postgraduate School (846-52-49) |
| 3:30 p.m.  | If f has Lipschitz constant less than 2.17008, then \[ x_{n+1} = x_n + f(x_n) \] has no odd periodic solutions.  
Roderick N. Lee* and David C. Fisher, Harvey Mudd College, and Elizabeth Knowles, University of California, Riverside (846-39-64) (Sponsored by Courtney S. Coleman) |
| 3:45 p.m.  | Laws of large numbers for \( D(R_+). \)  
| 4:00 p.m.  | Several rigorous counterexamples about Saint-Venant’s principle.  
Chenggui Huang, Tianjin Normal University, People’s Republic of China (846-73-80) (Sponsored by Lance W. Small) |

### Sunday, November 13

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<td>3:30 a.m.-9:50 a.m.</td>
<td><strong>AMS Special Session on Low Dimensional Geometry, III</strong></td>
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| 8:30 a.m.  | In hyperbolic space of dimension more than 2, quasi-isometries are almost isometries.  
Daryl Cooper, University of California, Santa Barbara (846-51-27) |
| 9:00 a.m.  | Open Problems |
| 9:30 a.m.  | Laminations transverse to finite depth foliations on 3-manifolds.  
David Gabai, California Institute of Technology (846-57-36) |
| 8:30 a.m.-9:40 a.m. | **AMS Special Session on Differential and Difference Equations, III** |
| 8:30 a.m.  | Meinkov transforms, Bernoulli bundles, and almost periodic perturbations.  
Kenneth R. Meyer, University of Cincinnati, and George R. Sell*, University of Minnesota, Minneapolis (846-34-50) |
| 8:55 a.m.  | Periodic perturbations of linear problems at resonance on convex domains. Preliminary report.  
Klaus Schmitt*, University of Utah, and Renate Schaefer, Universitat Heidelberg, West Germany (846-35-15) |
| 9:20 a.m.  | Chaos in almost periodic systems.  
Kenneth Palmer*, University of Miami, and Daniel Stoffer, Swiss Federal Institute of Technology, Switzerland (846-34-03) |
| 8:30 a.m.-9:50 a.m. | **AMS Special Session on Division Rings, III** |
| 8:30 a.m.  | Witt groups of Hermitian forms over *-fields.  
Thomas C. Craven, University of Hawaii, Honolulu (846-16-14) |
| 9:00 a.m.  | Witt rings and almost free pro-2-groups.  
Roger Ware, Pennsylvania State University, University Park (846-12-42) |
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<tr>
<td>9:30 a.m.</td>
<td>Diagonalization of quadratic forms over affine curves. Preliminary report.</td>
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<td></td>
<td>Leonardo Legorreta and Sergey Yuzvinsky*, University of Oregon (846-13-28)</td>
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<tr>
<td>10:00 a.m.</td>
<td>AMS Invited Address</td>
<td>Bauer Lecture Hall</td>
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<td>Robert Brooks, University of Southern California (846-58-23)</td>
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<tr>
<td>11:00 a.m.-12:20 p.m.</td>
<td>AMS Special Session on Low Dimensional Geometry, IV</td>
<td>Room 23</td>
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<tr>
<td>11:00 a.m.</td>
<td>Finiteness of Heegaard splittings for certain manifolds.</td>
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<td></td>
<td>Joel Hass, University of California, Davis (846-57-43)</td>
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<tr>
<td>11:30 a.m.</td>
<td>Straight subgroups in surface groups. Preliminary report.</td>
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<tr>
<td></td>
<td>D. D. Long, University of California, Santa Barbara (846-57-24)</td>
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<tr>
<td>12:00 noon</td>
<td>Group actions on nonclosed 2-manifolds.</td>
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<tr>
<td></td>
<td>Darryl McCullough* and Andy Miller, University of Oklahoma, and Bruno Zimmermann, University of Trieste, Italy (846-57-35)</td>
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</tr>
<tr>
<td>11:00 a.m.-12:20 p.m.</td>
<td>AMS Special Session on The Spectrum of the Laplacian, II</td>
<td>Room 25</td>
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<tr>
<td>11:00 a.m.</td>
<td>Inverse spectral problem for the Schrödinger equation with periodic vector potential. Preliminary report.</td>
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<td></td>
<td>Gregory Eskin, University of California, Los Angeles (846-35-39)</td>
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<tr>
<td>11:30 a.m.</td>
<td>Large time heat diffusion in Riemannian manifolds.</td>
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<td></td>
<td>Isaac Chavel*, City College, City University of New York, and Edgar A. Feldman, Graduate School and University Center, City University of New York (846-58-61)</td>
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<tr>
<td>12:00 noon</td>
<td>Homology of abelian covers. Preliminary report.</td>
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<tr>
<td></td>
<td>Peter Sarnak, Stanford University (846-58-73)</td>
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<tr>
<td>12:30 p.m.</td>
<td>Isospectrality and Fourier integral operators. Preliminary report.</td>
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<td></td>
<td>Steven Zelditch, Johns Hopkins University (846-58-58) (Sponsored by Robert Brooks)</td>
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AMS Special Session on Differential and Difference Equations, IV

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<tr>
<td>11:00 a.m.-12:35 p.m.</td>
<td>accelerated convergence and invariant manifolds in the methods of averaging for quasi-periodic motions. Shui-Nee Chow* and Ke-ning Lu, Georgia Institute of Technology (846-34-32)</td>
<td>Forum</td>
</tr>
<tr>
<td>11:25 a.m.</td>
<td>Sufficient conditions for the oscillation of difference equations.</td>
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<td></td>
<td>Gerry Ladas, University of Rhode Island (846-39-12)</td>
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<tr>
<td>11:50 a.m.</td>
<td>Generalized Hopf bifurcation.</td>
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<td>Russell A. Johnson, University of Southern California (846-34-01)</td>
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AMS Special Session on Division Rings, IV

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<tr>
<td>11:00 a.m.-12:20 p.m.</td>
<td>fans, quasifans and their reduced Witt rings. E. Becker, University of Dortmund, Federal Republic of Germany, C. Mulcahy, Emory University, and Alex Rosenberg*, University of California, Santa Barbara (846-12-40)</td>
<td>Room 22</td>
</tr>
<tr>
<td>11:30 a.m.</td>
<td>Generalized orderings and quadratic forms.</td>
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<td></td>
<td>Ján Minác, University of California, Berkeley (846-12-53)</td>
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<tr>
<td>12:00 noon</td>
<td>Division algebras and quadratic forms.</td>
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<td>Olga Taussky-Todd, California Institute of Technology (846-16-54)</td>
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AMS Special Session on Low Dimensional Geometry, V

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<tr>
<td>2:00 p.m.-3:20 p.m.</td>
<td>putting sutures on 3-manifold boundaries. Martin Scharlemann, University of California, Santa Barbara (846-57-56)</td>
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<td>2:30 p.m.</td>
<td>Discussion</td>
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<td>3:00 p.m.</td>
<td>Cyclic surgery on knots. Preliminary report.</td>
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<td>Shicheng Wang, University of California, Los Angeles (846-57-41)</td>
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<tr>
<td>2:00 p.m.-3:50 p.m.</td>
<td>upper bounds for eigenvalues. Peter Doyle, Princeton University (846-58-78)</td>
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<td>2:30 p.m.</td>
<td>Distinguishing geometric properties of some isospectral families of metrics.</td>
<td>Dennis Deturck and Herman Gluck, University of Pennsylvania, and Carolyn Gordon* and David Webb, Washington University (846-53-45)</td>
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<tr>
<td>3:00 p.m.</td>
<td>Compact isospectral sets of plane domains.</td>
<td>Brad Osgood, Stanford University (846-58-60)</td>
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<td>3:30 p.m.</td>
<td>On triangular membranes. Preliminary report.</td>
<td>B. A. Troesch, University of Southern California (846-58-30)</td>
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**AMS Special Session on Differential and Difference Equations, V**

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<td>2:00 p.m.-3:35 p.m.</td>
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<td>2:00 p.m.</td>
<td>Uniform difference schemes of arbitrary order for singularly perturbed problems.</td>
<td>A. Ashyraliev, Turkmen State University, U.S.S.R., and H. O. Fattorini*, University of California, Los Angeles (846-35-11)</td>
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<tr>
<td>2:25 p.m.</td>
<td>Convergence of Galerkin approximations for operator Riccati equations—a nonlinear evolution equation approach.</td>
<td>I. G. Rosen, University of Southern California (846-47-09) (Sponsored by H. A. Antosiewicz)</td>
</tr>
<tr>
<td>2:50 p.m.</td>
<td>Invariant manifolds of dynamical systems and their numerical calculation. Preliminary report.</td>
<td>Jens Lorenz, California Institute of Technology (846-34-19)</td>
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<td>3:15 p.m.</td>
<td>Convergence of fluctuating dynamics to the mean field.</td>
<td>Morris W. Hirsch, University of California, Berkeley (846-34-22)</td>
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<td>2:00 p.m.</td>
<td>Indecomposable quadratic forms.</td>
<td>Larry J. Gerstein, University of California, Santa Barbara (846-11-46)</td>
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<td>2:30 p.m.</td>
<td>On dihedral extensions of degree 8. Preliminary report.</td>
<td>T. Y. Lam*, University of California, Berkeley, David B. Leep, University of Kentucky, and J.-P. Tignol, Université Catholique de Louvain, Belgium (846-12-66)</td>
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<tr>
<td>3:00 p.m.</td>
<td>Factorization in quaternion orders. Preliminary report.</td>
<td>Dennis R. Estes*, University of Southern California, and Gordon Nipp, California State University, Los Angeles (846-11-52)</td>
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Lance W. Small  
Associate Secretary  
La Jolla, California
Presenters of Papers

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THEORIE DES VARIETES MINIMAI-ES ET APPLICATIONS (MINIMAL SUBMANIFOLDS)
SEMINAIRE PALAISEAU
(Asterisque, Number 154-155)

The study of minimal submanifolds is by now established as one of the deep and esthetically appealing parts of mathematics. It combines in an exemplary fashion geometric and analytical techniques both of a classical and of a more modern nature. In recent years it became a powerful tool to investigate the internal geometry of manifolds, a subject of interest today to both mathematicians and theoretical physicists.

This volume, devoted to notes of a seminar held from October 1983 to June 1984 under the direction of H. B. Lawson Jr. at Ecole Polytechnique in Palaiseau, presents recent contributions to the theory of minimal submanifolds in their diversity. It starts with an elementary approach to the subject, hence is appropriate as a source book for a graduate seminar.

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Phoenix Meetings
January 11–14, 1989

Preliminary Announcement

The January 1989 Joint Mathematics Meetings, including the 95th Annual Meeting of the AMS, the 72nd Annual Meeting of the Mathematical Association of America, and the 1989 annual meetings of the Association for Women in Mathematics and the National Association for Mathematicians will be held January 11–14 (Wednesday–Saturday), 1989, in Phoenix, Arizona. MAA will cosponsor a session on Thursday, January 12, with the National Council for Teachers of Mathematics (NCTM). Sessions will take place in the Hyatt Regency Phoenix and the Phoenix Civic Plaza.

The members of the Local Arrangements Committee are Andrew Bremner, Joaquin Bustoz, Matthew J. Hassett, William H. Jaco (ex-officio), Joan McCarter, John N. McDonald (chairman), Kenneth A. Ross (ex-officio), Lance W. Small (ex-officio), William T. Trotter, Jr.

AMS-MAA Invited Addresses

By invitation of the AMS-MAA Joint Program Committee (Sheldon Axler, Linda Keen (chairman), Carl Pomerance, and Nolan Wallach), four speakers will address the AMS and MAA on the history and development of mathematics. The names of the speakers, their affiliations, the titles, dates, and times of their talks follow:

RALPH P. BOAS, Northwestern University, Indeterminate forms revisited, 11:10 Saturday;
RONALD L. GRAHAM, AT&T Bell Laboratories, Arithmetic progressions: from Hilbert to Shelah, 11:10 a.m. Friday;
CATHELINE S. MORAWTEZ, Courant Institute of Mathematical Sciences, New York University, The mathematics of transonic flow, 11:10 a.m. Thursday;
STEPHEN SMALE, University of California, Berkeley, Story of the higher dimensional Poincare conjecture (What really happened on the beaches of Rio de Janeiro), 11:10 a.m. Wednesday.

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95th Annual Meeting of the AMS
January 11–14, 1989

Sixty-Second Josiah Willard Gibbs Lecture
The 1989 Gibbs lecture will be presented at 8:30 p.m. on Wednesday, January 11, by ELLIOTT H. LIEB of Princeton University. The title of his lecture will be announced later.

Colloquium Lectures
There will be a series of four Colloquium Lectures presented by NICHOLAS KATZ of Princeton University. The title of this lecture series will be announced later. The lectures will be given at 1:00 p.m. daily, Wednesday through Saturday, January 11–14.

Prizes
The 1989 Maxime Bôcher Memorial Prize will be awarded at 4:25 p.m. on Thursday, January 12.

Invited Addresses
By invitation of the Program Committee, there will be seven fifty-minute invited addresses. The names of the speakers, their affiliations, the dates and times of their talks, and some of the titles follow:

LENORE BLUM, Mills College, Computing over the reals or any arbitrary rings, 3:20 p.m. Thursday;

JOHN H. CONWAY, Princeton University, Old and new facts about surreal numbers, 9:00 a.m. Friday;

PERCY ALEC DEIFT, Courant Institute of Mathematical Sciences, New York University, title to be announced, 9:00 a.m. Wednesday;

DAVID FRIED, Boston University, Periodic orbits and determinants, 4:25 p.m. Saturday;

PETER LANDWEBER, Rutgers University, title to be announced, 2:15 p.m. Thursday;

DIANA FROST SHELSTAD, University of Utah, Salt Lake City, title to be announced, 2:15 p.m. Saturday;

LUC TARTAR, Carnegie Mellon University, title to be announced, 3:20 p.m. Saturday.

Special Sessions
By invitation of the same committee, there will be thirteen special sessions of selected twenty-minute papers. The topics of these special sessions, the names and affiliations of the mathematicians arranging them, and the dates and times they will meet, are as follows:

Mathematics of nonlinear science, MELVYN S. BERGER, University of Massachusetts, Amherst, Wednesday 2:15 p.m., Friday 1:00 p.m., Saturday 8:00 a.m.

Foundations of complexity theory for numerical analysis, LENORE BLUM, Mills College, Saturday 8:00 a.m. and 12:15 p.m.

Surreal numbers, JOHN H. CONWAY, HARRY GONSHOR, Rutgers University, and MARTIN KRUSKAL, Princeton University, Thursday 8:00 a.m., Friday 1:00 p.m., Saturday 8:00 a.m.

Integrable systems, PERCY ALEC DEIFT, Wednesday 2:15 p.m., Thursday 8:00 a.m., Friday 1:00 p.m.

Commutative algebra and algebraic geometry, DAVID EISENBUD, Brandeis University and CRAIG HUNEKE, Purdue University, Thursday 8:00 a.m., Friday 1:00 p.m., Saturday 8:00 a.m.

Geometry of hyperbolic dynamical systems, DAVID FRIED and JOSEPH CHRISTIE, Emory University, Wednesday 2:15 p.m., Thursday 8:00 a.m., Friday 1:00 p.m.

Computational group theory, LARRY C. GROVE, University of Arizona, Tucson, and M. F. NEWMAN, Australia National University, Monday 2:15 p.m., Thursday 8:00 a.m., Saturday 8:00 a.m.

Singular perturbation theory, WILLIAM A. HARRIS, University of Southern California, Wednesday 2:15 p.m., Thursday 8:00 a.m., Saturday 8:00 a.m.

History of mathematics, VICTOR J. KATZ, University of the District of Columbia and FLORENCE FASANELLI, National Science Foundation, Wednesday 2:15 p.m., Thursday 8:00 a.m., Friday 1:00 p.m.

Computational aspects of complex analysis, ALBERT MARDE'N, University of Minnesota, Minneapolis, and BURTON RODIN, University of California, San Diego.
Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in departments of mathematics, and should be sent to Abstracts, Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, so as to arrive by the abstract deadline of October 12, 1988. A charge of $16 is imposed for retyping abstracts that are not in camera-ready form.

Late papers will not be accepted.

Other AMS Sessions

AMS Committee on Science Policy
Special Presentation

A special presentation sponsored by the AMS Committee on Science Policy will take place on Friday, January 13, at 9:00 p.m. Speakers include James M. Hyman, Los Alamos National Laboratory, Using mathematical models to understand the AIDS epidemic, and Beverly Berger, Office of Science & Technology Policy, Mathematical models and public policy development: A view from the White House.

Banquet for 25-Year Members

The AMS will hold a banquet to honor individuals who have been members of the Society for twenty-five years or more. This is the first such banquet to recognize long-time members of the Society and the plan is to continue this function at future Annual Meetings. These banquets will provide an opportunity for people to meet in a social atmosphere to continue, renew or create new friendships. This year, the retiring secretary of the AMS, Everett Pitcher, is the principle speaker at the banquet. The banquet will be held on Saturday, January 14, with a cash bar at 7:00 p.m. and dinner at 7:30 p.m. The location will be announced in the program. All meeting participants are invited to attend.

The menu includes chicken breast marinated in lemon and grilled with peppercorns, tossed green salad, vegetable, starch, rolls and butter, apple walnut torte, coffee, tea, and decaffeinated coffee.

Please note that all tickets for this banquet must be purchased through preregistration, since a guarantee must be given to the caterer. Tickets are $25 each; the price includes the gratuity. Interested participants should complete the appropriate section of the Preregistration/Housing Form. In the event of cancellations, a 50% refund of the amount paid for the ticket will be made if notification is received in Providence prior to December 30. After that date, no refund can be made.

Council Meeting

The Council of the Society will meet at 5:00 p.m. on Tuesday, January 10.

Business Meeting

The Business Meeting of the Society will take place immediately following the award of the Bôcher Prize at 4:25 p.m. on Thursday, January 12. The secretary notes the following resolution of the Council: Each person who
meets a Business Meeting of the Society shall be willing
and able to identify himself as a member of the Society.
In further explanation, it is noted that each person who is
to vote at a meeting is thereby identifying himself as and
claiming to be a member of the American Mathematical
Society. For additional information on the Business
Meeting, please refer to the box titled Committee on the
Agenda for Business Meetings.

Other Joint AMS–MAA Sessions

AMS-MAA Committee on Employment
and Educational Policy

A panel discussion on Recruiting for graduate programs
in mathematics will be sponsored by the AMS-MAA
Committee on Employment and Educational Policy
(CEEP) on Saturday, January 14 at 4:30 p.m. Moderated
by EDWARD A. CONNORS (University of Massachusetts,
Amherst), the panelists include JOHN M. JOBE (Oklahoma
State University), RHONDA J. HUGHES (Bryn Mawr Col-
lege), PAUL D. HUMKE (St. Olaf College), and RALPH N.
McKENZIE (University of California, Berkeley).

AMS-MAA TA/PTI Workshop

The joint AMS-MAA Committee on TA/PTI
(Training Assistants and Part-Time Instructors) will
sponsor a workshop on Saturday, January 14. Further
information about the workshop can be found elsewhere
in this announcement.

Presidents’ Concert

A special concert will be given by WILLIAM BROWDER
(flute) and LEONARD GILLMAN (piano), presidents of the
AMS and MAA, at 5:30 p.m. on Saturday, January 14.
The tentative program is: Sonata in G Minor by J. S.
Bach, Sonata by Francis Poulenc, and Introduction and
Variations by Franz Schubert.

72nd Annual Meeting of the MAA
January 11–14, 1989

Hedrick Lectures

The 36th Earle Raymond Hedrick Lectures will be given
by DON BERNARD ZAGIER of Max Planck Institute and
the University of Maryland, College Park. The title of
this series is Zeta functions in number theory. These
lectures will be given at 10:05 a.m. on Wednesday,
Thursday and Friday, January 11–13.

Special Address

A special address by BASSAM Z. SHAKHASHIRI, Direc-
tor for Science and Engineering Education, National
Science Foundation, is scheduled for 3:15 p.m. on Friday,
January 13. The title of his talk is Developing a national
will to enhance the quality of science and mathematics
education in America.

Invited Addresses

There will be six invited fifty-minute addresses. The
names of the speakers, their affiliations, the dates and
times of their talks, and some of the titles follow:

H. THOMAS BANKS, Brown University, Inverse prob-
lems in mechanics and biology, 3:20 p.m. Wednesday;

PETER B. GILKEY, University of Oregon, Eugene, Can
you hear the shape of a drum?, 10:05 a.m. Saturday;

ALFRED W. HALES, University of California, Los
Angeles, Lewis Carroll, alternating sign matrices and
plane partitions, 9:00 a.m. Thursday;

MARIAN B. POUR-EL, University of Minnesota, Min-
neapolis, Computable data, noncomputable solutions,
2:15 p.m. Friday;

GEORGE R. SELL, University of Minnesota, Min-
neapolis, Inertial manifolds, 1:10 p.m. Friday;

RUTH J. WILLIAMS, University of California, San
Diego, Multidimensional diffusion processes, 2:15 p.m.
Wednesday.

Minicourses

Fifteen Minicourses are being offered by the MAA. The
names and affiliations of the organizers, the topics, the
dates and times of their meetings, and the enrollment
limitations of each are as follows:

Minicourse #1: Computer graphics in elementary
statistics is being organized by FLORENCE S. GORDON,
New York Institute of Technology, and SHELDON P.
GORDON, Suffolk Community College. Part A is sched-
duled from 6:00 p.m. to 8:00 p.m. on Tuesday, January 10,
and Part B from 6:00 p.m. to 8:00 p.m. on Wednesday,
January 11. Enrollment is limited to 30.

This Minicourse is intended to provide a hands-on
introduction to the use of microcomputer graphics for an
elementary, non-calculus-based, statistics course. All par-
ticipants will have the opportunity to work with a graphics
software package developed by the organizers which
covers virtually all of the topics normally encountered
in elementary statistics and probability including: data
analysis and descriptive statistics; probability simula-
tions of random processes; the normal and t-distributions; the
Central Limit Theorem; simulations of a wide variety
of other sampling distributions; estimation; hypothesis
testing; linear regression and correlation analysis; etc.
The Minicourse is designed for individuals who have
taught such an introductory statistics course. However,
the presentation will be geared to individuals who have
had very little or no previous academic computing
experience.

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Minicourse #2: Using computer graphics to enhance the teaching and learning of calculus and precalculus mathematics is being organized by FRANKLIN D. DEMANA and BERT K. WAITS, Ohio State University. Part A is scheduled from 8:00 a.m. to 9:50 a.m. on Wednesday, January 11, and Part B from 2:15 p.m. to 4:10 p.m. on Thursday, January 12. Enrollment is limited to 30.

Technology can dramatically change the way we teach mathematics and the way students learn mathematics. Participants will learn how to use “state of the art” computer graphing software with features such as zoom out and zoom in to enhance the understanding of important topics from calculus and precalculus mathematics. Computer graphing is a powerful tool that permits the user to make and test generalizations by looking at a large number of examples in a short period of time, to easily solve difficult problems, and to deal with problems and applications that are not contrived. Mathematical topics will include inequalities, theory of equations, two dimensional and three dimensional analytic geometry, polar and parametric equations, general conics, maximum and minimum problems, systems of equations (limits of integration for area between two curves), and numerical analysis. Software will be available to participants for the Macintosh, IBM, and Apple II (e, c, or GS) computers.

Minicourse #3: Using history in teaching calculus is being organized by V. FREDERICK RICKEY, Bowling Green State University. Part A is scheduled from 8:00 a.m. to 9:50 a.m. on Wednesday, January 11, and Part B from 2:15 p.m. to 4:10 p.m. on Thursday, January 12. Enrollment is limited to 50.

Students of the calculus instinctively ask many penetrating questions: What is the calculus? What good is it? Why are the concepts presented the way they are? When the calculus reform movement eliminates the computational drudgery to concentrate on the fundamental ideas of the calculus, it will be even more imperative to respond to these questions. The answers are inherently historical, and so by interjecting a historical vein into our teaching we can respond to these questions in meaningful and inspiring ways. A wide variety of ideas for using the history of the calculus that have been successfully used to motivate students will be presented. Some samples: The geographical origins of the integral of the secant, an idea of Fermat for integrating to a trick of Euler's for maximal problems, and how an analysis of a wrong proof of Cauchy leads to the definition of uniform convergence. Bibliographies and historical notes will be provided.

Minicourse #4: Applications of discrete mathematics is being organized by FRED S. ROBERTS, Rutgers University. Part A is scheduled from 8:00 a.m. to 9:50 a.m. on Wednesday, January 11 and Part B from 2:15 p.m. to 4:10 p.m. on Thursday, January 12. Enrollment is limited to 80.

One of the reasons that discrete mathematics has become so important is the enormous variety of applications of the subject. This Minicourse will explore these applications. The emphasis will be on several simple and traditional discrete techniques: basic counting rules of combinatorics, the principle of inclusion and exclusion, the notion of graph coloring, and the concept of eulerian path. These techniques will be quickly reviewed (though prior knowledge of combinatorics or graph theory will not be necessary). Applications will include switching functions in computer science, DNA chains in genetics, power in simple games in economics and political science, scheduling and operations research, engineering problems involving telecommunications and mobile radio transmission, urban sciences, computer graph plotting of electrical networks, and keypunching errors in computing.

Minicourse #5: Writing in mathematics courses is being organized by GEORGE D. GOPEN and DAVID A. SMITH, Duke University. Part A is scheduled from 8:00 a.m. to 9:50 a.m. on Wednesday, January 11; Part B from 2:15 p.m. to 4:10 p.m. on Thursday, January 12; and Part C from 6:30 p.m. to 8:30 p.m. on Thursday, January 12. Enrollment is limited to 50.

The organizers will present an effective strategy for incorporating writing assignments into mathematics courses, for helping students improve their writing, and for keeping the grading burden within reasonable bounds. This strategy is based on Reader Expectation Theory, a new way of viewing the composition and revision process. We will present the elements of the theory and explore (not just assume) the connections between writing and thinking that it implies. Where possible, examples will be based on tests written by students in calculus courses. The theory and its practical applications are not limited to calculus, of course, not even to mathematics; it is the basis for an efficient and effective Writing Across the Curriculum program that has already been implemented at the University of Chicago, Harvard Law School, and Duke University.

Minicourse #6: Surreal numbers is being organized by LEON HARKER ROAD, Bellarmine College and Cornell University. Part A is scheduled from 8:00 a.m. to 9:50 a.m. on Wednesday, January 11, and Part B from 2:15 p.m. to 4:10 p.m. on Thursday, January 12. Enrollment is limited to 80.

The surreal numbers combine such objects as the real numbers, infinitesimals, and the ordinal numbers all into a single system (a field, in fact). Surprisingly, this rich system can be built from scratch by a very simple construction demanding no specialized prerequisites. This Minicourse will include an examination of the surreal numbers, some of their properties, how they relate to other systems of numbers, and how they may be used in undergraduate classes.
Minicourse #7: Computer based discrete mathematics is being organized by NANCY HOOD BAXTER, Dickinson College and ED DUBINSKY, Purdue University. Part A is scheduled from 6:30 p.m. to 8:30 p.m. on Thursday, January 12; Part B from 8:00 a.m. to 9:50 a.m. on Saturday, January 14; and Part C from 3:30 p.m. to 5:30 p.m. on Saturday, January 14. Enrollment is limited to 30.

This Minicourse is about a new way of teaching discrete mathematics. The content agrees with what is generally recommended. The method is based on contemporary research in learning abstract mathematics and makes use of a very high level programming language ISETL. ISETL is interactive and its syntax is close to mathematical notation. Participants will learn to understand several mathematical programs that express complicated mathematical ideas and will write their own. The point for teaching is that students learn to use important mathematical constructs (such as set formers, quantifiers, function definitions) in the context of getting their programs to do the right thing. The syntax is sufficiently simple that most of their mental energy is devoted to understanding mathematical processes that become realities for them.

The course includes “hands-on” experience with ISETL and discrete mathematics, as well as discussion of what topics can be handled and how. Software and detailed lecture notes will be sent to participants after the course on request (for a nominal handling fee).

Minicourse #8: Teaching mathematical modeling is being organized by FRANK R. GIORDANO, U.S. Military Academy and MAURICE D. WEIR, Naval Postgraduate School. Part A is scheduled from 6:30 p.m. to 8:30 p.m. on Thursday, January 12, and Part B from 8:00 a.m. to 9:50 a.m. on Friday, January 13. An optional third session, Part C, will use the microcomputer facility and is scheduled from 6:30 p.m. to 8:30 p.m. on Friday, January 13. Enrollment is limited to 40.

The MAA Committee on the Undergraduate Program in Mathematics recommended in 1981 that “Students should have an opportunity to undertake ‘real world’ mathematical modeling projects...” as part of the common core curriculum for all mathematical science majors. This is because many applications of problems in science, industry, and government are best approached using mathematical modeling techniques.

This Minicourse provides an introduction to the modeling process, to several topics underlying the construction of mathematical models, and addresses issues related to the design of an undergraduate course in modeling. The optional third session will consist of demonstrations and “hands-on” running of models on microcomputers.

Minicourse #9: Learning math through discrete dynamical systems is being organized by JAMES T. SANDE-FUR, Georgetown University. Part A is scheduled from 6:30 p.m. to 8:30 p.m. on Thursday, January 12, and Part B from 8:00 a.m. to 9:50 a.m. on Friday, January 13. Enrollment is limited to 60.

This course will consider difference equations as a dynamical process. Difference equations, which only require an algebra background to study, give students an appreciation of the beauty and applicability of mathematics. There is also a unifying effect in that they can be combined with linear algebra and probability to study interesting models including the Markov processes and predator-prey relationships. Linearization of nonlinear difference equations, which arise in population models and Newton’s method, uses differentiation, the product rule, the chain rule, and graphing techniques. This shows students one connection between discrete and continuous mathematics. Other applications include annuities, amortization of loans, selection and mutation in genetics, the gambler’s ruin, harvesting strategies, and population models with age structure. Connections between difference equations and differential equations will be covered, as well as a discussion on the similarities and differences between continuous and discrete models.

Minicourse #10: Applied mathematics via classroom experiments is being organized by HERBERT R. BAILEY, Rose-Hulman Institute of Technology. Part A is scheduled from 6:30 p.m. to 8:30 p.m. on Thursday, January 12, and Part B from 8:00 a.m. to 9:50 a.m. on Friday, January 13. Enrollment is limited to 80.

This Minicourse is based on a junior level applied mathematics course which has been developed to encourage students to combine their knowledge of physics, calculus, and differential equations. Students are asked to derive and solve the equations that model simple classroom experiments. For example, the first experiment is to let a ball bounce until it stops. The problems is to relate “percent rebound” and “time to stop bouncing”. The student must combine the concepts of time of fall and summation of geometric series. The full course includes five units: I-The Chain, II-Rotation, III-Fluid Flow, IV-Heat Flow, and V-Calculus of Variations. The Minicourse will begin with a brief description of each unit including demonstrations of most of the experiments. Participants will then be asked to work through some of the units either individually or in small groups. Each participant will be given a writeup and a solution manual for each of the units. The writeups include review sections covering the necessary mathematics and physics.

Minicourse #11: Modeling with the Poisson process is being organized by LINN I. SENNOTT, Illinois State University, Normal. Part A is scheduled from 6:30 p.m. to 8:30 p.m. on Thursday, January 12, and Part B from 8:00 a.m. to 9:50 a.m. on Friday, January 13. Enrollment is limited to 80.
The Poisson process is one of the most important and flexible stochastic processes for the modeling of diverse situations. It has applications in engineering, computer science, manufacturing, telephony, management science, and other fields. For example, the Poisson process and its relative, the Poisson distribution, may be used to model the number of bacteria growing in a Petri dish, the number of customers arriving at a bank, the number of calls coming into a switchboard, the number of jobs arriving to a mainframe computer, etc.

Participants should have an elementary knowledge of probability, including the common discrete and continuous distributions. The binomial, exponential, uniform, and Poisson distributions will be reviewed prior to the development of the Poisson process and its important properties. Numerous applications will be included, as well as a discussion of parameter estimation and goodness-of-fit tests. Real data, collected by students in the organizer’s math modeling class, will be discussed. The nonhomogeneous and compound Poisson processes will be developed. Bring scientific calculators.

Minicourse #12: muMath workshop is being organized by Wade Ellis, Jr., West Valley College. Part A is scheduled from 8:00 a.m. to 9:50 a.m. on Friday, January 13, and Part B from 1:15 p.m. to 3:15 p.m. on Saturday, January 14. Enrollment is limited to 30.

muMath, a computer algebra system developed by David Stoutemyer and Albert Rich, is based on a LISP-like programming language. The system contains many specialized mathematically-oriented functions and operators. In the Minicourse, each participant will use muMath on an IBM Personal Computer. No prior knowledge of computer programming will be assumed. The first session will begin with a demonstration of the muMath formula entry conventions and computing environment. Participants will then work through hands-on guided exercises to become familiar with muMath's built-in operations and the muSIMP computer language. The second session will be devoted to muMath modules on calculus, linear algebra, and differential equations. A discussion period including a brief comparison of muMath with other mathematical computer environments will conclude the workshop.

Minicourse #13: Applications of the HP28S supercalculator for more experienced users is being organized by Thomas W. Tucker, Colgate University. Part A is scheduled from 6:30 p.m. to 8:30 p.m. on Friday, January 13, and Part B from 1:15 p.m. to 3:15 p.m. on Saturday, January 14. Enrollment is limited to 40.

This Minicourse will illustrate uses of the HP28S in the various courses of the first two years of undergraduate mathematics: calculus, linear algebra, statistics, discrete mathematics. Participants will be given programs that create customized environments for particular applications. For example, the graphing environment allows automatic range finding, zooming, superimposing an unlimited number of graphs, storing and recalling graphs, computation of zeros, extrema, and inflection points, definite integrals, polar, and parametric curves; each of these is obtained by a single button push with no need for more technical HP28S syntax. Other bells and whistles include pivoting for use in matrix computations and linear programming, curve fitting for exploratory data analysis, and "rationalizing" decimal numbers into fractions via the Euclidean algorithm.

Most of these programs are very short. Participants will be given assignments to write their own programs and develop their own environments. All participants will be expected to have their own HP28S calculators, to have used their HP28S more than once or twice, and to be willing to think in reverse Polish.

Minicourse #14: Creating order out of chaos in freshman mathematics: instituting a mathematics placement program is being organized by Billy E. Rhoades, Indiana University at Bloomington and is sponsored by the Committee on Placement Examinations. Part A is scheduled from 6:30 p.m. to 8:30 p.m. on Friday, January 13, and Part B from 1:15 p.m. to 3:15 p.m. on Saturday, January 14. Enrollment is limited to 40.

Members of the MAA Committee on Placement Examinations will present, through lectures, worksheets, and questions and answer sessions, an overview of the task of establishing a mathematics placement program. Topics covered will include: reasonable expectations of a placement program, the tests available through the MAA Placement Test Program (PTP), the selection or creation of a placement test or series of tests, statistical analyses of test items and tests, and the administration of a placement program.

Minicourse #15: Ada for mathematicians is being organized by Joseph Straight, SUNY College at Fredonia. Part A is scheduled from 6:30 p.m. to 8:30 p.m. on Friday, January 13, and Part B from 1:15 p.m. to 3:15 p.m. on Saturday, January 14. Enrollment is limited to 40.

Ada is a relatively new programming language that was designed for and under the auspices of the U.S. Department of Defense. It is intended to support the development and maintenance of large programs by teams of programmers, particularly embedded-systems applications. As such, Ada is expected to gain widespread use, not only for defense-related projects, but for other commercial software, also. Moreover, the design of Ada represents, in several important respects, a culmination in the evolution of high-level imperative programming languages. Its support for modularity, abstraction, generic units, concurrency, real-time control, and error-handling, as well as its high degree of portability, make Ada an excellent language for mathematical programming. Prospective participants are referred to the article, "Why
Ada is Not Just Another Programming Language,” by Jean Sammet, in the August, 1986 issue of Communications of the ACM.

This Minicourse presents a survey of some of Ada’s more important features. Participants should be fluent in a high-level programming language, such as Pascal or FORTRAN.

Participants interested in attending any of the MAA Minicourses should complete the MAA Minicourse Pre-registration Form and send it directly to the MAA office at the address given on the form so as to arrive prior to the November 10 deadline. DO NOT SEND THIS FORM TO PROVIDENCE. Please note that these MAA Minicourses are NOT the AMS Short Course. After the deadline, interested participants are encouraged to call the MAA headquarters at 800-331-1622.

Please note that prepayment is required. Payment can be made by check payable to MAA (Canadian checks must be marked “in U.S. funds”) or VISA or MASTERCARD credit cards.

The MAA Minicourses are open only to persons who register for the Joint Mathematics Meetings and pay the Joint Meetings registration fee. If the only reason for registering for the Joint Meetings is to gain admission to a MAA Minicourse, this should be indicated by checking the appropriate box on the MAA Minicourse Pre-registration Form. Then, if the Minicourse is fully subscribed, full refund can be made of the Joint Meetings preregistration fee. Otherwise, the Joint Meetings preregistration will be processed, and then be subject to the 50 percent refund rule. Participants should take care when cancelling Minicourse preregistration to make clear their intention as to their Joint Meetings preregistration, since if no instruction is given, the Joint Meetings registration will also be cancelled. PREREGISTRATION FORMS FOR THE JOINT MEETINGS SHOULD BE MAILED TO PROVIDENCE PRIOR TO THE DEADLINE OF NOVEMBER 10.

The registration fee for MAA Minicourses #1, #2, #7, #12 is $50 each. The registration fee for all other MAA Minicourses is $30 each.

AMS-MAA TA/PTI Workshop
A Workshop about teaching assistants and part-time instructors is being organized by BETTYE ANNE CASE, Florida State University, for Saturday, January 14. The Workshop will begin with a plenary session from 8:30 a.m. to 9:50 a.m. The next Workshop activity will be lunch at 12:05 p.m. (cost included in the registration fee). Small discussion sessions follow from 1:00 p.m. to 1:50 p.m. and 2:00 p.m. to 2:50 p.m. The groups will reconvene at 3:20 p.m. to hear the discussion group reports and discuss strategy for the future. The preregistration form provides an opportunity for participants to choose their discussion sessions. Registration fee is $15.

The procedures and deadlines are the same as for the Minicourses.

The now joint AMS-MAA Committee on TA/PTI (Teaching Assistants and Part-Time Instructors) is chaired by BETTYE ANNE CASE and has been collecting information for the past three years. This committee wants to share survey information and models of programs which are responses to the challenge of mathematical instruction by other than regular faculty. The morning plenary session will be devoted to the general issues of selection, orientation and training, supervision and evaluation, as well as the general support of graduate teaching assistants and part-time instructors. Each participant will then take part in small group discussions with colleagues in similar situations of unique and specific problems, concerns and answers. The final session will present session reports and discuss strategies for the future.

Each participant is asked to list three or more discussion groups of interest on the Minicourse and Workshop Preregistration Form. The choices include: Administrative support for programs; Lecture/recitation and multi-section formats; Part-time instructors at two- and four-year colleges; Academic concerns of TAs; International TA concerns; TAs in master’s-only departments; University-wide TA training programs; Departmental TA training; Summer TA programs.

The committee members are Thomas F. Banchoff, Brown University; Phil Huneke, Ohio State University; David Kraines, Duke University, and Bettye Anne Case, chair. They will be joined in presenting the workshop by colleagues and topic experts including Lida Bhatnagar, University of Nevada, Las Vegas; Annette Blackwelder, Florida State University; Stephen A. Doblin, Southern Mississippi University; Jack E. Graver, Syracuse University; David McMichael, University of Wisconsin; Richard S. Millman, Wright State University; Shelba J. Morman, North Lake College, Texas; Roger Ponder, Florida State University (Spoken English); Thomas T. Read, Western Washington University.

Contributed Papers
Contributed papers were accepted on six topics in collegiate mathematics. The topics, organizers, their affiliations, and days they will meet are:

- Precalculus mathematics, S. C. BHATNAGAR, University of Nevada, Las Vegas, 8:00 a.m. Wednesday and/or 2:15 p.m. Thursday
- Graphing calculators, GREGORY D. FOLEY, Ohio State University, 8:00 a.m. Wednesday and/or 2:15 p.m. Thursday
- Humanistic mathematics, ELENA ANNE MARCHISSOTTO, California State University, Northridge, and ALVIN...
M. White, Harvey Mudd College, 8:00 a.m. Wednesday and/or 2:15 p.m. Thursday
- Writing across the curriculum, Gerald M. Bryce, Hampden-Sydney College, 8:00 a.m. Friday and/or 1:15 p.m. Saturday
- History of mathematics, Charles V. Jones, Ball State University, 8:00 a.m. Friday and/or 1:15 p.m. Saturday
- What is happening with calculus revision?, John W. Kenelly, National Science Foundation, and Thomas W. Tucker, Colgate University, 1:15 p.m. Saturday and, if needed, 8:00 a.m. Friday.
The deadline for submitting papers for these sessions was September 30. Late papers will not be accepted.

Other MAA Sessions
Software Session Panel Discussion
A panel discussion on EDUCOM's 1988 distinguished mathematics software sponsored by the Committee on Computers in Mathematics Education (CCIME) is scheduled at 8:00 a.m. on Wednesday, January 11. The organizer is Warren Page, New York City Technical College. The other participants and the software they will discuss are: Eugene A. Herman, Grinnell College, MAX—the MAtRX Algebra Calculator; Herman E. Gollwitzer, Drexel University, Phase portraits; and David S. Griffeth, University of Wisconsin, Madison/Robert Fisch, University of North Carolina, Charlotte, GASP—Graphical Aids for Stochastic Processes.

Panel Discussion and Program sponsored by Committee on Participation of Women
The Committee on Participation of Women is sponsoring two related programs. The first will be a panel discussion on How to break into print in mathematics. This session is scheduled at 8:30 a.m. on Wednesday, January 11, and will be moderated by Marjorie L. Stein, U.S. Postal Service.

The second program is titled Meet the editors and will provide opportunities to talk in small groups with several editors of journals and Wednesday's panelists. There will be two half-hour sessions on Thursday afternoon, one from 2:15 p.m. to 2:45 p.m. and one from 2:50 p.m. to 3:20 p.m.

Teaching Computer Science in Mathematics Departments Panel Discussion
This panel discussion is sponsored by the Task Force of the MAA-ACM-IEEE Computer Society on Teaching Computer Science within Mathematics Departments and is scheduled from 8:30 a.m. to 9:50 a.m. on Wednesday, January 11. The moderator will be the chair of the task force, Zaven A. Karian, Denison University. The other participants will be David W. Ballew, Western Illinois University, and Cris T. Roosenraad, Carleton College.

Two-Year College Reception
The Committee on Two-Year Colleges is sponsoring an informal reception for two-year college faculty from 4:30 p.m. to 6:00 p.m. on Wednesday, January 11.

MAA/NCTM Panel Discussion
The MAA and the National Council of Teachers of Mathematics are jointly sponsoring a panel discussion on Mathematics teacher education—responses to the Holmes/Carnegie recommendations. The panel is scheduled from 2:15 p.m. to 4:10 p.m. on Thursday, January 12, and will be moderated by F. Joe Crosswhite, Northern Arizona University. The other panelists are Shirley A. Hill, University of Missouri at Kansas City, Thomas J. Cooney, University of Georgia, Alan Osborne, Ohio State University, and Steve Willoughby, University of Arizona.

Computers in Geometry Panel Discussion
A panel discussion on Computers in geometry is scheduled from 2:15 p.m. to 4:10 p.m. on Thursday, January 12. It is sponsored by the Committee on Computers in Mathematics Education (CCIME) and is being organized by James R. King, University of Washington, Seattle. The speakers and their titles include the organizer, Teaching geometry with Logo, and Doris W. Schattschneider, Moravian College, Visual geometry project: Tools for teaching.

Task Force on Minorities Panel Discussion and Workshop
Beginning at 2:15 p.m. on Thursday, January 12, the Task Force on Minorities, chaired by Louise A. Raphael, Howard University, will sponsor a two-hour informal workshop on Exploring funding possibilities for mathematics education projects for minorities. Richard Witter, MAA Development Officer, will present an overview of foundations and funded projects, whose purpose is to increase the number of minorities in mathematics. Also, successful principal investigators and NSF program officers will discuss strategies for preparing proposals for projects such as: Undergraduate students; Undergraduate faculty workshops; Computers for curriculum development; Summer workshops for pre-college teachers; Pre-college young scholars' program; Research experience for undergraduates. In order to structure the workshop, participants are asked to send in advance a brief outline of the kind of project(s) for which they are seeking funds to Louise A. Raphael, Department of Mathematics, Howard University, Washington, DC 20059.

Also, the Task Force is sponsoring a panel discussion on MAA sections and minorities—How can they work...
Together? This panel is scheduled from 8:00 a.m. to 9:50 a.m. on Friday, January 13. The panel will discuss that part of the Task Force's Report which focuses on how existing resources of the MAA sections can help to improve mathematics education for minorities, and ways to strengthen the MAA sections through increased minority membership and participation.

Aftermath of ICME-6 Panel Discussion
A panel presentation on the Aftermath of ICME-6 is scheduled from 8:15 a.m. to 9:50 a.m. on Friday, January 13. The organizer and moderator is Eileen L. Poiani, Saint Peter's College. The panelists will include Shirley M. Frye, Scottsdale School District and President of NCTM, James F. Hurley, University of Connecticut, R. O. Wells, JR., Rice University, and Thomas J. Cooney, University of Georgia, Athens.

Special Program for Arizona High School Students
A special program for selected high school students from Maricopa County is planned for Friday, January 13. An orientation is scheduled from 9:00 a.m. to 9:50 a.m. A lecture and awards ceremony is scheduled from 1:30 p.m. to 3:00 p.m. The organizer is Matthew J. Hassett, Arizona State University.

Calculus Initiatives Panel Discussion
Several activities are concerned with calculus initiatives. There will be a panel discussion on Calculus initiatives—an update scheduled from 8:00 a.m. to 9:50 a.m. on Saturday, January 14. This panel is jointly sponsored by the MAA CUPM Subcommittee on the First Two Years of College Mathematics and the NRC-MS2000 Task Force on Calculus. The organizers are Ronald G. Douglas, SUNY at Stony Brook, and Thomas W. Tucker, Colgate University. This panel will provide an update on activities related to the calculus reform begun by the "Lean and Lively Calculus" of the 1986 Tulane Conference and the "Calculus for a New Century" of the 1987 Washington symposium. There will be reports on projects planned or underway both with National Science Foundation support and without. The present NSF initiative in calculus will be described and its possible future directions will be discussed. Finally, the question of whether there really is a need for calculus reform will be addressed.

There are several related sessions of interest. On Saturday afternoon there will be a session of contributed papers on What is happening with calculus revision? At 3:15 p.m. on Friday there will be a special invited address by Bassam Z. Shakhshiri titled Developing a national will to enhance the quality of science and mathematics education in America.

Session on Teaching Mathematical Modeling
B. A. Fusaro, Salisbury State University and E. J. Manfred, United States Coast Guard Academy, are organizing a session of reports on Teaching mathematical modeling. This session will begin at 1:15 p.m. on Saturday, January 14.

Ramanujan Film
The film program at 7:30 p.m. on Friday, January 13, will feature the Nova program The man who loved numbers. This will be accompanied by a report by George E. Andrews, Pennsylvania State University, who will bring people up-to-date on how things stand on some of the problems mentioned in the film.

Audio-Visual Equipment
Rooms where MAA sessions will be held are equipped with one overhead projector and screen. (Invited 50-minute speakers are automatically provided with two overhead projectors.) Blackboards are not available.

Upon written request, the following projection equipment will be made available: one additional overhead projector/screen, 35 mm carousel slide projector, 16 mm film projector, or VHS video cassette recorder with one color monitor. Speakers requiring any of the equipment listed in this paragraph are required to submit their needs in writing prior to November 4.

No other equipment can be made available for these sessions without approval of the MAA Secretary. Requests for equipment not listed above should also be addressed to the Audio-Visual Coordinator in Providence (again, prior to November 4), who will forward them to the Secretary for possible approval.

Prize Session and Business Meeting
The MAA Prize Session and Business Meeting is scheduled from 4:15 p.m. to 5:15 p.m. on Friday, January 13. The Chauvenet Prize, the Award for Distinguished Service to Mathematics, and six Certificates of Meritorious Service will be presented. This meeting is open to all members of the Association.

Board of Governors
The MAA Board of Governors will meet at 9:00 a.m. on Tuesday, January 10. This meeting is open to all members of the Association.

Section Officers
There will be a Section Officers' meeting at 7:00 p.m. on Tuesday, January 10.
Activities of Other Organizations

The Association for Women in Mathematics (AWM) will sponsor the tenth annual Emmy Noether Lecture at 9:00 a.m. on Thursday, January 12.

The AWM will also sponsor a panel discussion on Gender differences in mathematical ability - Performance vs. perceptions, on Wednesday, January 11 at 3:20 p.m.

The AWM Business Meeting will be held at 4:20 p.m. on Wednesday, January 11.

An open reception is being planned by AWM at 9:30 p.m. on Wednesday, January 11.

The Interagency Commission for Extramural Mathematics Programs (ICEMAP) will present a session at 7:15 p.m. on Wednesday, January 11.

The Joint Policy Board for Mathematics (JPBM) Committee for Mathematics Department Heads has organized a National Meeting of Department Heads on Outside funding for the undergraduate curriculum at 7:00 p.m. on Friday, January 13. At 8:00 p.m. there will be three Birds-of-a-Feather sessions.

Plans are being made by The Office of Governmental and Public Affairs of JPBM for a gala reception on Thursday, January 12, followed by talks by leaders from the research, education, and corporate communities on The role of mathematics in the future of American business and industry.

The National Association of Mathematicians (NAM) will receive the William W. Claytor Lecture at 1:00 p.m. on Saturday, January 14.

NAM will also sponsor a panel discussion on Saturday, January 14, at 9:00 a.m.

The NAM Business Meeting will take place at 10:00 a.m. on Saturday, January 14.

NAM will also sponsor Presentations by Recent Ph.D. Recipients at 2:15 p.m. on Saturday, January 14. This session is being organized by Donald M. Hill, Florida Agricultural and Mechanical University.

The National Science Foundation (NSF) will sponsor a session at 5:45 p.m. on Wednesday, January 11.

The NSF will also be represented at a booth in the exhibit area. NSF staff members will be available to provide counsel and information on NSF programs of interest to mathematicians. The booth will be open the same days and hours as the exhibits.

The Mathematicians and Education Reform Network will sponsor a presentation on Saturday, January 14 at 2:15 p.m. Presenters include Philip D. Wagreich, University of Illinois at Chicago, and Harvey B. Keynes, University of Minnesota, Minneapolis. The recently organized Mathematicians and Education Reform Network is a three year project funded by the National Science Foundation to promote discussions within the mathematics community about issues in precollege mathematics education, and to attract a pool of mathematicians who are committed to doing sustained work in this area. The Network is organizing support services to advise mathematicians in planning and implementing precollege mathematics education projects. Wagreich and Keynes, Co-principal Investigators/Directors of the Network, will discuss the background and rationale of the Network, and will give details of current and future activities, including national workshops for interested mathematicians. Further information, contact Naomi Fisher, Associate Director of the Mathematicians and Education Reform Network, Office of Mathematics and Computer Education (M/C 249), Department of Mathematics, Statistics, and Computer Science, University of Illinois at Chicago, 208 Science and Engineering Offices, Box 4348, Chicago, IL 60680 or call 312-996-2439 or 312-413-3749.

The Rocky Mountain Mathematics Consortium (RMMC) Board of Directors will meet on Thursday, January 12, from 2:15 p.m. to 4:15 p.m.

Other Events of Interest

Book Sales

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

Exhibits

The book and educational media exhibits will be open Wednesday through Saturday, January 11–14. The hours they will be open are 1:00 p.m. to 5:00 p.m. on Wednesday, 9:00 a.m. to 5:00 p.m. Thursday and Friday, and 9:00 a.m. to noon on Saturday. All participants are encouraged to visit the exhibits during the meeting. Participants visiting the exhibits will be asked to display their meeting badge or acknowledgment of preregistration from the Mathematics Meetings Housing Bureau in order to enter the exhibit area.

Mathematical Sciences Employment Register

Those wishing to participate in the Employment Register at the Phoenix meetings should read carefully the important article about the Register which follows this meeting announcement.
How to Preregister

The importance of early preregistration cannot be overemphasized. Some of the benefits of early preregistration are assignment to hotels with the lowest rates, inclusion in the alphabetical list of preregistrants displayed in the registration area, reduced waiting time at the Joint Meetings Registration Desk, and registration at fees considerably lower than the fees that will be charged for registration at the meeting.

Preregistration for these meetings must be completed by November 10, 1988.

However, those who preregister by the EARLY deadline of October 31 will be eligible for a drawing to select the winners of complimentary hotel rooms in Phoenix (multiple occupancy of these rooms is permissible). Winners will be randomly selected from the names of all participants who preregister by October 31. The winners will be notified by mail prior to December 31. So preregister early! (A list of the winners in Atlanta appears in the section titled How to Obtain Hotel Accommodations.

It is essential that the Preregistration/Housing Form (found at the back of this issue) be completed fully and clearly. In the case of several preregistrations from the same family, each family member who is preregistering should complete a separate copy of the Preregistration/Housing Form, but all preregistrations from one family may be covered by one payment. Please print or type the information requested, and be sure to complete all sections. Absence of information (missing credit card numbers, incomplete addresses, etc.) causes a delay in the processing of preregistration for that person.

Please provide your nickname if you wish this information to be printed on your badge. Also, it is planned to make available at the meeting a list of preregistrants by area of interest. If you wish to be included in this list, please provide the Mathematical Reviews classification number of your major area of interest on the Preregistration/Housing Form. The master copy of this list will be available for review by participants at the Message Center section of the registration desk.

Modes of payment which are acceptable, provided they are payable in U.S. dollars to the order of the American Mathematical Society, are U.S. Postal Money Orders, certified U.S. bank checks, U.S. bank money orders, personal checks drawn on a U.S. bank, or credit card (Visa or MasterCard only).

Receipt of the Preregistration/Housing Form and payment will be acknowledged by the Mathematics Meetings Housing Bureau. Participants are advised to bring a copy of this acknowledgement with them to Phoenix.

The Joint Meetings registration fees at the meeting will be 30% higher than the preregistration fees listed below.

Joint Mathematics Meetings

<table>
<thead>
<tr>
<th>Category</th>
<th>Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member of AMS, Canadian Mathematical Society</td>
<td>$63</td>
</tr>
<tr>
<td>Society, MAA, NCTM, Sociedad Matematica</td>
<td></td>
</tr>
<tr>
<td>Mexicana</td>
<td></td>
</tr>
<tr>
<td>Emeritus Member of AMS, MAA</td>
<td>$18</td>
</tr>
<tr>
<td>Nonmember</td>
<td>$98</td>
</tr>
<tr>
<td>Student/Unemployed</td>
<td>$18</td>
</tr>
<tr>
<td>Employment Register</td>
<td></td>
</tr>
<tr>
<td>Employer</td>
<td>$75</td>
</tr>
<tr>
<td>Additional interviewer (each)</td>
<td>$35</td>
</tr>
<tr>
<td>Applicant</td>
<td>$15</td>
</tr>
<tr>
<td>Employer posting fee</td>
<td>$10</td>
</tr>
<tr>
<td>AMS Short Course</td>
<td></td>
</tr>
<tr>
<td>Student/Unemployed</td>
<td>$15</td>
</tr>
<tr>
<td>All Other Participants</td>
<td>$40</td>
</tr>
<tr>
<td>MAA Minicourses</td>
<td></td>
</tr>
<tr>
<td>(if openings available)</td>
<td></td>
</tr>
<tr>
<td>Minicourses # 1, 2, 7, 12</td>
<td>$50</td>
</tr>
<tr>
<td>Minicourses # 3, 4, 5, 6, 8, 9, 10, 11, 13, 14, 15</td>
<td>$30</td>
</tr>
</tbody>
</table>

A $5 charge will be imposed for all invoices prepared when preregistration forms are submitted without accompanying check(s) for the preregistration fee or are accompanied by an amount insufficient to cover the total payments due. We are sorry, but it is not possible for the Mathematics Meetings Housing Bureau to refund amounts less than $2. Preregistration forms received well before the deadline of November 10 which are not accompanied by correct payment will be returned to the participant with a request for resubmission with full payment. This will, of course, delay the processing of any housing request.

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

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

All full-time students currently working toward a degree or diploma qualify for the student registration fees, regardless of income.
The unemployed status refers to any person currently unemployed, actively seeking employment, and who is not a student. It is not intended to include any person who has voluntarily resigned or retired from his or her latest position.

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

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

How to Obtain Hotel Accommodations

The rates listed below are subject to a 9.1 percent sales/occupancy tax. The estimated mileage from the hotel to the Civic Plaza is given in parenthesis following the telephone number. Checkout time for all hotels is 12:00 noon. Checkin time for all hotels is 3:00 p.m.

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

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

If you hold a guaranteed reservation at a hotel, but are informed upon arrival that there is no room for you, there are certain things you can request the hotel do. First, they should provide for a room at another hotel in town for that evening, at no charge. (You have already paid for the first night when you made your deposit.) They should pay for taxi fares to the other hotel that evening, and back to the meetings the following morning. They should also pay for one telephone toll call so that you can let people know you are not at the hotel you expected. They should make every effort to find a room for you in their hotel the following day, and if successful, pay your taxi fares to and from the second hotel so that you can pick up your baggage and bring it to the first hotel. Not all hotels in all cities follow this practice, so your request for these services may bring mixed results, or none at all.

Please make all changes to or cancellations of hotel reservations with the Mathematics Meetings Housing Bureau in Providence before December 14, 1988. The telephone number in Providence is 401-272-9500 (extension 290). Please allow the Housing Bureau from December 15 to December 21 to get all final housing lists and changes sent to the hotels. After that date, changes should be made directly with the hotel. Cancellations must be made directly with the hotel 48 hours prior to date of arrival in order to receive refunds of deposits. A deposit of $50 by check OR a guarantee made by Visa, MasterCard, or American Express credit cards is required for each room reservation. Canadian checks should be marked “In U.S. funds”. American Express cards may be used for housing guarantees only and not for preregistration.

Participants desiring confirmed reservations for the following hotels must make the reservations through the Mathematics Meetings Housing Bureau prior to the November 10, 1988 deadline. Reservations at these hotels cannot be made by calling the hotel directly until after
Meetings

December 21, 1988. Ample time is needed for the Housing Bureau to process all reservations received inhouse by the November 10 deadline. After December 21, 1988, the rates below may not apply. It is imperative that all hotels listed on the back of the preregistration form be numbered in order of preference to insure accurate hotel assignments.

The following hotels have nonsmoking rooms available and are also equipped for the handicapped.

**Hyatt Regency Phoenix (Headquarters)**

North Second Street
Phoenix, Arizona 85004
Telephone: 602-252-1234 (at Civic Plaza)

<table>
<thead>
<tr>
<th>Type</th>
<th>Single</th>
<th>Double</th>
<th>Triple</th>
<th>Triple w/cot*</th>
<th>Quadruple</th>
<th>Quadruple w/cot</th>
<th>One Bedroom Suite</th>
<th>Two Bedroom Suite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate</td>
<td>$73</td>
<td>$73</td>
<td>$83</td>
<td>$93</td>
<td>$93</td>
<td>$103</td>
<td>$200</td>
<td>$300</td>
</tr>
</tbody>
</table>

* Number of cots is limited.

Full service hotel. Restaurants, lounge, outdoor pool and whirlpool. Self parking is $4.50 for overnight parking in the garage. This does not include in/out privileges during the day. Self parking in and out during the day is subject to hourly rates at the garage (approximately $1 first hour and $.50 thereafter for each additional hour). Valet parking is $6.50 per day with in/out privileges.

*(See Parking section.)*

Children 18 years and younger are free in same room as parents. Credit cards accepted are MasterCard, Visa, American Express, Diners Club, Carte Blanche, and Discover. Personal and company checks are accepted with personal ID or a major credit card along with TeleCredit. Company checks are accepted with proof of employment.

**Days Inn San Carlos**

202 North Central Avenue
Phoenix, Arizona 85004
Telephone: 602-253-4121 (1 mile)

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<thead>
<tr>
<th>Type</th>
<th>Single</th>
<th>Double</th>
<th>Triple</th>
<th>Triple w/cot*</th>
<th>Quadruple</th>
<th>Quadruple w/cot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate</td>
<td>$45</td>
<td>$45</td>
<td>$51</td>
<td>$60</td>
<td>$57</td>
<td>$66</td>
</tr>
</tbody>
</table>

* Number of cots is limited.

Full service hotel. Restaurant, lounge, outdoor pool. Parking is $3.50 per day with in/out privileges. Parking lot is located on the Northeast corner of Central and Van Buren (1 block from the front door). *(See Parking section.)*

Children 18 years and younger are free in same room as parents. Credit cards accepted are MasterCard, Visa, American Express, Diners Club, Carte Blanche. Personal and company checks are accepted with personal ID, major credit card, or bank guarantee card.

**Sheraton Phoenix**

Central & Adams
Phoenix, Arizona 85001
Telephone: 602-257-1525 (.5 miles)

<table>
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<tr>
<th>Type</th>
<th>Single</th>
<th>Double</th>
<th>Triple</th>
<th>Triple w/cot*</th>
<th>Quadruple</th>
<th>Quadruple w/cot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate</td>
<td>$75</td>
<td>$75</td>
<td>$85</td>
<td>$95</td>
<td>$95</td>
<td>$105</td>
</tr>
<tr>
<td>One Bedroom Suite</td>
<td>$225</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two Bedroom Suite</td>
<td>$300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Number of cots is limited.

Full service hotel. Restaurant, lounge, outdoor pool, whirlpool spa. Parking is $6.00 per day with in/out privileges. *(See Parking section.)*

Children 18 years and younger are free in same room as parents. Credit cards accepted are MasterCard, Visa, American Express, Diners Club, Carte Blanche, Discover, and Holiday Inn Card. Personal and company checks are accepted with personal ID.

**Holiday Inn-Financial Center**

3600 N. 2nd Avenue
Phoenix, Arizona 85013
Telephone: 602-248-0222 (3 miles)

<table>
<thead>
<tr>
<th>Type</th>
<th>Single</th>
<th>Double</th>
<th>Triple</th>
<th>Quadruple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate</td>
<td>$59</td>
<td>$59</td>
<td>$69</td>
<td>$79</td>
</tr>
</tbody>
</table>

Full service hotel. Restaurant, lounge, outdoor pool, free parking. The hotel will run regular shuttles to and from the Civic Plaza. A time schedule will be posted in the lobby of the hotel and in the registration area during the meeting.

Children 18 years and younger are free in same room as parents. Credit cards accepted are MasterCard, Visa, American Express, Diners Club, Carte Blanche, Discover, and Holiday Inn Card. Personal and company checks are accepted with personal ID.

**Holiday Inn-Airport East**

4300 East Washington
Phoenix, Arizona 85034
Telephone: 602-273-7778 (3.5 miles)
Single $59  
Double $59  
Triple $69  
Quadruple $69

Meetings

Full service hotel. Restaurant, lounge, outdoor pool, free parking. The hotel will run regular shuttles to and from the Civic Plaza. A time schedule will be posted in the lobby of the hotel and in the registration area during the meeting.

Children 18 years and younger are free in same room as parents. Credit cards accepted are MasterCard, Visa, American Express, Diners Club, Carte Blanche, Discover, Holiday Inn Card, and En Route. Personal and company checks are accepted with Diners Club or American Express.

Participants should be aware that when major conventions occur in any large city, additional safety problems are created, especially at night. Those who are attending the meetings alone, or who are concerned about walking to and from the meetings after dark, are encouraged to choose a hotel in close proximity to the Civic Plaza. Participants are also urged to read the “Words to the Wise” in the local information insert in the program they receive at the meetings.

Atlanta Room Lottery Winners

The following participants received a complimentary hotel room during the Atlanta meetings. They qualified for these rooms by submitting their Preregistration/Housing Form by the early preregistration deadline. Since these rooms can be occupied by as many as four persons, this represented a considerable savings.

All participants wishing to preregister for the Phoenix meetings are urged to consider the early deadline of October 31 in order to qualify for the Phoenix Room Lottery. (See the section titled How To Preregister)

Days Inn

Henry Alder  
Robert Dobbins

Radisson

Philip Carlson  
William Golightly  
Paul Irwin  
Richard Jarvinen

American

Roger Hering  
Nigel Kalton

Heinz Schaettler  
Harry Sedinger  
Charles Shaw  
Dale Varberg  
James Strayer  
Richard Trudeau

Registration at the Meetings

Meeting preregistration and registration fees only partially cover expenses of holding meetings. All mathematicians who wish to attend sessions are expected to register, and should be prepared to show their meeting badge, if so requested. Badges are required to enter the exhibit area, to obtain discounts at the AMS and MAA Book Sales, to cash a check with the meeting cashier, and to attend all sessions scheduled in the Ballroom in the Phoenix Civic Plaza. If a preregistrant should arrive too late in the day to pick up his/her badge, he/she may show the acknowledgment of preregistration received from the Mathematics Meetings Housing Bureau as proof of registration.

The AMS-MAA Joint Meetings Committee has, in response to a request by the AMS Council, initiated some new procedures, effective with the January 1989 meeting in Phoenix.

I. Individuals who state that they have not yet registered, or who have failed to bring the badge to the event, will be asked to give name and address at the door, admitted, and asked to obtain the regular badge as soon as is feasible. Any who in fact have not registered by the end of the meeting will be sent a bill after the meeting.

II. A person who has not preregistered or registered will be sent to the registration desk to obtain a badge. This could be a regular registration badge, or a special one if the person prefers not to register. The latter badge will be of a distinctive color, and will be valid only for a single event in question. It will be preprinted with the words Not Registered, and will have the person's name on it.

The fees for Joint Meetings registration at the meeting listed below are 30 percent more than the preregistration fees.

Joint Mathematics Meetings

| Member of AMS, NCTM, Sociedad Matematica Mexicanana | $ 82 |
| Emeritus Member of AMS, MAA | $ 23 |
| Nonmember | $127 |
| Student/Unemployed | $ 23 |

Employment Register

| Employer | $100 |
| Additional interviewers (each) | $ 50 |
| Applicant | $ 20 |
| Employer Posting fee | $ 15 |

AMS Short Course

| Student/Unemployed | $ 20 |
| All Other Participants | $ 50 |

MAA Minicourses

| Minicourses # 1, 2, 7, 12 | $ 50 |
| Minicourses # 3, 4, 5, 6, 8, 9, 10, 11, 13, 14, 15 | $ 30 |

Registration fees may be paid at the meetings in cash, by personal or travelers' check, or by VISA or MASTER-
Meetings

CARD credit card. Canadian checks must be marked for payment in U.S. funds. Although American Express and other cards are being accepted by hotels for housing payments, unfortunately only Visa or MasterCard can be accepted for registration.

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

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

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

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

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

Registration Dates and Times

AMS Short Course
Tuesday, January 10 8:00 a.m. to 2:30 p.m.

Joint Mathematics Meetings
[and MAA Minicourses (until filled)]
Tuesday, January 10 3:00 p.m. to 7:00 p.m.
Wednesday, January 11 through 7:30 a.m. to 4:00 p.m.
Friday, January 13 7:30 a.m. to 3:00 p.m.
Saturday, January 14

Registration Desk Services

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

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

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

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

Baggage and Coat Check
Baggage and coats may be left in the Joint Meetings registration area only during the hours that registration is open. The staff cannot, however, take responsibility for lost or stolen articles.

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

Local Information
This section of the desk will be staffed by members of the Local Arrangements Committee and other volunteers from the Phoenix mathematical community.

Lost and Found
See the Joint Meetings cashier. At the Phoenix Civic Plaza, lost and found is located in the Security Office (go to Lobby I and follow the signs).

Mail
All mail and telegrams for persons attending the meetings should be addressed as follows: Name of Participant, Joint Mathematics Meetings, c/o Phoenix Civic Plaza, 225 East Adams, Phoenix, AZ 85004. Mail and telegrams so addressed may be picked up at the mailbox in the registration area during the hours the registration desk is open. U.S. mail not picked up will be forwarded after the meeting to the mailing address given on the participant's registration record.
Meetings

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

A telephone message center is located in the registration area to receive incoming calls for participants. The center is open from January 10 through 14, during the hours that the Joint Mathematics Meetings registration desk is open. Messages will be taken and the name of any individual for whom a message has been received will be posted until the message has been picked up at the message center. Once the registration desk has closed for the day there is no mechanism for contacting participants other than calling them directly at their hotel. The telephone number of the message center is 602-239-7902.

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

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

Miscellaneous Information

Child Care
There are many day care facilities in the Phoenix area which are available on a short term basis. One which is fairly close to the downtown area is Mary Moppet's preschool (part of a state-licensed chain of day care facilities), 6807 S. Central, 602-268-8341. Rates are $2.50 per hour for 3 years and older, $2.65 for 2 to 3 years, $2.80 for 1 to 2 years, two hour minimum (daily rates $12.25 for 3 years and older, $12.50 for 2 to 3 years, $13 for 1 to 2 years).

Other day care facilities include Kinder-care, 4123 Nth 15th, 602-265-6800 and Palo Alto, 3546 E. Thomas.

For child care in your hotel room there is Grandmother's Childcare Network Company (certified and bonded, 602-264-5454). Rates/child $5.50 per hour, 2 children $6 per hour, 3 children $7 per hour, 4 children $8 per hour (4 hour minimum plus parking costs).

In addition, a Parent-Child Lounge will be located near the Joint Meetings registration area. It will be furnished with casual furniture, a crib, a changing area, some assorted toys and a television set. Any child using this lounge MUST be accompanied by a parent (not simply an adult) who must be responsible for supervision of the child. This lounge will be unattended and parents assume all responsibility for their children. This lounge will only be open during the hours of registration and all persons must leave the lounge at the close of registration each day.

Local Information
Phoenix, the state capitol, is located in central Arizona in an area known locally as the Valley of the Sun. The Phoenix area has been expanding rapidly in population and economic activity throughout the 60s, 70s and 80s. Its major industries include electronics, banking and tourism. The area is popular with winter visitors from all over the U.S. and Canada. Adjacent to Phoenix are the cities of Scottsdale and Tempe. Tempe is the home of Arizona State University, one of the largest state universities in the U.S. with an enrollment of over 40,000.

Local points of interest include:
Heard Museum, 22 E. Monte Vista Road, just east of Central Avenue about 2.5 miles east of north of the Convention Center. This renowned museum deals
mainly with the art and culture of native peoples of the southwest. (Accessible via Central Avenue buses.)
Open Monday through Saturday 10:00 a.m. to 4:45 p.m.,
Sunday 1:00 p.m. to 4:45 p.m.
Phoenix Zoo, 5810 East Van Buren, about 4 miles
east of the Convention Center. This zoo features a fine
collection of animals from all over the world, as well as
local species like the desert big horn sheep. There is a
children's zoo with areas for direct contact with some of
the animals. (Accessible via city buses.) Open daily 9:00
a.m. to 5:00 p.m.
Desert Botanical Garden, 1201 N. Galvin Parkway
adjacent to Phoenix Zoo. Contains 130 acres of plants
from the deserts of the world including 1800 different
kinds of cacti. (Accessible via city buses.) Open daily
9:00 a.m. until sunset.
Pueblo Grande, 4619 East Washington, about 4 miles
east of the Convention Center. The excavated ruins of the
Hohokam culture which flourished in the Phoenix area
from 300 B.C. to 1400 A.D. Adjacent to the ruins there
is an associated museum. (Accessible via city buses.)
Open Monday through Saturday 9:00 a.m. to 4:30 p.m.,
Sunday 1:00 p.m. to 4:30 p.m.
South Mountain Park. This 16,000 acre park contains
unusual rock formations, many varieties of native desert
plants, picnic areas and many miles of hiking trails. The
main entrance to South Mountain Park is at the southern
terminus of Central Avenue.
Phoenix Art Museum, 1625 North Central Avenue.
Features various art works including a nice collection
of Oriental Porcelain and art from Mexico. (Accessible
via city buses.) Open Thursday through Saturday 10:00
a.m. to 5:00 p.m., Wednesday 10:00 a.m. to 9:00 p.m.,
Sunday 1:00 p.m. to 5:00 p.m.
There are four city of Phoenix tennis courts located
across the street from the Phoenix Sheraton on top of
the Regency garage. There are 8 city tennis courts in
Encanto Park at 15th Avenue and Encanto Drive (open
until 10:00 p.m.) There are also two city golf courses
located adjacent to Encanto Park. The Phoenix area also
has numerous privately owned golf and tennis facilities.
Inquire at hotels for more information.
There will be performances of the Opera Lakmé in
Phoenix on January 12 and 14 at 7:30 p.m. in the Phoenix
Symphony Hall in the Phoenix Civic Plaza. This is a
revival of a great French romantic classic (1883) tailored
for brilliant coloratura singing, set in mid-19th century
India during British colonial rule. The cast includes
BEVERLY HOCH as Lakmé, an Indian priest's daughter;
CARROLL FREEMAN as her lover, Gerald; DAN SULLIVAN
as her father, the Brahman priest. The role of Lakmé
was last sung by Lily Pons in the Metropolitan Opera
production in the 1930's, where she sang the entrancing
"Bell Song". Call the Phoenix Symphony Hall box office
at 602-262-7272 for tickets. Single ticket prices range
from $9 to $36.
Tours of various scenic areas of Arizona such as the
Grand Canyon, Monument Valley, etc. are available.
Phoenix residents depend more heavily on private
vehicles for transport than do the inhabitants of other
U.S. cities. Nevertheless, there is a city bus system which
provides adequate service along the central corridor of
the city as well as to points of interest like the zoo and
botanical gardens. Inquire at your hotel for details
concerning bus service. Note: There is no bus service on
Sundays.
Parking
Parking is available in the various hotel parking garages.
Parking is also available in the Civic Plaza Parking
Garage for $3 per day. (If you plan to leave your car
overnight at the Civic Plaza garage you should notify the
attendant.) See the information on the individual hotels
in the section on How to Obtain Hotel Accommodations
for more on parking.
Smoking
Please note that smoking is not allowed in any of the
session rooms in the Hyatt Regency Phoenix or the
Phoenix Civic Plaza.
Social Events
There will be a no-host cocktail party on Friday evening,
January 13, from 8:00 p.m. to 10:00 p.m. Participants
are encouraged to use this occasion to spend some time
with old and new friends.
The Local Arrangements Committee has organized a
hike to South Mountain Park in the Sonoran Desert on
Friday, January 13. Tickets are $10. Interested particip­
ants should complete the appropriate section of the
Preregistration/Housing Form. In the event of cancella­
tions a 50% refund of the amount paid for the ticket will
be made if notification is received in Providence prior to
December 30. After that date, no refund can be made.
If a sufficient number of participants have not signed up
for the hike, it will be cancelled; please be sure to check
at the Local Information section of the Registration
Desk by Thursday, January 12. The Sonoran Desert is a
distinct biological entity, filled with an unusual diversity
of flora and fauna; in fact, it contains species found
nowhere else. Throughout the year, the desert is dense
with saguaro, mixed cacti and palo verde trees. With
the rise in elevation of the mountain foothills, a lush
greenland—first grass, then chapparal—emerges, and then
a pine/oak woodland. Finally, near the summit of the
mountains, a forest of fir covers the terrain. Basically,
it's a dry desert climate with minimal cloud cover. The
season for extreme change is the late spring, after early
wildflowers bloom and before summer rainstorms begin.
Meetings

Following two months or so of drought, a single one- to two-inch storm brings an amazing overnight change. A description from a recently published book describing the state's history, people and geography, says it best: "Toads come croaking up out of the ground; gourds send out several feet of vine; and skeleton-like trees sprout leaves."

Travel

In January, Phoenix is on Rocky Mountain Standard Time. The city airport is Sky Harbor which is about four miles from downtown. The airport is served by most of the major airlines. Shuttle service to and from the airport is provided by:

- Courier Cab, 602-244-1818, $5 for one person, $3 for two or more
- Supershuttle, 602-244-9000, $5 per person

Shuttle service to and from the hotels to the airport is as follows (courtesy telephones are located in the airport for all hotels and the Air Courier Super Shuttle):

Participants can take the Air Courier Super Shuttle to the Hyatt Regency Phoenix. This shuttle runs from 6:00 a.m. to 2:00 p.m., every half hour. The cost is $5 for one person or $3 per person if more than one. The Holiday Inn – Airport East, the Holiday Inn – Financial Center, and Phoenix Sheraton provide complimentary shuttle service from the airport to their hotel. The AA Cab Company will transport participants to the Days Inn San Carlos for $5 one way regardless of the number of occupants in the cab.

Directions for those arriving via automobile. (NOTE: It is sometimes a source of confusion to visitors that north-south numbered thoroughfares in Phoenix are designated “Avenue” on the west of Central Avenue and “Street” on the east.)

- From the west: follow I10. After I10 merges with I17 take Jefferson Street exit. Left onto Jefferson Street. Proceed to 2nd Street and take left onto 2nd Street. Hyatt is one-and-one-half blocks on left.
- From the north: from I17 take the Jefferson Street exit and follow above directions.
- From the south: from I10, take 7th Street exit. Turn right onto 7th to Van Buren Street. Take left onto Van Buren to 2nd Street. Left onto 2nd Street. Hotel is about one-and-one-half blocks on right.

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

Weather

During January the days in Phoenix are typically sunny with high temperatures in the 60s (average maximum temperature is 64.8 degrees F) and the evenings are clear and chilly with temperatures dropping into the 30s (average minimum temperature is 37.6 degrees F). Average total rainfall accumulation for January is .71 inches. On the average there are 6.82 rainy days during January. The last snowstorm to hit the city of Phoenix occurred before 1920!

Lance W. Small
Associate Secretary
La Jolla, California
MICA, Inc., the official travel management firm for the Joint Mathematics Meetings to be held in Phoenix, January 11-14, 1989, has arranged for special discounts aboard American Airlines.

Save 5% off published promotional fares, meeting all restrictions, or 40% off regular roundtrip coach fares, with a seven day advance purchase. Only through MICA can you receive these substantial discounts on American Airlines. It may be possible to receive an even lower airfare depending upon your individual flight itinerary.

The lowest promotional fares require a Saturday night stay, are subject to an airline change/cancellation penalty and must usually be purchased at least 30 days prior to departure.

Make your reservations today! For reservations on all airlines, call MICA directly on their nationwide toll-free number, 1-800-888-6422. MICA reservationists will advise you of the most convenient flights and lowest airfares available. You may pay by credit card or ask to be invoiced. Your airfare is guaranteed when your ticket is written!

**Free Flight Insurance!** In addition to the discounted airfares aboard American Airlines, MICA will also provide complimentary flight insurance for each ticket purchased for the Joint Mathematics Meetings in Phoenix. Each attendee will receive $100,000 flight accident insurance. A notice outlining the coverage will be included with your tickets.

Call today: 1-800-888-6422 And Save!  
Monday-Friday, 9:00 a.m.-6:00 p.m. EST

Meetings, Incentives, Conventions of America, Inc. (MICA, Inc.)  
Suite 303, 195 Farmington Avenue, Farmington, CT 06032  
(203) 678-1040
The purpose of this timetable is to provide assistance to preregistrants in the selection of arrival and departure dates. The program, as outlined below, is based on information at press time.

### Tuesday, January 10

<table>
<thead>
<tr>
<th>Time</th>
<th>American Mathematical Society</th>
<th>Mathematical Association of America</th>
<th>Other Organizations</th>
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</thead>
<tbody>
<tr>
<td><strong>MORNING</strong></td>
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<tr>
<td>8:00 a.m. - 2:30 p.m.</td>
<td>SHORT COURSE REGISTRATION</td>
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<tr>
<td>9:00 a.m. - 4:00 p.m.</td>
<td>SHORT COURSE LECTURE #1</td>
<td>BOARD OF GOVERNORS' MEETING</td>
<td></td>
</tr>
<tr>
<td>9:30 a.m. - 10:15 a.m.</td>
<td>Overview of the subject and the course</td>
<td>Charles R. Johnson</td>
<td></td>
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<tr>
<td>10:30 a.m. - 11:45 a.m.</td>
<td>SHORT COURSE LECTURE #2</td>
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<tr>
<td></td>
<td>Combinatorial matrix theory</td>
<td>Richard A. Brualdi</td>
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<tr>
<td><strong>AFTERNOON</strong></td>
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<tr>
<td>2:00 p.m. - 3:15 p.m.</td>
<td>SHORT COURSE LECTURE #3</td>
<td></td>
<td>REGISTRATION FOR JOINT MEETINGS</td>
</tr>
<tr>
<td>3:00 p.m. - 7:00 p.m.</td>
<td>Eigen analyses of matrices with symmetry properties</td>
<td>Persi Diaconis</td>
<td></td>
</tr>
<tr>
<td>3:30 p.m. - 4:30 p.m.</td>
<td>SHORT COURSE LECTURE #4</td>
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<tr>
<td></td>
<td>The role of nonnegative idempotent matrices in certain problems in probability</td>
<td>Arunava Mukherjea</td>
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<tr>
<td>5:00 p.m. - 10:00 p.m.</td>
<td>COUNCIL MEETING</td>
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<tr>
<td><strong>EVENING</strong></td>
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<tr>
<td>6:00 p.m. - 8:00 p.m.</td>
<td>MINICOURSE #1 (Part A)</td>
<td></td>
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<tr>
<td></td>
<td>Computer graphics in elementary statistics</td>
<td>Florence S. Gordon, Sheldon P. Gordon</td>
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</tbody>
</table>

*OCTOBER 1988, VOLUME 37, NUMBER 8*
### Tuesday, January 10 (cont’d)

#### EVENING (cont’d)

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00 p.m. - 9:00 p.m.</td>
<td>SECTION OFFICERS' MEETING</td>
</tr>
</tbody>
</table>

### Wednesday, January 11

#### MORNING

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>7:30 a.m. - 4:00 p.m.</td>
<td>REGISTRATION</td>
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<tr>
<td>8:00 a.m. - 9:50 a.m.</td>
<td>CONTRIBUTED PAPER SESSION</td>
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<tr>
<td></td>
<td>Precalculus mathematics</td>
</tr>
<tr>
<td></td>
<td>S. C. Bhatnagar</td>
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<tr>
<td>8:00 a.m. - 9:50 a.m.</td>
<td>CONTRIBUTED PAPER SESSION</td>
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<tr>
<td></td>
<td>Graphing calculators</td>
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<td>Gregory D. Foley</td>
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<tr>
<td>8:00 a.m. - 9:50 a.m.</td>
<td>CONTRIBUTED PAPER SESSION</td>
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<tr>
<td></td>
<td>Humanistic mathematics</td>
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<td></td>
<td>Elena Anne Marchisotto</td>
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<td></td>
<td>Alvin M. White</td>
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<tr>
<td>8:00 a.m. - 9:50 a.m.</td>
<td>MINICOURSE #2 (Part A)</td>
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<tr>
<td></td>
<td>Using computer graphics to enhance the teaching and learning of calculus</td>
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<td></td>
<td>and precalculus mathematics</td>
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<td></td>
<td>Franklin D. Demana</td>
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<td></td>
<td>Bert K. Waits</td>
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<tr>
<td>8:00 a.m. - 9:50 a.m.</td>
<td>MINICOURSE #3 (Part A)</td>
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<tr>
<td></td>
<td>Using history in teaching calculus</td>
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<td></td>
<td>V. Frederick Rickey</td>
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<tr>
<td>8:00 a.m. - 9:50 a.m.</td>
<td>MINICOURSE #4 (Part A)</td>
</tr>
<tr>
<td></td>
<td>Applications of discrete mathematics</td>
</tr>
<tr>
<td></td>
<td>Fred S. Roberts</td>
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<tr>
<td>8:00 a.m. - 9:50 a.m.</td>
<td>MINICOURSE #5 (Part A)</td>
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<tr>
<td></td>
<td>Writing in mathematics courses</td>
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<td></td>
<td>George D. Gopen</td>
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<td></td>
<td>David A. Smith</td>
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<tr>
<td>8:00 a.m. - 9:50 a.m.</td>
<td>MINICOURSE #6 (Part A)</td>
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<tr>
<td></td>
<td>Surreal numbers</td>
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<td></td>
<td>Leon Harkleroad</td>
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</table>
**Wednesday, January 11 (cont’d)**

**MORNING (cont’d)**

<table>
<thead>
<tr>
<th>Time</th>
<th>American Mathematical Society</th>
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</thead>
<tbody>
<tr>
<td>8:00 a.m. - 9:50 a.m.</td>
<td></td>
<td>COMMITTEE ON COMPUTERS IN MATHEMATICS EDUCATION PANEL DISCUSSION EDUCOM’s 1988 distinguished mathematics software Eugene A. Herman Herman E. Gollwitzer David S. Griffeath/Robert Fisch Warren Page (organizer)</td>
<td></td>
</tr>
<tr>
<td>8:30 a.m. - 9:45 a.m.</td>
<td>SHORT COURSE LECTURE #5 The Hadamard product Roger A. Horn</td>
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<tr>
<td>8:30 a.m. - 9:50 a.m.</td>
<td></td>
<td>COMMITTEE ON THE PARTICIPATION OF WOMEN PANEL DISCUSSION How to break into print in mathematics Marjorie L. Stein (moderator)</td>
<td></td>
</tr>
<tr>
<td>8:30 a.m. - 9:50 a.m.</td>
<td></td>
<td>TASK FORCE ON TEACHING COMPUTER SCIENCE WITHIN MATHEMATICS DEPARTMENTS PANEL DISCUSSION Teaching computer science in mathematics departments David W. Ballew Zaven A. Karian (moderator) Cris T. Roosenraad</td>
<td></td>
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<tr>
<td>9:00 a.m. - 9:50 a.m.</td>
<td>INVITED ADDRESS Title to be announced Percy Alec Deift</td>
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<tr>
<td>9:00 a.m. - 9:30 a.m.</td>
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<tr>
<td>9:30 a.m. - 4:00 p.m.</td>
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<tr>
<td>10:05 a.m. - 10:55 a.m.</td>
<td></td>
<td>EARLE RAYMOND HEDRICK LECTURE I Zeta functions in number theory Don Bernard Zagier</td>
<td></td>
</tr>
<tr>
<td>11:00 a.m. - noon</td>
<td></td>
<td>AMS-MAA INVITED ADDRESS Story of the higher dimensional Poincare conjecture (What really happened on the beaches of Rio de Janeiro) Stephen Smale</td>
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</table>

**AFTERNOON**

<table>
<thead>
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<tr>
<td>1:00 p.m. - 2:00 p.m.</td>
<td>COLLOQUIUM LECTURE I Title to be announced Nicholas Katz</td>
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</table>
**Wednesday**  
**January 11 (cont'd)**

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<tr>
<td>1:00 p.m. - 5:00 p.m.</td>
<td>EXHIBIT AND BOOK SALE</td>
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<tr>
<td>1:00 p.m. - 5:00 p.m.</td>
<td>BOOK SALE</td>
</tr>
</tbody>
</table>
| 2:15 p.m. - 3:05 p.m. | INVITED ADDRESS  
Multidimensional diffusion  
processes  
Ruth J. Williams  
2:15 p.m. - 3:30 p.m.   
SHORT COURSE LECTURE #6  
Interpolation problems for rational  
matrix functions  
I. Gohberg  
2:15 p.m. - 6:05 p.m.   
SPECIAL SESSIONS  
Mathematics of nonlinear science  
Integrable systems  
Geometry of hyperbolic dynamical systems  
Computational group theory  
Singular perturbation theory  
History of mathematics  
Computational aspects of complex analysis  
Operator algebras and geometry  
Mathematics in population biology  
3:15 p.m. - 6:05 p.m.   
SESSIONS FOR CONTRIBUTED PAPERS  
3:15 p.m. - 6:05 p.m.   
SPECIAL SESSION  
Stochastic processes  
3:45 p.m. - 5:00 p.m.   
SHORT LECTURE #7  
Interplay between matrix theory and multivariate statistics (tentative title)  
Ingram Olkin  
3:20 p.m. - 4:20 p.m.   
ASSOCIATION FOR WOMEN IN MATHEMATICS PANEL DISCUSSION  
Gender differences in mathematics ability--Performance vs. perception

**American Mathematical Society**

**Mathematical Association of America**

**Other Organizations**
### Wednesday, January 11 (cont'd)

**AFTERNOON (cont'd)**
- 4:20 p.m. - 4:50 p.m.: AWM BUSINESS MEETING
- 4:30 p.m. - 6:00 p.m.: NATIONAL SCIENCE FOUNDATION
- 5:45 p.m. - 6:45 p.m.

**EVENING**
- 6:00 p.m. - 8:00 p.m.: MINICOURSE #1 (Part B)
  - Computer graphics in elementary statistics
  - Florence S. Gordon
  - Sheldon P. Gordon
- 7:15 p.m. - 8:15 p.m.: INTERAGENCY COMMISSION FOR EXTRAMURAL MATHEMATICS PROGRAMS (ICEMAP)
- 8:30 p.m. - 9:30 p.m.: JOSIAH WILLARD GIBBS LECTURE
  - Title to be announced
  - Elliott H. Lieb
- 9:30 p.m. - 11:00 p.m.

### Thursday, January 12

**MORNING**
- 7:30 a.m. - 4:00 p.m.: SPECIAL SESSIONS
  - Surreal numbers
  - Integrable systems
  - Commutative algebra and algebraic geometry
  - Geometry of hyperbolic dynamical systems
  - Computational group theory
  - Singular perturbation theory
  - History of mathematics
  - Operator algebras and geometry
  - Mathematics in population biology
- 8:00 a.m. - 9:50 a.m.: REGISTRATION
**Thursday, January 12 (cont'd)**

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<tr>
<td>8:00 a.m. - 10:25 a.m.</td>
<td>SPECIAL SESSION Computational aspects of complex analysis</td>
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<tr>
<td>8:00 a.m. - 9:50 a.m.</td>
<td>SESSIONS FOR CONTRIBUTED PAPERS</td>
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<tr>
<td>9:00 a.m. - 9:50 a.m.</td>
<td>Invited Address Lewis Carroll, alternating sign matrices and plane partitions Alfred W. Hales</td>
<td></td>
<td>AWM Emmy Noether Lecture</td>
</tr>
<tr>
<td>9:00 a.m. - 5:00 p.m.</td>
<td>EXHIBIT AND BOOK SALE</td>
<td>BOOK SALE</td>
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</tr>
<tr>
<td>10:05 a.m. - 10:55 a.m.</td>
<td>EARLE RAYMOND HEDRICK LECTURE II Zeta functions in number theory Don Bernard Zagier</td>
<td></td>
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<tr>
<td>11:10 a.m. - noon</td>
<td>AMS-MAA INVITED ADDRESS The mathematics of transonic flow Cathleen S. Morawetz</td>
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<tr>
<td><strong>AFTERNOON</strong></td>
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<tr>
<td>1:00 p.m. - 2:00 p.m.</td>
<td>COLLOQUIUM LECTURE II Title to be announced Nicholas Katz</td>
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<tr>
<td>2:15 p.m. - 3:05 p.m.</td>
<td>INVITED ADDRESS Title to be announced Peter Landweber</td>
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</tr>
<tr>
<td>2:15 p.m. - 4:10 p.m.</td>
<td>CONTRIBUTED PAPER SESSION Precalculus mathematics S. C. Bhatnagar</td>
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<tr>
<td>2:15 p.m. - 4:10 p.m.</td>
<td>CONTRIBUTED PAPER SESSION Graphing calculators Gregory D. Foley</td>
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<tr>
<td>2:15 p.m. - 4:10 p.m.</td>
<td>CONTRIBUTED PAPER SESSION Humanistic mathematics Elena Anne Marchisotto Alvin M. White</td>
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<tr>
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<tr>
<td>2:15 p.m. - 4:10 p.m.</td>
<td>MINICOURSE #2 (Part B) Using computer graphing to enhance the teaching and learning of calculus and precalculus mathematics Franklin D. Demana Bert K. Waits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:15 p.m. - 4:10 p.m.</td>
<td>MINICOURSE #3 (Part B) Using history in teaching calculus V. Frederick Rickey</td>
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<tr>
<td>2:15 p.m. - 4:10 p.m.</td>
<td>MINICOURSE #4 (Part B) Applications of discrete mathematics Fred S. Roberts</td>
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<tr>
<td>2:15 p.m. - 4:10 p.m.</td>
<td>MINICOURSE #5 (Part B) Writing in mathematics courses George D. Gopen David A. Smith</td>
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<td>2:15 p.m. - 4:10 p.m.</td>
<td>MINICOURSE #6 (Part B) Surreal numbers Leon Harkleroad</td>
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<tr>
<td>2:15 p.m. - 4:10 p.m.</td>
<td>MAA/NCTM PANEL DISCUSSION ON MATHEMATICS EDUCATION Mathematics teacher education responses to the Holmes/Carnegie recommendations Thomas J. Cooney F. Joe Crosswhite (moderator) Shirley A. Hill Alan Osborne Steve Willoughby</td>
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<tr>
<td>2:15 p.m. - 4:10 p.m.</td>
<td>COMMITTEE ON COMPUTERS IN MATHEMATICS EDUCATION PANEL DISCUSSION ON COMPUTERS IN GEOMETRY Teaching geometry with Logo James R. King (organizer) Visual geometry project: Tools for teaching Doris W. Schattschneider</td>
<td></td>
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<tr>
<td>2:15 p.m. - 3:20 p.m.</td>
<td>COMMITTEE ON THE PARTICIPATION OF WOMEN PROGRAM Meet the Editors</td>
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<tr>
<td>2:15 p.m. - 4:10 p.m.</td>
<td>TASK FORCE ON MINORITIES INFORMAL WORKSHOP Exploring funding possibilities for mathematics education projects for minorities Louise A. Raphael (organizer) Richard Witter</td>
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<td>2:15 p.m. - 4:10 p.m.</td>
<td>AFTERNOON (cont'd) INVITED ADDRESS</td>
<td>American Mathematical Society</td>
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<tr>
<td>3:20 p.m. - 4:10 p.m.</td>
<td>Computing over the reals or any arbitrary rings</td>
<td>Mathematical Association of America</td>
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<tr>
<td>4:25 p.m. - 6:00 p.m.</td>
<td>Bôcher Prize Session and Business Meeting</td>
<td>Other Organizations</td>
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<tr>
<td>6:00 p.m. - 10:00 p.m.</td>
<td>EVENING RECEPTION LECTURES</td>
<td>ROCKY MOUNTAIN MATHEMATICS CONSORTIUM BOARD OF DIRECTORS' MEETING</td>
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<tr>
<td>6:00 p.m. - 7:00 p.m.</td>
<td>MINICOURSE #5 (Part C) Writing in mathematics courses</td>
<td>JOINT POLICY BOARD FOR MATHEMATICS OFFICE OF GOVERNMENTAL AND PUBLIC AFFAIRS</td>
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<tr>
<td>7:00 p.m. - 10:00 p.m.</td>
<td>MINICOURSE #7 (Part A) Computer based discrete mathematics</td>
<td>The role of mathematics in the future of American business and industry</td>
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</tr>
<tr>
<td>6:30 p.m. - 8:30 p.m.</td>
<td>MINICOURSE #8 (Part A) Teaching mathematical modeling</td>
<td>RECEPTION</td>
<td></td>
</tr>
<tr>
<td>6:30 p.m. - 8:30 p.m.</td>
<td>MINICOURSE #9 (Part A) Learning math through discrete dynamical systems</td>
<td>LECTURES</td>
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<tr>
<td>6:30 p.m. - 8:30 p.m.</td>
<td>MINICOURSE #10 (Part A) Applied mathematics via classroom experiments</td>
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<tr>
<td>6:30 p.m. - 8:30 p.m.</td>
<td>MINICOURSE #11 (Part A) Modeling with the Poisson process</td>
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</table>
**TIMETABLE**

**Friday, January 13**

### MORNING

<table>
<thead>
<tr>
<th>Time</th>
<th>American Mathematical Society</th>
<th>Mathematical Association of America</th>
<th>Other Organizations</th>
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<tr>
<td>7:30 a.m. - 4:00 p.m.</td>
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<td>REGISTRATION</td>
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<tr>
<td>8:00 a.m. - 9:50 a.m.</td>
<td>CONTRIBUTED PAPER SESSION</td>
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<tr>
<td></td>
<td>What is happening with calculus revision?</td>
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<td>John W. Kenelly</td>
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<td>Thomas W. Tucker</td>
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<td>Writing across the curriculum</td>
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<td>Gerald M. Bryce</td>
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<td></td>
<td>History of mathematics</td>
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<td>Charles V. Jones</td>
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<td>8:00 a.m. - 9:50 a.m.</td>
<td>MINICOURSE #8 (Part B)</td>
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<td></td>
<td>Teaching mathematical modeling</td>
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<td>Frank R. Giordano</td>
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<td>Maurice D. Weir</td>
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<td>James T. Sandefur</td>
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<td>Applied mathematics via classroom experiments</td>
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<td>Herbert R. Bailey</td>
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<td>8:00 a.m. - 9:50 a.m.</td>
<td>MINICOURSE #11 (Part B)</td>
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<td>Modeling with the Poisson process</td>
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<td>Linn I. Sennott</td>
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<td>8:00 a.m. - 9:50 a.m.</td>
<td>MINICOURSE #12 (Part A)</td>
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<td>muMATH workshop</td>
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<td>Wade Ellis, Jr.</td>
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<td>8:00 a.m. - 9:50 a.m.</td>
<td>TASK FORCE ON MINORITIES PANEL DISCUSSION</td>
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<td></td>
<td>MAA sections and minorities—How can they work together?</td>
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<td>Louise A. Raphael (organizer)</td>
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<td>8:15 a.m. - 9:50 a.m.</td>
<td>INVITED ADDRESS</td>
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<td>Old and new facts about surreal numbers</td>
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<td>John H. Conway</td>
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**OCTOBER 1988, VOLUME 37, NUMBER 8**
## TIMETABLE

### Friday, January 13 (cont'd)

#### MORNING (cont'd)

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<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>9:00 a.m.</td>
<td>EXHIBIT AND BOOK SALE</td>
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<tr>
<td>9:00 a.m.</td>
<td>BOOK SALE</td>
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<tr>
<td>9:00 a.m.</td>
<td>EMPLOYMENT REGISTER DISTRIBUTION OF SCHEDULES</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>ORIENTATION FOR ARIZONA HIGH SCHOOL STUDENTS</td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>EMPLOYMENT REGISTER INTERVIEWS</td>
</tr>
<tr>
<td>10:05 a.m.</td>
<td>EARLE RAYMOND HEDRICK LECTURE III</td>
</tr>
<tr>
<td>11:10 a.m.</td>
<td>AMS-MAA INVITED ADDRESS</td>
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#### AFTERNOON

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>1:00 p.m.</td>
<td>COLLOQUIUM LECTURE III</td>
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<tr>
<td>1:00 p.m.</td>
<td>SPECIAL SESSIONS</td>
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<td>Mathematics of nonlinear science</td>
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<td>Surreal numbers</td>
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<td>Integrable systems</td>
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<td>Commutative algebra and algebraic geometry</td>
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<td>Geometry of hyperbolic dynamical systems</td>
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<td>History of mathematics</td>
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<td>Computational aspects of complex analysis</td>
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<td>Stochastic processes</td>
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<td>Operator algebras and geometry</td>
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<td>Mathematics in population biology</td>
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<tr>
<td>1:00 p.m.</td>
<td>SESSIONS FOR CONTRIBUTED PAPERS</td>
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<tr>
<td>1:10 p.m.</td>
<td>INVITED ADDRESS</td>
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<tr>
<td></td>
<td>Inertial manifolds</td>
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<td>George R. Sell</td>
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<td>1:30 p.m.</td>
<td>LECTURE AND AWARDS FOR ARIZONA HIGH SCHOOL STUDENTS</td>
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<td>Matthew J. Hassett (organizer)</td>
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<td>2:15 p.m.</td>
<td>INVITED ADDRESS</td>
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<td>Computable data, noncomputable solutions</td>
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<td>Marian B. Pour-El</td>
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<td>3:15 p.m.</td>
<td>SPECIAL INVITED ADDRESS</td>
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<td>Developing a national will to enhance the quality of science and math</td>
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<td>education in America</td>
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<td>Bassam Z. Shakhashiri</td>
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<td>4:15 p.m.</td>
<td>PRIZE SESSION AND BUSINESS MEETING</td>
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<tr>
<td>6:30 p.m.</td>
<td>MINICOURSE #8 (Part C)</td>
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<td></td>
<td>Teaching mathematical modeling</td>
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<td>Frank R. Giordano</td>
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<td>Maurice D. Weir</td>
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<td>6:30 p.m.</td>
<td>MINICOURSE #13 (Part A)</td>
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<td></td>
<td>Applications of the HP28S super-calculator for more experienced users</td>
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<td>Thomas W. Tucker</td>
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<td>6:30 p.m.</td>
<td>MINICOURSE #14 (Part A)</td>
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<td>Creating order out of chaos in freshman mathematics: instituting a</td>
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<td>mathematics placement program</td>
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<td>Billy E. Rhoades</td>
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<td>6:30 p.m.</td>
<td>MINICOURSE #15 (Part A)</td>
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<td>Ada for mathematicians</td>
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<td>Joseph Straight</td>
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<tr>
<td>7:00 p.m.</td>
<td>NATIONAL MEETING OF DEPARTMENT HEADS</td>
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<td>Outside funding for the undergraduate curriculum</td>
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<td>7:30 p.m.</td>
<td>FILM PROGRAM ON RAMANUJAN</td>
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<td>The man who loved numbers</td>
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<td>8:00 p.m.</td>
<td>NO-HOST COCKTAIL PARTY</td>
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<td>9:00 p.m. - 10:30 p.m.</td>
<td>COMMITTEE ON SCIENCE POLICY SPECIAL PRESENTATION</td>
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<tr>
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<td>Using mathematical models to understand the AIDS epidemic</td>
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<td>James M. Hyman</td>
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<td>Mathematical models and public policy development: A view from the</td>
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<td>White House</td>
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<td>Beverly Berger</td>
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<td>REGISTRATION</td>
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<td>8:00 a.m. - 9:50 a.m.</td>
<td>CUPM/NRC-MS2000 CALCULUS INITIATIVES PANEL DISCUSSION</td>
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<td>Calculus initiatives-an update</td>
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<td>Ronald G. Douglas (co-organizer)</td>
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<td>Thomas W. Tucker (co-organizer)</td>
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<td>8:00 a.m. - 9:50 a.m.</td>
<td>MINICOURSE #7 (Part B)</td>
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<td>Computer based discrete mathematics</td>
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<td>Nancy Hood Baxter</td>
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<td>Ed Dubinsky</td>
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<td>8:00 a.m. - 10:50 a.m.</td>
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<td>Mathematics of nonlinear science</td>
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<td>Foundations of complexity theory for numerical analysis</td>
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<td>Commutative algebra and algebraic geometry</td>
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<td>Computational group theory</td>
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<td>Singular perturbation theory</td>
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<tr>
<td>8:30 a.m. - 9:50 a.m.</td>
<td><strong>AMS-MAA TEACHING ASSISTANTS AND PART-TIME INSTRUCTORS WORKSHOP (TA/PTI)</strong>&lt;br&gt;<strong>PLENARY SESSION</strong>&lt;br&gt;Bettye Anne Case (organizer)</td>
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<tr>
<td>9:00 a.m. - 10:00 a.m.</td>
<td><strong>EXHIBIT AND BOOK SALE</strong></td>
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<tr>
<td>9:00 a.m. - noon</td>
<td><strong>BOOK SALE</strong></td>
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<tr>
<td>10:00 a.m. - 10:55 a.m.</td>
<td><strong>INVITED ADDRESS</strong>&lt;br&gt;Can you hear the shape of a drum?&lt;br&gt;Peter B. Gilkey</td>
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<tr>
<td>11:10 a.m. - noon</td>
<td><strong>AMS-MAA INVITED ADDRESS</strong>&lt;br&gt;Indeterminate forms revisited&lt;br&gt;Ralph P. Boas</td>
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<tr>
<td>12:05 p.m. - 1:00 p.m.</td>
<td><strong>AMS-MAA TA/PTI WORKSHOP LUNCHEON MEETING</strong></td>
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<tr>
<td>12:15 p.m. - 2:05 p.m.</td>
<td><strong>SPECIAL SESSION</strong>&lt;br&gt;Foundations of complexity theory for numerical analysis&lt;br&gt;Computational aspects of complex analysis</td>
</tr>
<tr>
<td>1:00 p.m. - 2:00 p.m.</td>
<td><strong>COLLOQUIUM LECTURE IV</strong>&lt;br&gt;Title to be announced&lt;br&gt;Nicholas Katz</td>
</tr>
<tr>
<td>1:00 p.m. - 2:00 p.m.</td>
<td><strong>AMS-MAA TA/PTI WORKSHOP DISCUSSION PERIOD</strong>&lt;br&gt;Bettye Anne Case (organizer)</td>
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<tr>
<td>1:15 p.m. - 5:00 p.m.</td>
<td><strong>CONTRIBUTED PAPER SESSION</strong>&lt;br&gt;What is happening with calculus revision?&lt;br&gt;John W. Kenelly&lt;br&gt;Thomas W. Tucker</td>
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### Saturday, January 14 (cont'd)

#### AFTERNOON (cont'd)

<table>
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<tr>
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<th>Session</th>
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| 1:15 p.m. - 4:00 p.m. | CONTRIBUTED PAPER SESSION  
Writing across the curriculum  
Gerald M. Bryce                  |
| 1:15 p.m. - 4:00 p.m. | CONTRIBUTED PAPER SESSION  
History of mathematics  
Charles V. Jones                 |
| 1:15 p.m. - 3:15 p.m. | MINICOURSE #12 (Part B)  
muMATH workshop  
Wade Ellis, Jr.                  |
| 1:15 p.m. - 3:15 p.m. | MINICOURSE #13 (Part B)  
Applications of the HP28S super-calculator for more experienced users  
Thomas W. Tucker               |
| 1:15 p.m. - 3:15 p.m. | MINICOURSE #14 (Part B)  
Creating order out of chaos in freshman mathematics: instituting a mathematics placement program  
Billy E. Rhoades               |
| 1:15 p.m. - 3:15 p.m. | MINICOURSE #15 (Part B)  
Ada for mathematicians  
Joseph Straight                  |
| 1:15 p.m. - 4:00 p.m. | SESSION ON TEACHING  
MATHEMATICAL MODELING  
B. A. Fusaro (co-organizer)  
E. J. Manfred (co-organizer) |
**Saturday, January 14, (cont’d)**

**AFTERNOON (cont’d)**

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<td>AMS-MAA TA/PTI WORKSHOP PLENARY SESSION Bettye Anne Case (organizer)</td>
<td>MINICOURSE #7 (Part C) Computer based discrete mathematics Nancy Hood Baxter Ed Dubinsky</td>
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<td>3:30 p.m. - 5:30 p.m.</td>
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<td>AMS-MAA COMMITTEE ON EMPLOYMENT AND EDUCATIONAL POLICY PANEL DISCUSSION Recruiting for graduate programs in mathematics Edward A. Connors (moderator) Rhonda J. Hughes Paul D. Humke John M. Jobe Ralph N. McKenzie</td>
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<tr>
<td>4:25 p.m. - 5:15 p.m.</td>
<td>INVITED ADDRESS Periodic orbits and determinants David Fried</td>
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<td>AMS-MAA PRESIDENTS’ CONCERT William Browder Leonard Gillman</td>
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<td>4:30 p.m. - 5:45 p.m.</td>
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<td>5:30 p.m. - 7:00 p.m.</td>
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<td>BANQUET FOR 25-YEAR MEMBERS</td>
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The Mathematical Sciences Employment Register (MSER), held annually at the Joint Mathematics Meetings in January, provides opportunities for mathematical scientists seeking professional employment to meet employers who have positions to be filled. Job listings (or descriptions) and résumés prepared by employers and applicants are displayed at the meeting for the participants so that members of each group may determine which members of the other group they would like to have an opportunity to interview. A computer program assigns the appointments, matching requests to the extent possible, using an algorithm which maximizes the number of interviews which can be scheduled subject to constraints determined by the number of time periods available, the numbers of applicants and employers, and the pattern of requests. The report below outlines the operation of the register, indicating some of the procedures involved for the benefit of those not familiar with its operation.

The Mathematical Sciences Employment Register is apparently unique among employment services offered by professional organizations in the sciences, engineering and the humanities. The computer programs used are constructed around a matching program, devised by Donald R. Morrison, and based on an algorithm described in his paper "Matching Algorithms" in Journal of Combinatorial Theory, volume 6 (1969), pages 20 to 32; see also "Matching Algorithms" (abstract) Notices, August 1967, page 630. The number of interviews arranged by the program is significantly greater than the number possible at the employment registers of other organizations, in many cases greater by an order of magnitude.

1989 Employment Register in Phoenix

The Employment Register will be held on Wednesday, Thursday, and Friday, January 11, 12, and 13, 1989. A short (optional) orientation session will be conducted by the AMS-MAA-SIAM Committee on Employment Opportunities at 9:00 a.m. on Wednesday, January 11. The purpose of the orientation session is to familiarize participants with the operation of the Register and with the various forms involved. Following orientation, participants should pick up their material for participating in the Employment Register. Computer-scheduled interviews will be held on Thursday and Friday, January 12 and 13. No interviews will be held on Wednesday.

Fifteen-minute intervals are allowed for interviews, including two or three minutes between successive interviews. The interviews are scheduled in half-day sessions: Thursday morning and afternoon, and Friday morning and afternoon, amounting to four half-day sessions for interviews. There are ten time periods (9:30 – 11:45 a.m.) in which interviews can be scheduled in the morning and fourteen time periods (1:15 – 5:00 p.m.) in the afternoon. It is possible that an applicant or employer may be scheduled for the maximum number of interviews in a session. Requests for interviews will be accommodated depending on the availability of participants. The scheduling program does not have a provision allowing participants to specify particular times for interviews beyond the choice of session (day, and morning or afternoon). Such requests cannot be accommodated.

Requests for interviews taking place during the two sessions on Thursday MUST BE SUBMITTED on Wednesday between 9:30 a.m. and 4:00 p.m. Requests for interviews to take place during the Friday sessions must be submitted on Thursday before 4:00 p.m. Those who fail to do so cannot be included in the pool of available participants when the matching program which schedules the interviews is run on the computer that night. This applies to all employers and applicants both preregistered and on-site registrants. Forms submitted with preregistration achieve registration for the Employment Register only. These forms do not automatically include the participant

Background of Applicants

Statistics from previous Employment Registers have shown employers sought to fill approximately 180 positions, 10 of which were nonacademic jobs. For 98% of the positions, holders of doctoral degrees were preferred, for 65% of the positions only applicants with doctorates were acceptable, for 30% of the positions, holders of masters degrees were considered eligible. Few of the nonacademic employers indicated an interest in holders of bachelors degrees in mathematics.
in the interviewing process. The interview request forms handed out at the Employment Register must be turned in before the 4:00 p.m. deadline in order to receive a computer printed schedule the next day.

On Thursday and Friday mornings at 9 a.m. all schedules for applicants and employers for the day (both morning and afternoon sessions) will be available for distribution.

The Friday afternoon session is the annual “employers’ choice” session. For this session interviews will be scheduled on the basis of requests made by employers. Applicants do not submit specific interview requests for this session; but, in order to participate they must indicate their availability for the session by returning the Interview Request Form for Friday, indicating that they will attend the afternoon session that day.

Applicants should be aware of the fact that interviews arranged by the Employment Register represent only an initial contact with employers, and that hiring decisions are not ordinarily made during or immediately following such interviews. Applicants are advised to bring a number of copies of their vitae or résumés so that they may leave them with prospective employers.

The Mathematical Sciences Employment Register is sponsored by the American Mathematical Society, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics; it is operated by members of the AMS staff under the general supervision of the joint AMS-MAA-SIAM Committee on Employment Opportunities.

Anyone with questions about the Employment Register should contact Carole Kohanski at the American Mathematical Society at 401-272-9500, extension 286. The telephone number to be used after the Register begins will be announced in a later issue. Participants should note that this number will be for those who will be participating in the Employment Register and is not for contacting participants or taking messages. Those who wish to leave messages should call the message center telephone number found in the Phoenix meeting announcement.

Preregistered Employers/Applicants

Preregistration for the Mathematical Sciences Employment Register must be completed by November 10, 1988. Applicants and employers (including all interviewers) who wish to preregister for the Employment Register must also register for the Joint Mathematics Meetings. Forms for preregistration, housing, the applicant résumé form, and the employer form are located in the back of this issue. Preregistration for the Employment Register, in addition to permitting inclusion in the printed winter lists of Applicants and Employers, has the advantage of reduced fees and the services of the Mathematics Meetings Housing Bureau, and has the further advantage of helping to reduce waiting times at the meeting in Phoenix.

Employer or Applicant forms received after the November 10 deadline cannot be included in the printed lists. For details on registration and preregistration for the Phoenix Joint Mathematics Meetings, please refer to the information on these subjects which may be found elsewhere in this issue.

Employers and applicants who have preregistered for the Employment Register may pick up their MSER material after 9:30 a.m. on Wednesday, January 11. (This material includes the interview request forms which are handed out at the meeting only.) These are not the forms that are submitted with preregistration.

Employers’ job listings and applicants’ résumés will be posted at the meeting, so that applicants and employers may review them.

Material for the Employment Register will not be mailed in advance.

Preregistered Applicants

In addition to the Joint Meetings preregistration fee, there is an applicant fee of $15 payable prior to the November 10 deadline. These fees must be accompanied by the Preregistration/Housing Form.

Applicants’ résumés will be made available to employers at the Employment Register in printed form, so that they may be studied carefully at leisure. The December issue of Employment Information in the Mathematical Sciences (EIMS) will contain photographic reproductions of the résumés of applicants who have preregistered by November 10. Forms not received in time cannot be included in this issue. See the section on preparation of résumés elsewhere in this announcement.

Employers’ job listings and applicants’ résumés will be posted at the meeting, so that applicants and employers may review them.

Preregistered Employers

In addition to the Joint Meetings preregistration fee, there is a separate charge for each employer who will be interviewing applicants at the register. There is no additional charge for posting more than one position, provided they are in the same department.

Please refer to the Preregistration/Housing Form for the Joint Mathematics Meetings and the Employment Register fees. These fees must be accompanied by the Preregistration/Housing Form. The registration fee for employers covers the cost of a copy of the December Issue of Employment Information in the Mathematical Sciences (EIMS). This publication (distributed at the meeting) contains printed copies of the résumés of applicants who preregistered prior to the deadline; it also contains a copy of the Winter List of Applicants. It is requested that employers submit both employer and
Preregistration/Housing Forms with appropriate fees in the same envelope. It would also be helpful if the names of cointerviewers are listed on the employer form. If possible, these individuals should also preregister at the same time.

It is the policy of some institutions to pay for employer fees. These payments do not always accompany the preregistration forms but are sent in after the deadline has passed, or when the meeting is over. It is important that the institution’s fiscal department indicate the name of the participating employer with their remittance advice or payment order so that proper credit can be made in Providence.

Employers are encouraged to provide more than one interviewer, when they are able to do so, in order to increase the number of interviews which may be scheduled. Please take care to indicate on the form the number and names of interviewers for whom simultaneous interviews may be scheduled. (If all interviewers will be interviewing for the same position, or for the same set of positions, only one form should be submitted and only one employer code number will be assigned; therefore, each interviewer would then receive a separate computer schedule and separate table number.) More than one employer code will be required if some interviewers will not interview for all positions. Thus, if there are two disjoint sets of positions, two forms are required and two employer codes will be assigned.

A coded strip at the bottom of the form summarizes the information on each form. All employers are required to complete the Summary Strip. This is used to prepare a computer-printed list of preregistered employers for distribution to the applicants at the meeting.

Nonpreregistered Applicants and Employers

Employers and applicants who wish to participate in the Register who have neither preregistered nor paid the Employment Register fee must first go to the Joint Mathematics Meetings registration desk, in order to complete their registration. No provision will be made to handle cash transactions at the site of the Employment Register. Registration for the Joint Meetings is required for participation in the Employment Register. It is also required that all participating employer interviewers register for the Joint Mathematics Meetings.

Please refer to the Preregistration/Housing Form for onsite registration fees.

Onsite registration for the Employment Register is $100 for employers and an additional $50 for each additional interviewer and $20 for applicants. The registration fee for employers covers the cost of a copy of the December Issue of Employment Information in the Mathematical Sciences (EIMS). This publication contains printed copies of the résumés of applicants who preregistered prior to the deadline and a copy of the Winter List of Applicants.

After registration has been completed, applicants and employers should come to fill out the forms necessary to participate in the Employment Register. Employers’ job listings and applicants’ résumés will be posted at the meeting, so that applicants and employers may review them.

Nonparticipating Employers

Employers who do not plan to participate in the Employment Register, but wish to display job descriptions, may obtain special forms from Carole Kohanski, MSER, P. O. Box 6248, Providence, RI 02940. These job descriptions, subject to approval, must be received in the Providence office by November 10 in order to qualify for the reduced fee of $10. There is a $15 fee for listings received after the November 10 deadline.

Employers who attend the Joint Mathematics Meetings, but do not want to interview, can post job descriptions, subject to approval, at the Employment Register. Postings will not be allowed in the Joint Meetings registration area. A fee of $15 will be charged payable to the cashier at the Joint Mathematics Meetings registration desk. Participants should be sure to inform the cashier that they would like to post a job description but are not planning to interview and obtain the proper receipt in order to receive the form necessary for posting at the Employment Register desk.

Applicants Not Planning to Attend

Applicants for professional positions in the mathematical sciences, who do not plan to attend the meeting in Phoenix and participate in the Employment Register, may also submit résumés for publication in the December issue if they use the MSER Form for Applicants at the back of this issue and observe the deadline of November 10. (It is, of course, not necessary to preregister for the meeting or pay the Employment Register registration fee if one is not attending the meeting. Résumés will not be posted at the Employment Register if the participant is not attending the meeting.)

Winter Lists of Applicants and Employers

The Winter List of Applicants, which is a summary of the résumés of preregistered applicants, will be available for sale at the AMS Exhibits and Book Sale at the meeting. The price at the meeting is $5 each. Any copies remaining after the meeting will be available from the Providence office of the Society for $7 each.

The Winter List of Employers consists of summaries of the position listings submitted by the employers who preregistered for the meeting; it will be distributed to the applicants participating in the Register. Others may purchase the Winter List of Employers at the AMS Exhibits and Book Sale at the meeting or from the Providence office after the meeting. The prices are the
Meetings

applicants are strongly advised to study the suggestions given below before the forms are filled out, so that the original copy will be neither marred nor damaged.

The forms must be carefully typed using a new black ribbon. The best results are obtained by using a modern typewriter with a carbon-coated polyethylene film ribbon, but satisfactory results may be obtained with a ribbon made of nylon or other woven fabric if suitable care is exercised. It is important that the keys be clean and make a sharp, clear impression, which must be a uniform dark black. Gray, blue, or other colors will not reproduce and should, therefore, not be used. Do not use an eraser, as it will cause smudges which reproduce when photographed. Use a correcting typewriter, or correction tape or fluid, if necessary.

Only an original copy of the form should be submitted, a photocopy or xerographic reproduction will not reproduce as well and may not be accepted for publication. It is therefore important to exercise care in order to assure that the results are satisfactory.

Submission of copy of good quality is entirely the responsibility of the applicant. The Society (which will print this material) must be the final judge of what copy is capable of being reproduced adequately, and therefore of what is acceptable for inclusion in the printed booklet. The Society will not correct or replace inadequate copy, and cannot prepare original copy. In the event the quality of a résumé, submitted by an applicant participating in the Employment Register, does not meet the necessary conditions for inclusion in the December issue, the résumé will be returned if time allows; otherwise the résumé will be posted at the Employment Register in Phoenix, along with those of the other participants. Forms received past the deadline of November 10 will be returned.

List of Retired Mathematicians
Available for Employment

The annual List of Retired Mathematicians will be included in the December and January issues of the publication Employment Information in the Mathematical Sciences. Retired mathematicians who are interested in being included in the list may send the following information to the Mathematical Sciences Employment Register, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940.

1. Full Name
2. Mailing Address
3. Highest degree, year, university
4. Most recent employment: institution
5. Type of position desired
6. Academic or industrial employment preferred
7. Date available for employment (month/year)
8. Geographic location preferred

The deadline for receipt of this information is November 10. Offprints of the list will be available from the Mathematical Sciences Employment Register, American Mathematical Society, P.O. Box 6887, Providence, Rhode Island 02940.
The American Mathematical Society, in conjunction with its ninety-fifth Annual Meeting, will present a two day Short Course entitled "Matrix Theory and Applications" on Tuesday and Wednesday, January 10-11, 1989, at the Phoenix Civic Plaza. The program is under the direction of Charles R. Johnson of The College of William and Mary.

Matrix theory is a part of mathematics that has undergone a renaissance in the last fifteen years, in part due to stimulation from applications and computing, and in part due to extensive connections with most other areas of mathematics. The emphasis in this Short Course will be upon concepts from matrix analysis that are important in areas of modern applied mathematics. This program will exhibit the interplay between applications and theoretical development of matrix theory, and provide a setting in which participants can become acquainted with newer methods and ideas of the subject. The course should be especially useful to those currently involved or planning to become involved in research or teaching in the field.

The course will consist of an overview by the organizer, and six 75-minute lectures, representing a selection of areas that are major users of and stimuli to matrix theory. Speakers and topics scheduled are as follows:

Tuesday, January 10, 1988:
Charles R. Johnson, The College of William and Mary, An Overview of the Subject and the Course.
Richard A. Brualdi, University of Wisconsin, Combinatorial Matrix Theory.
Persi Diaconis, Harvard University, Eigen Analyses of Matrices with Symmetry Properties.
Arunava Mukherjea, University of South Florida, The Role of Nonnegative Idempotent Matrices in Certain Problems in Probability.

Wednesday, January 11, 1988:
Roger A. Horn, Johns Hopkins University, The Hadamard Product.
I. Gohberg, Tel Aviv University, Interpolation Problems for Rational Matrix Functions.
Ingram Olkin, Stanford University, Interplay between Matrix Theory and Multivariate Statistics (tentative title).

Synopses of the talks and accompanying reading lists appear in this issue of Notices. Complete lecture notes will be mailed to those who preregister for the course and will be available at the Short Course registration desk for those registering on site.

The lectures will require no advanced background in matrix theory or the particular subject areas to which it is applied, and should be accessible to participants with conventional graduate training in mathematics. Fundamental skills in linear algebra, an interest in matrix theory, and prior reading of materials suggested by the speakers will make the course more meaningful. A rich general background of topics in the spirit of the course may be found in Matrix Analysis by R. Horn and C. Johnson, Cambridge University Press, 1985.

All who wish to participate in the Short Course may do so upon payment of a $40 advance registration fee ($50 on site). There are reduced fees for students and unemployed individuals. For registration and housing information, please refer to the sections in this issue of Notices titled Preregistration, Housing and Registration at the Meetings.

The Short Course was recommended by the AMS-MAA Committee on Employment and Educational Policy (CEEP), whose members are Morton Brown, Stefan A. Burr, Edward A. Connors (chair), Philip C. Curtis, Jr., Don O. Loftsgaarden, David J. Lutzer, and Audrey A. Terras. The Short Course series is under the direction of the Short Course Subcommittee, whose members are Stefan A. Burr (chair), R. Peter DeLong, Lisl Novak Gaal, Robert P. Kurshan, Barbara L. Osofsky, Marjorie L. Stein, and James J. Tattersall.
The following synopses are arranged in the order of presentation as currently scheduled. The final schedule will be available at the Short Course registration desk.

**Combinatorial Matrix Theory** (Richard A. Brualdi). Combinatorics and matrix theory impact on one another in several ways. (i) The introduction of the incidence matrix of a combinatorial configuration allows the powerful tools of matrix theory to be applied in combinatorics. For example, Fisher's inequality that the number of blocks in a balanced incomplete block design is at least as large as the number of points is a simple consequence of an elementary property of rank. (ii) Combinatorics has also been an important tool in the finer analysis of matrices. The combinatorial structure of a matrix (the zero-nonzero pattern, or the graph, bipartite graph, or digraph of the matrix) often gives additional information about matrix properties and suggests new problems. For example, Gershgorin's theorem for eigenvalue location has been extended to take into account the combinatorial structure of the matrix. In addition, several classical matrix theorems have been given new and revealing proofs which are mainly combinatorial in nature. (iii) Finally, there are a large number of theorems which are combinatorial theorems about matrices in which the matrix is regarded not as an algebraic object but as a data structure. One of the most famous examples is König's theorem about the maximum number of independent 1's in a matrix of 0's and 1's.

I will give many illustrations of the increasing influence of combinatorics on matrix theory and of matrix theory on combinatorics.


**Eigen Analyses of Matrices with Symmetry Properties** (Persi Diaconis). Patterned matrices arise in applications like statistics, probability, and inversion of Radon transforms. Often a group of symmetries can be found to describe the pattern. This allows character theory to go to work and provide all the eigenvalues and eigenvectors. This provides a sweeping generalization of circulants. Recent developments include a way of interpolating between class functions and bi-invariant functions on a Gel'fand pair.


**The Role of Nonnegative Idempotent Matrices in Certain Problems in Probability** (A. Mukherjea). Idempotent matrices occur frequently in probability and statistics in various contexts. Here we will discuss their role in contexts only recently studied. The structure of an idempotent stochastic matrix is wellknown and very simple—roughly, except for a number of zero columns and corresponding rows, it consists of diagonal blocks of rank one stochastic matrices. This motivates and helps us determine the structure of idempotent nonnegative matrices and even idempotent nonnegative kernels. This, in turn, helps us understand the structure of certain important (multiplicative) semigroups of nonnegative matrices. Facts such as compact (with usual topology) groups of nonnegative matrices have to be finite, or that the only limiting (in the weak sense) distributions of products of independent and identically distributed (iid) random bistochastic matrices, are uniform distributions on finite subgroups of these matrices are easy observations of the aforementioned structure theory. We will discuss how some of these ideas can often lead to easy-to-check necessary and sufficient conditions for convergence in distribution of products of iid random nonnegative matrices. We will also discuss how one can often describe completely the
convergence of forward as well as backward products of stochastic matrices in terms of the block structure of a certain stochastic idempotent matrix. Here ergodicity of matrix products becomes relevant and ergodicity results for products of finite as well as infinite dimensional nonnegative matrices will also be discussed.


The Hadamard Product (R. A. Horn). The Hadamard product of two matrices $A = [a_{ij}]$ and $B = [b_{ij}]$ of the same size with entries in a given ring is the entry-wise product $A \circ B = [a_{ij}b_{ij}]$. This seemingly naive rule for composing two matrices (sometimes called the Schur product) is much simpler than the usual rule for matrix multiplication, but nevertheless it enjoys considerable rich structure.

Although the Hadamard product arises naturally in numerous interesting applications, it is rarely even mentioned in linear algebra texts. In the context of integral equations, however, it is entirely natural: If one has two complex-valued integral kernels $K(x, y)$ and $H(x, y)$ over some real interval $(a, b) \times (a, b)$, one may be interested in their ordinary pointwise product $L(x, y) = K(x, y)H(x, y)$, which corresponds to the Hadamard product, not the ordinary matrix product. In matrix theory itself, the value of the Hadamard product is suggested by the observation that the ordinary product of two Hermitian matrices need not be Hermitian, but their Hadamard product is always Hermitian. In this same spirit, the celebrated Schur Product Theorem says that the Hadamard product of two positive definite matrices is always positive definite, a closure property that is, of course, false for the ordinary product.

To illustrate that a systematic study of the Hadamard product may be of more than just theoretical interest, we first present examples of how it arises in such areas as partial differential equations, statistics, probability, conformal mapping, moment problems, perturbation theory, systems theory, and control theory. We then discuss some theorems about Hadamard products that give useful results in the areas in which they arise.


Interpolation Problems for Rational Matrix Functions (I. Gohberg). A number of basic interpolation problems and results for scalar rational functions are generalized for rational matrix valued functions. The talk is a review of recent results and methods.

The problem of how a rational matrix function is determined via its zero and pole structure will be analyzed. The role of this problem in solving Nevanlinna-Pick problems will be discussed. Nonstandard interpolation problems for rational unitary matrix functions and their connections with inertia theorems are also included.

Interplay between Matrix Theory and Multivariate Statistics (Ingram Olkin). Linear algebra is a fundamental tool for the development of multivariate statistical methods. Conversely, statistical questions often give rise to new problems in linear algebra and matrix theory. I will illustrate this mutual interdependence and feedback by citing a number of examples from statistics that have led to interesting developments in matrix theory and linear algebra.

Some of the main areas that exhibit this dependence are: (1) characterization of distributions, (2) multivariate distribution theory, (3) multivariate probability inequalities, (4) extremal problems, (5) least squares type problems.

Multivariate characterization problems are frequently stated in terms of independence properties, which give rise to functional equations with matrix arguments. Multivariate distribution theory involves matrix transformations and the evaluation of multiple integrals. Probability inequalities, often called Chebyshev inequalities, can be formulated as extremal problems. In several important examples these result in showing the existence of new matrix factorizations. Extremal problems arise primarily from maximum likelihood estimation. As an alternative least square type problems often provide a solution for multivariate models with a linear structure on the means.


The length of time allotted to the lecture will not permit a detailed discussion of each topic, and we will try to provide a survey of the highlights that will serve to illustrate the main ideas.

Joint Mathematics Meetings

January 11-14, 1989
Phoenix, Arizona
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.

Phoenix, January 1989
Lenore Blum
Ralph P. Boas (AMS-MAA)
John H. Conway
Percy Alec Deift
David Fried
Ronald L. Graham (AMS-MAA)

Peter Landweber (AMS-MAA)
Diana Frost Shelstad
Stephen Smale (AMS-MAA)
Luc Tartar

Worcester, April 1989
Igor Frankel
Thomas H. Parker

Karl Rubin
Adrian Ocneanu

Chicago, May 1989
Henri Gillet
Nicholas Lerner

Richard Rochberg
Shmuel Weinberger

Muncie, October 1989
Kenneth Meyer
Paul S. Muhly

Steven Sperber

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.

January 1989 Meeting in Phoenix
Associate Secretary: Lance W. Small
Deadline for organizers: Expired
Deadline for consideration: Expired
Melvyn S. Berger, *Mathematics of nonlinear science*
Lenore Blum, *Foundations of complexity theory for numerical analysis*
John H. Conway, Harry Gonshor, and Martin Kruskal, *Surreal numbers*
Percy Alec Deift, *Integrable systems*
David Eisenbud and Craig Huneke, *Commutative algebra and algebraic geometry*
David Fried and Joseph Christie, *Geometry of hyperbolic dynamical systems*
Larry C. Grove and M. F. Newman, *Computational group theory*
William A. Harris, *Singular perturbation theory*
Victor J. Katz and Florence Fasanelli, *History of Mathematics*
Albert Marden and Burton Rodin, *Computational aspects of complex analysis*
Sidney Port, *Stochastic processes*
Marc A. Rieffel, *Operator algebras and geometry*
Hal L. Smith and James Cushing, *Mathematics in population biology*

April 1989 Meeting in Worcester
Eastern Section
Associate Secretary: W. Wistar Comfort
Deadline for organizers: Expired
Deadline for consideration: January 4, 1989
Richard Herman and Adrian Ocneanu, *Operator algebras, Galois theory and representations*
James Lepowsky, *Infinite-dimensional symmetries in mathematics and physics*
Thomas H. Parker, *Gauge theory and differential geometry*
Karl Rubin and Glenn Stevens, *L-functions and arithmetic*
Lee Rudolph, *Knot theory and algebraic geometry in the large*
May 1989 Meeting in Chicago  
Central Section  
Associate Secretary: Andy Roy Magid  
Deadline for organizers: November 15, 1988  
Deadline for consideration: August 9, 1989  

Jeffery Bergen, Noncommutative ring theory  
Martin Butinas and Billy Rhoades, Sequence spaces and summability  
Jonathan Cohen, Numerical methods in harmonic analysis  
Vinay Deodhar, Kazhdan-Lusztig theory and related topics  
Stephen Doty, Algebraic groups and related topics  
Christine Haught, Recursion theory  
Cary Huffman and Neal Brand, Codes and designs  
Ronnie Lee and Steven Weintraub, Algebraic topology of varieties  
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: November 15, 1988  
Deadline for consideration: April 25, 1989

October 1989 Meeting in Hoboken  
Eastern Section  
Associate Secretary: W. Wistar Comfort  
Deadline for organizers: January 15, 1989  
Deadline for consideration: August 9, 1989

October 1989 Meeting in Muncie  
Central Section  
Associate Secretary: Andy Roy Magid  
Deadline for organizers: January 15, 1989  
Deadline for consideration: August 9, 1989

Information for Organizers

Special Sessions at Annual and Summer Meetings are held under the supervision of the Program Committee for National Meetings. They are administered by the Associate Secretary in charge of that meeting with staff assistance from the Meetings and Editorial Departments in the Society office in Providence.

According to the “Rules for Special Sessions” of the Society, Special Sessions are selected by the Program Committee from a list of proposed Special Sessions in essentially the same manner as Invited Speakers are selected. The number of Special Sessions at a Summer or Annual Meeting is limited. The algorithm that determines the number of Special Sessions allowed at a given meeting, while simple, is not repeated here, but may be found in “Rules for Special Sessions” which can be found on page 614 in the April 1988 issue of Notices.

Each Invited Speaker is invited to generate a Special Session, either by personally organizing one or by having a Special Session organized by others. Proposals to organize a Special Session are sometimes requested either by the Program Committee or by the Associate Secretary. Other proposals to organize a Special Session may be submitted to the Associate Secretary in charge of that meeting (who is an ex-officio member of the committee and whose address may be found below). These proposals must be in the hands of the Program Committee well in advance of the meeting and, in any case, at least nine (9) months prior to the meeting at which the Special Session is to be held in order that the committee may consider all the proposals for Special Sessions simultaneously. Proposals that are sent to the Providence office of the Society, to the Notices, or directed to anyone other than the Associate Secretary will have to be forwarded and may not be received in time to be considered for acceptance.

It should be noticed that Special Sessions must be announced in the Notices in such a timely fashion that any member of the Society who so wishes may submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration. This deadline is usually three (3) weeks before the Deadline for Abstracts for the meeting in question.

Special Sessions are very effective at Sectional Meetings and can usually be accommodated. They are selected by the Committee to Select Hour Speakers for the Section. The processing of proposals for Special Sessions for Sectional Meetings is handled by the Associate Secretary for the Section, who then forwards the proposals to the Committee to Select which makes the final selection of the proposals. Each Invited Speaker at a Sectional Meeting is invited to organize a Special Session. Just as for national meetings, no Special Session at a Sectional Meeting may be approved so late that its announcement appears past the deadline after which members can no longer send abstracts for consideration for presentation in that Special Session.

The Society reserves the right of first refusal for the publication of proceedings of any Special Session. These proceedings appear in the book series Contemporary Mathematics.

More precise details concerning proposals for and organizing of Special Sessions may be found in the “Rules for Special Sessions” or may be obtained from any Associate Secretary.

Send Proposals for Special Sessions to the Associate Secretaries

The programs of sectional meetings are arranged by the Associate Secretary for the section in question:

Far Western Section (Pacific and Mountain)  
Lance W. Small, Associate Secretary  
Department of Mathematics  
University of California, San Diego  
La Jolla, CA 92093  
(Telephone 619–534–3590)
Central Section
Andy Roy Magid, Associate Secretary
Department of Mathematics
University of Oklahoma
601 Elm PHSC 423
Norman, OK 73019
(Telephone 405-325-2052)

Eastern Section
W. Wistar Comfort, Associate Secretary
Department of Mathematics
Wesleyan University
Middletown, CT 06457
(Telephone 203-347-9411)

Southeastern Section
Frank T. Birtel, Associate Secretary
Department of Mathematics
Tulane University
New Orleans, LA 70118
(Telephone 504-865-5646)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

Information for Speakers
A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special Session has been scheduled. Contributors should know that there is a limitation in size of a single special session, so that it is sometimes true that all places are filled by invitation. Papers not accepted for a Special Session are considered as ten-minute contributed papers.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Editorial Department, American Mathematical Society, P. O. Box 6248, Providence, RI 02940) by the special deadline for Special Sessions, which is usually three weeks earlier than the deadline for contributed papers for the same meeting. The Council has decreed that no paper, whether invited or contributed, may be listed in the program of a meeting of the Society unless an abstract of the paper has been received in Providence prior to the deadline.

Read Why Chaos is Being Called the Third Great Revolution of the 20th Century in

CHAOS: Making a New Science, by James Gleick

Over the last decade, a new way of understanding the growth of complexity in nature has developed. This new science, called chaos, offers a way of seeing order and pattern where formerly only the random, the erratic, the unpredictable had been observed.

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CHAOS is a history of scientific discovery. It chronicles, in the participants' own words, their conflicts and frustrations, their emotions and moments of revelation. It is a record of a revolution, the birth of a new science.

"Gleick covers the ideas masterfully, clearly explaining just what 'mathematical chaos' means, and telling how and why it crops up in so many diverse domains. Also by vividly portraying many of the major figures in the development of the theory, Gleick shows how complexly tangled the story is, on the human level. Gleick's CHAOS is not only enthralling and precise, but full of beautifully strange and strangely beautiful ideas."

Douglas Hofstadter
author of "Godel, Escher, Bach"

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Mathematical Sciences
Meetings and Conferences


October 1988

11–14. Conference on Mathematical Topics in Biology, Kyoto University, Japan.

INFORMATION: Research Institute for Mathematical Sciences, Kyoto University, Kitashirakawa, Sakyo-ku, Kyoto 66, Japan.


PROGRAM: The scientific program will consist of approximately 18 lectures, communications, and problem sessions on discrete programming and optimization; combinatorics of graphs and relations; scheduling and algorithms of ordered sets; automata, languages and universal algebra; logic and languages in computer science.

INFORMATION: A. Achache or M. Pouzet, Groupe LMDI de l'I.S.M., Université Claude Bernard Lyon 1 43, Boulevard du 11 Novembre 1918, 69622 - Villeurbanne cedex - France; G. Hahn or I. Rosenberg, Département de Mathématiques et Statistiques, Université de Montréal, Case postale 6128 succ. A, Montréal H3C3J7 - Québec - Canada.

*17–21. Conference on Solvable Methods in Quantum Field Theory and Statistical Mechanics, Kyoto University, Japan.

INFORMATION: Research Institute for Mathematical Sciences, Kyoto University, Kitashirakawa, Sakyo-ku, Kyoto 606, Japan.


INFORMATION: Research Institute for Mathematical Sciences, Kyoto University, Kitashirakawa, Sakyo-ku, Kyoto 606, Japan.


28–30. Central Sectional Meeting of the AMS, Lawrence, Kansas.
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| 5–7. Conference on Operator Theory, Kyoto University, Japan. |
| **INFORMATION** | Research Institute for Mathematical Sciences, Kyoto University, Kitashirakawa, Sakyo-ku, Kyoto 606, Japan. |
| **INFORMATION** | W. R. Young, Medical Research Division, American Cyanamid Building 60, Room 203, Pearl River, New York 10965, 914-735-5000, extension 3224. |
| **INFORMATION** | Research Institute for Mathematical Sciences, Kyoto University, Kitashirakawa, Sakyo-ku, Kyoto 606, Japan. |
| *7–9. Conference on Soliton Theory, Kyoto University, Japan. |
| **INFORMATION** | Research Institute for Mathematical Sciences, Kyoto University, Kitashirakawa, Sakyo-ku, Kyoto 606, Japan. |
| **INFORMATION** | Research Institute for Mathematical Sciences, Kyoto University, Kitashirakawa, Sakyo-ku, Kyoto 606, Japan. |
| **INFORMATION** | Research Institute for Mathematical Sciences, Kyoto University, Kitashirakawa, Sakyo-ku, Kyoto 606, Japan. |
Meetings and Conferences


INFORMATION: Research Institute for Mathematical Sciences, Kyoto University, Kitashirakawa, Sakyo-ku, Kyoto 606, Japan.


12-17. International Course on Computational Geometry, Dipartimento di Matematica, Università, Catania, Italy. (May/June 1988, p. 730)


14-16. Raj Chandra Bose Memorial Conference on Combinatorial Mathematics and Applications, Calcutta, India. (July/August 1988, p. 894)

*15-18. Interdisciplinary Conference on Axiomatic Systems, Ohio State University, Columbus, Ohio.

PROGRAM: Approximately 25 invited speakers are expected to participate, representing the fields of proof theory, nonstandard logics, axiomatic algebra/geometry, measurement theory, decision theory/probability, software verification, database systems and proof checking.

INFORMATION: L. Roberts, Department of Conferences and Institutes, 225 Mount Hall, 1050 Carmack Road, Columbus, Ohio 43210, 614-292-8571.


27-31. Holiday Symposium on Fermat's Last Theorem, New Mexico State University, Las Cruces, New Mexico. (September 1988, p. 1057)

January 1989

2-5. International Colloquium in Ring Theory, Bar-Ilan University, Ramat-Gan, Israel. (May/June 1988, p. 730)

2-5. Fifth Haifa Matrix Conference, Technicon City, Haifa, Israel. (September 1988, p. 1057)

*2-20. Conference on Automatic Continuity and Banach Algebras, Australian National University, Canberra.

INFORMATION: R. J. Loy, Department of Mathematics, Faculty of Science, Australian National University, Post Office Box 4, Canberra, ACT 2601.

3-10. Workshop on Two Phase Waves in Fluidized Beds, Sedimentation, and Granular Flows, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (September 1988, p. 1057)


*4-7. Second International Workshop on Artificial Intelligence and Statistics, Fort Lauderdale, Florida.

INFORMATION: W. Gale, AT&T Bell Laboratories, 2C278, 600 Mountain Avenue, Murray Hill, New Jersey 07974.

6-10. Sixth Texas International Symposium on Approximation Theory, College Station, Texas. (Note date change from April 1988, p. 638)

6-12. Nonlinear Wave Equations, George Mason University, Fairfax, Virginia. (April 1988, p. 638)

7-10. Conference on the Arithmetic of Algebraic Curves, University of Arizona, Tucson, Arizona. (Note date change from September 1988, p. 1057)

8-10. Symposium in Honor of the Seventieth Birthday of Ted Harris, Los Angeles, California. (May/June 1988, p. 730)

8-11. First Caribbean Conference on Fluid Dynamics, Saint Augustine, Trinidad, West Indies. (June 1987, p. 686)


INFORMATION: International Centre for Theoretical Physics, 34100 Trieste, Italy, P.O.B. 586, Miramare, Strada Costiera 11. Telephone: 2240-1.


INFORMATION: M. Foulkes, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


INFORMATION: H. Daly, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02940.

14-19. American Association for the Advancement of Science Annual Meeting, San Francisco, California. (Note date change from May/June 1988, p. 731)

*17-19. Conference on Flow Instability and Structure of Turbulence, Kyoto University, Japan.

INFORMATION: Research Institute for Mathematical Sciences, Kyoto University, Kitashirakawa, Sakyo-ku, Kyoto 606, Japan.

*18-20. The McKnight Lecture Series: Classification of Finite Simple Groups, University of Miami, Coral Gables, Florida.

PROGRAM: The titles of the talks will be “Overview,” “Uniqueness Theorems,” and “Identifying Simple Groups.”

INVITED SPEAKERS: D. Gorenstein; R. Lyons; R. Solomon.

INFORMATION: S. Ahmad or A. Turoll, Department of Mathematics and Computer Science, University of Miami, Coral Gables, Florida 33124.

23-27. Workshop on Algorithms, Word Problems, and Classification in Combina-
torial Group Theory, Mathematical Sciences Research Institute, Berkeley, California. (February 1988, p. 313)

INFORMATION: Research Institute for Mathematical Sciences, Kyoto University, Kitashirakawa, Sakyo-ku, Kyoto 606, Japan.

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February 1989


INFORMATION: M. A. Page, Department of Mathematics, Monash University, Clayton, Victoria 3168.

6-10. Minisymposium on Plasticity, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (September 1988, p. 1057)

19-23. Analyse quantitative de la sensibilité en optimisation, Centre de recherches mathématiques, Université de Montréal. (September 1988, p. 1057)


March 1989

6-10. Workshop on Ellipticity in Evolution Equations, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (September 1988, p. 1058)

13-18. East European Category Seminar (EECS '89), Sofia, Bulgaria. (September 1988, p. 1058)


INFORMATION: G. Dydk, University of Tennessee at Knoxville, Knoxville, Tennessee, 37996-1300, 615-974-2461.


27-30. Twentieth Annual Iranian Mathematical Conference, University of Tehran, Tehran, Iran.

INFORMATION: Chairmen, Department of Mathematics, Faculty of Science, University of Tehran, Tehran, Iran.


INFORMATION: E. C. Gartland, Department of Mathematical Sciences, Kent State University, Kent, Ohio 44242.

April 1989


CONFERENCE DIRECTOR: H. M. Uehlinger, Conference Director, SoftStat '89, ZUMA, Postfach 5969, D-6800 Mannheim 1, Federal Republic of Germany.

* 3-5. Third SIAM Conference on Optimization, Boston, Massachusetts.

CONFERENCE THEMES: Interior point methods for optimization; algorithms for network optimization; algorithms for constrained optimization; algorithms for large-scale optimization problems.

CALL FOR PAPERS: The deadline for abstracts for contributed presentations is November 15, 1988.


CALL FOR PAPERS: The deadline for contributed papers is November 15, 1988.


10-13. IEEE Artificial Neural Networks Conference, Sheraton International Conference Center, Reston, Virginia. (Note date change, March 1988, p. 465)

Recent Developments in Linear and Nonlinear Programming, April 2, 1989)
Meetings and Conferences


INFORMATION: J. Vandewalle, General Chairman, Katholieke Universiteit Leuven, ESAT, Kardinaal Mercierlaan, 94, B-3030 Heverlee, Belgium, or J. J. Quisquater, Program Chairman, Philips Research Laboratory, Avenue Van Becelaere, 2, B-1170 Brussels, Belgium.


INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


17–21. Minisymposium on Front Tracking in a Supercomputer Environment, Minneapolis, Minnesota.

INFORMATION: W. Miller, Jr., Institute for Mathematics and its Applications, University of Minnesota, 514 Vincent Hall, 206 Church Street Southeast, Minneapolis, Minnesota 55455.

17–28. Topical Meeting on Hyperbolic Geometry and Ergodic Theory, Trieste, Italy.

INFORMATION: International Centre for Theoretical Physics, 34100 Trieste, Italy, P. O. B. 586, Miramare, Strada, Costiera 11. Telephone: 2240-1.


INVITED SPEAKERS: H. Delange; P. Erdos; H. Iwaniec; M. Knopp; M. Mendes-France; H. L. Montgomery; A. Odlyzko; C. Pomerance; W. Schmidt; H. Stark; R. C. Vaughan.

SPONSORS: University of Illinois College of Liberal Arts and Sciences and Department of Mathematics, Institute for Mathematics and Applications. Applications for support by the National Science Foundation and National Security Agency are pending.


27–29. Third Annual Conference on Undergraduate Research, Trinity University, San Antonio, Texas.

INFORMATION: A. Knoebel, EUREKA, Trinity University, Holt Center, 106 Oakmont, San Antonio, Texas 78212, 512-356-7601. (For further details, see the News and Announcements section of this issue of Notices).

May 1989


8–12. Workshop on Arithmetic Groups and Buildings, Mathematical Sciences Research Institute, Berkeley, California. (March 1988, p. 465)


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)

28–June 3. NATO Advanced Study Institute on Orthogonal Polynomials and Their Applications, The Ohio State University, Columbus, Ohio. (September 1988, p. 1059)


June 1989


CONFERENCE THEME: Karamata's regular variation in analysis, probability and mathematical physics.

INFORMATION: C. V. Stanojevic, Department of Mathematics and Statistics, University of Missouri-Rolla, Rolla, Missouri 65401.


INFORMATION: R. Chellappa, PHE324, Department EE-Systems, University of Southern California, University...
Meetings and Conferences

Park, MC-0272, Los Angeles, California 90089, 213-743-8559.


*5–8. Fourth Annual Symposium on Logic in Computer Science (LICS), Asilomar, California.

**CONFERENCE THEMES:** The Symposium will cover a wide range of theoretical and practical issues in computer science that relate to logic in a broad sense, including algebraic and topological approaches.

**CALL FOR PAPERS:** Fifteen copies of a detailed abstract (not a full paper) should be received by October 21, 1988 by the program chairman at the address given below. Papers from outside the USA should arrive by October 25. The authors will be notified of acceptance or rejection by December 23, 1988. Accepted papers, typed on special forms for inclusion in the symposium proceedings, will be due February 20, 1989.

**INFORMATION:** R. Parikh, LICS, Department of Computer Science, Brooklyn College of CUNY, Bedford Avenue and Avenue H, Brooklyn, New York 11210.


*6–10. Analytic Number Theory, Centre de recherches mathématiques, Université de Montréal. (September 1988, p. 1059)


**PROGRAM:** The program will include lectures by invited speakers and contributed talks. These talks will be published in the proceedings of the conference.

**INVITED SPEAKERS:** A. Balakrishnan, UCLA; L. H. Erbe, Alberta; H. Hermes, University of Colorado; V. Lakshmikantham, University of Texas at Arlington; I. Lasiecka, Virginia; S. M. Meerkov, Michigan; G. R. Sell, Minnesota; D. Siljak, Santa Clara; O. Staffans, Helsinki.


**PROGRAM:** The program comprises a workshop (June 8-10) and conference (June 12-16).

**INFORMATION:** J. H. Lou, The Organizing Secretary, Singapore Probability Conference, Department of Mathematics, National University of Singapore, Lower Kent Ridge Road, Singapore 0511, Republic of Singapore.


**INFORMATION:** Institut für Mathematik (Banach Space Conference), Johannes Kepler Universität Linz, Altenbergerstraße 69, A-4040 Linz, Austria.

*14–17. International Conference on Dynamical Systems, Control Theory, and Applications, Wright State University, Dayton, Ohio.

**PROGRAM:** There will be special sessions for short invited lectures.

**INVITED SPEAKERS:** M. J. Balas; R. W. Brockett; S. Chow; J. K. Hale; P. S. Krishnaprasad; P. R. Sethna.

**INFORMATION:** G. H. Fricke, Department of Mathematics and Statistics, Wright State University, Dayton, Ohio 45435, 513-873-2785.


**INFORMATION:** M. A. Kaashoek, c/o Bureau Congreszaken (Conference Service), Vrije Universiteit, Post Office Box 7161, 1007 MC Amsterdam, The Netherlands.


**INFORMATION:** NECC '89, International Council for Computers in Education, University of Oregon, 1787 Agate Street, Eugene, Oregon 97403-9905.

*27–30. Second Conference of the International Federation of Classification Societies (IFCS), Charlottesville, Virginia.

**CONFERENCE THEMES:** This conference is devoted to the presentation of theoretical, methodological, and applied papers on classification, pattern recognition, and related methods of statistics and data analysis in the broad sense. Papers are invited for this meeting.

**CALL FOR PAPERS:** If you plan to present a paper, send an English abstract of at most one page to R. F. Ling, Chairman, IFCS-89 Program Committee, Department of Mathematical Sciences, Clemson University, Clemson, South Carolina 29634-1907. The deadline for submission of papers is January 15, 1989.

**INFORMATION:** IFCS-89, Department of Mathematics, University of Virginia, Charlottesville, Virginia 22903, 804-924-4919.

July 1989


10–12. International Conference on Computational Techniques and Applications, Griffith University, Brisbane. (April 1988, p. 639)


30–August 4. Sixteenth Annual Conference and Exhibition on Computer Graph-
Meetings and Conferences

August 1989


INFORMATION: Submissions must be postmarked by December 12, 1988 to N. Sridharan, FMC Corporation, 1205 Coleman Avenue, Box 580, Santa Clara, California 95052, 408-289-0315. Registration information from C. Mazzetti, AAAI Office, 445 Burgess Drive, #100, Menlo Park California 94025, 415-328-3123.


28–September 8. Topical Meeting on Variational Problems in Analysis, Trieste, Italy.

INFORMATION: International Centre for Theoretical Physics, 34100 Trieste, Italy, P.O.B. 586, Miramare, Strada Costiera 11. Telephone: 2240-1.


September 1989

16–October 20. Sixth World Congress on Medical Information, Beijing, China. (April 1988, p. 639)


October 1989


INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

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.

January 1990


INFORMATION: H. Daly, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02940.

May 1990

25–31. Tenth International Conference on Pattern Recognition, Resorts Hotel, Atlantic City, New Jersey. (March 1988, p. 466)

June 1990

6–12. 1990 Barcelona Conference on Algebraic Topology, Centre de Recerca Matematica, Barcelona, Spain. (September 1988, p. 1060)

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.

January 1991


INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

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.

19–22. 1991 Joint Statistical Meetings, Atlanta, Georgia. (March 1988, p. 466)

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.

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.
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INTRODUCTION TO THE SPECTRAL THEORY OF POLYNOMIAL OPERATOR PENCILS
A. S. Markus
(Translations of Mathematical Monographs, Volume 71)

This monograph contains an exposition of the foundations of the spectral theory of polynomial operator pencils acting in a Hilbert space. Spectral problems for polynomial pencils have attracted a steady interest in the last 35 years, mainly because they arise naturally in such diverse areas of mathematical physics as differential equations and boundary value problems, controllable systems, the theory of oscillations and waves, elasticity theory, and hydromechanics.

In this book, the author devotes most of his attention to the fundamental results of Keldysh on multiple completeness of the eigenvectors and associate vectors of a pencil, and on the asymptotic behavior of its eigenvalues and generalizations of these results. The author also presents various theorems on spectral factorization of pencils which grew out of known results of M. G. Krein and Heinz Langer. A large portion of the book involves the theory of selfadjoint pencils, an area having numerous applications. Intended for mathematicians, researchers in mechanics, and theoretical physicists interested in spectral theory and its applications, the book assumes a familiarity with the fundamentals of spectral theory of operators acting in a Hilbert space.

Contents
Operators with compact resolvent which are close to being normal
Keldysh pencils
Factorization of pencils
Selfadjoint pencils

BENDINGS OF SURFACES AND STABILITY OF SHELLS
A. V. Pogorelov
(Translations of Mathematical Monographs, Volume 72)

This book contains an accessible exposition of the geometric theory of stability of elastic shells, starting from the basic facts of the theory of finite and infinitesimal bendings of surfaces. The author has included a number of new results obtained in recent years. In particular, the complete solution of the problem of stability of spherical shells under an external pressure is contained here without any assumptions regarding the character of buckling.

Within the framework of the mathematical model of the phenomenon, the author gives a complete investigation of the loss of stability of a general, strictly convex shell fastened along an edge under external pressure. The author considers the question of the loss of stability of cylindrical shells under axial compression and the effect of various factors on the critical load, among other questions. In contrast to the author's 1967 book on the subject, this work is limited to a relatively small number of classical problems on the loss of stability of shells, but these problems are investigated more thoroughly.

Contents
Bendings of surfaces and elastic deformations of shells
Elastic states of general convex shells
Supercritical elastic states of a cylindrical shell under axial compression
Infinitesimal bendings of surfaces and the stability of shells
Loss of stability of a cylindrical shell under axial compression

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**L^p HARMONIC ANALYSIS ON SL(2, R)**

**William H. Barker**

(Memoirs of the AMS, Number 393)

This book is directed at graduate students and researchers interested in Fourier analysis on reductive groups and requires a familiarity with the basic concepts of Lie group representation theory. Because the computations are presented explicitly, this book will prove a useful companion to more general papers published on Fourier analysis on reductive groups, particularly in its treatment of asymptotics of matrix coefficients.

The author presents an explicit solution to an interesting but difficult problem for the case of SL(2, R), the group of 2 by 2 real matrices. The author determines, for each 0 < p ≤ 2, the image under the operator-valued Fourier transform for the L^p-Schwartz space of SL(2, R). The image space is realized as a space of rapidly decreasing operator-valued functions defined on the union of Z \ {0} with strips in two copies of the complex plane; the space possesses a natural topology for which the Fourier transform becomes a topological isomorphism. The main theorem establishes for SL(2, R) a conjecture originally made by Peter Trombi for all semisimple Lie groups of real rank one. A similar result is obtained for the zero-Schwartz space, defined as the intersection of all the L^p-Schwartz spaces. The case of SL(2, R) is the only one in which the problem has been solved, though the techniques used in this book may extend to larger classes of reductive groups.

**Contents**

The L^p Schwartz spaces

The principal series

The discrete series

Leading exponents and distributions

Relationships between principal and discrete series matrix coefficients

The Trombi-Varadarajan estimates for SL(2, R)

The Fourier transform on C^p(G)

The Plancherel inversion formula

The decomposition of C^p(G)

Asymptotic approximation of matrix coefficients

Growth of asymptotic coefficients for the principal series

Calculation of asymptotic coefficients for the discrete series

The inverse transform

The isomorphism theorem: non-integral case

The Campoli functions

The isomorphism theorem: general case

The zero-Schwartz space (with Henrik Schlichtkrull)

1980 Mathematics Subject Classifications: 22E30, 22E46; 43A15, 43A30


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**LOGARITHMIC DESCRIPTIONS OF WHITEHEAD GROUPS AND CLASS GROUPS FOR p-GROUPS**

**Robert Oliver and Lawrence R. Taylor**

(Memoirs of the AMS, Number 392)

The goal of this work is to present a procedure for using logarithms to translate localization sequences into sequences involving additive groups. Specifically, the authors use p-adic logarithms to translate localization sequences that involve multiplicative groups of units to simpler additive descriptions of D(ZG) and Wh'(G) for a p-group G. For the case p = 2, the authors provide several applications, including explicit computations of D(ZG) in many cases, a general formula for |D(ZG)|, a description of the Tate cohomology of Wh'(G) under the involution induced by an orientation G → {±1}, and results on representing elements of Wh'(G) by units.

**Contents**

Localization sequences and logarithms

Factoring homomorphisms of functors on p-groups

The main theorem

Wh'(G) for finite 2-groups G

D(ZG) for 2-groups

Classgroups of G × C^2

Wh'(G) and D(ZG) for odd p-groups

1980 Mathematics Subject Classifications: 19A31; 19B28

ISBN 0-8218-2455-4

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Artin introduced braid groups into the mathematical literature in 1925. In the years since, and particularly in the last five to ten years, braid groups have played diverse and unexpected roles in widely different areas of mathematics, including knot theory, homotopy theory, singularity theory, and dynamical systems. Most recently, the area of operator algebras has brought striking new applications to knots and links.

This volume contains the proceedings of the AMS-IMS-SIAM Joint Summer Research Conference on Artin's Braid Group, held at the University of California, Santa Cruz, in July 1986. This interdisciplinary conference brought together leading specialists in diverse areas of mathematics to discuss their discoveries and to exchange ideas and problems concerning this important and fundamental group. Because the proceedings present a mix of expository articles and new research, this volume will be of interest to graduate students and researchers who wish to learn more about braids, as well as more experienced workers in this area. The required background includes the basics of knot theory, group theory, and low-dimensional topology.

Contents

K. Aomoto, A construction of integrable differential system associated with braid groups
Joan S. Birman, Mapping class groups of surfaces
E. Brieskorn, Automorphic sets and braids and singularities
Alan L. Carey and David E. Evans, The operator algebras of the two-dimensional Ising model
F. R. Cohen, Artin's braid groups, classical homotopy theory, and sundry other curiosities
William D. Dunbar, Classification of solvorbifolds in dimension three
Michael Falk and Richard Randell, Pure braid groups and products of free groups
Vagn Lundsgraed Hansen, Polynomial covering maps
Yasutaka Ihara, Arithmetic analogues of braid groups and Galois representations
Boju Jiang, Application of braids to fixed points of surface maps
Louis H. Kauffman, Statistical mechanics and the Jones polynomial
Paul Kliutmann, Hurwitz action and finite quotients of braid groups
Tsunoi Kobayashi, Heights of simple loops and pseudo-Anosov homeomorphisms
Toshitake Kohno, Linear representations of braid groups and classical Yang-Baxter equations
G. I. Lehrer, A survey of Hecke algebras and the Artin braid groups
A. Libgober, On divisibility properties of braids associated with algebraic groups
W. B. R. Lickorish, The panorama of polynomials for knots, links, and skeins
R. James Milgram and Peter Löffler, The structure of deleted symmetric products
B. Moishezon and M. Teicher, Braid group technique in complex geometry, I: Line arrangements in $CP^2$
Edited by H. R. Morton, Problems
H. R. Morton, Polynomials from braids
H. R. Morton and P. Traczyk, The Jones polynomial of satellite links around mutants
Mutsuo Oka, On the deformation of certain type of algebraic varieties
Peter Orlik and Louis Solomon, Braids and discriminants
Józef H. Przytycki, $t_k$ moves on links
Lee Rudolph, Mutually braided open books and new invariants of fibered links
Mario Salvetti, Generalized braid groups and self-energy Feynman integrals
Bronislaw Wajnryb, Markov classes in certain finite symplectic representations of braid groups
R. F. Williams, The braid index of an algebraic link
David N. Yetter, Markov Algebras

1980 Mathematics Subject Classifications: 55P, 55S, 57M, 58F, 14B, 46L10, 46L35, 11R29; 14E20, 14H30, 32B30, 55Q52
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Committee members' terms of office on standing committees expire on December 31 of the year given in parentheses following their names, unless otherwise specified.

Armand Borel, Paul H. Rabinowitz, Hugo Rossi, John T. Tate, and Alan Weinstein have been appointed by President G. D. Mostow to the Selection Committee for the Lecture Series Progress in Mathematics. Professor Borel will serve as chairman.


President G. D. Mostow has appointed Steve Armentrout, Ramesh Gangolli, and Elliot H. Lieb to an ad hoc Committee on AMS Publications in Applied Mathematics.

President G. D. Mostow has appointed Jane Cronin Scanlon, Thomas Crawford Spencer and Shmuel Winograd to the Committee to Select Gibbs Lecturers for 1989 and 1990. Professor Scanlon will serve as chairman.

David Eisenbud (1990), Lawrence Craig Evans (1990), Victor L. Klee, Jr. (1990), and Karen Vogtmann (1990) have been appointed by President G. D. Mostow to the Committee on Centennial Fellowships. Continuing members of the committee are Frederick J. Almgren, Jr. (1989), chairman, Dorian Goldfeld (1989), and John W. Morgan (1989).

M. Beth Ruskai has been appointed by President G. D. Mostow to the Committee on Fellowship Policy. Continuing members of the committee are George E. Andrews, Kenneth Millet, M. Susan Montgomery, chairman, and Paul J. Sally, Jr.

President G. D. Mostow has appointed R. Creighton Buck, Franklin P. Peterson, and Murray H. Protter to the Coordinating Committee for the Doctoral Program in Mathematics. Professor Buck will serve as chairman.


Report of Past Meetings
The March Meeting in East Lansing

The eight-hundred-and-fortieth meeting of the American Mathematical Society was held at Michigan State University in East Lansing, Michigan on Friday, March 18 and Saturday, March 19, 1988. This meeting was in conjunction with a meeting of the Association for Symbolic Logic. There were 125 registered attendees.

Invited Addresses

By invitation of the Committee to Select Hour Speakers for Central Sectional Meetings, there were four invited one-hour addresses. The speakers, their affiliations, and titles were:

BARBARA L. KEYFITZ, University of Houston, Systems of conservation laws that change type, introduced by Daniel Phillips.

BRIAN PARSHALL, University of Illinois at Urbana-Champaign, Modular representations of algebraic groups, introduced by James Humphreys.

KARL RUBIN, Ohio State University, Elliptic curves and the Birch and Swinnerton-Dyer conjecture, introduced by William Brown.

WILLIAM P. ZIEMER, Indiana University, Fine regularity in partial differential equations, introduced by Konstantin Mischaikow.

Special Sessions

By invitation of the same committee, there were five special sessions of selected twenty-minute papers. Topics, the names and affiliations of the organizers, and lists of the speakers follow.

Algebraic groups and related topics, WILLIAM HABOUSH and BRIAN PARSHALL, University of Illinois at Urbana-Champaign.
Speakers included: Kaan Akin, Vinay Deodhar, Richard Dipper, Steven Doty, Robert L. Griess, J. E. Humphreys, Jens Jantzen, Andy R. Magid, Nazih Nahlus, A. Neeman, Mark Ronan, Peter Sin, Stephen D. Smith, Lin Tan, and David Vella.

Groups and geometries, JONATHAN HALL and BERNT STELLMACHER, Michigan State University. Speakers were Andrew Cherms, Steven Cohen, Alberto Delgado, Daniel Frohardt, Robert L. Griess, P. R. Hett, Peter Johnson, Peter B. Kleidman, Mark Ronan, A. Ryba, Yoav Segev, Stephen D. Smith, Gernot Stroth, Ernest Shult, and Satoshi Yoshiara.


Nonlinear partial differential equations, Daniel Phillips, Purdue University. Speakers included Christoph Borgers, Kuo-Shung Cheng, David Hoff, Bradley J. Lucier, Nicholas C. Owen, Daniel Phillips, Paul Sacks, Jie Shen, Marshall Slemrod, and Joel Smoller.


Contributed Papers
There were three sessions for contributed ten-minute papers on Friday, March 18 at 3:00 p.m., and Saturday, March 19 at 8:40 a.m. and 3:00 p.m. The session chairs were MICHAEL GREGORY, Michigan State University; HEMA SRINIVASAN, Michigan State University and RAMESH SHARMA, Michigan State University, respectively.

Local Arrangements
Local arrangements were handled by Gerald Ludden of the Michigan State University mathematics department.

Andy Roy Magid
Associate Secretary
Norman, Oklahoma

The March Meeting in Knoxville
The eight-hundred-and-forty-first meeting of the American Mathematical Society was held at the Knoxville Convention Center, in Knoxville, Tennessee on Friday, March 25 and Saturday, March 26, 1988. The meeting was hosted by the Department of Mathematics, University of Tennessee at Knoxville. There were 143 registrants including 103 members of the Society.

Invited Addresses
By invitation of the Committee to Select Hour Speakers for Southeastern Sectional Meetings, there were four invited one-hour addresses. The speakers and their affiliations are as follows:

J. Alan George, University of Tennessee at Knoxville and Oak Ridge National Laboratories, Solution of large sparse systems of equations.

Louis N. Howard, Florida State University, Some aspects of double-diffusive convection.

Craig Huneke, Purdue University, The use of Frobenius in commutative algebra.

S. James Taylor, University of Virginia, The measure theory of random fractals.

Special Sessions
By invitation of the same committee, there were four special sessions of selected twenty-minute papers. The topics, the names and affiliations of the organizers, and a list of speakers is as follows.


Finite field theory and applications, ROBERT MCCONNEL, University of Tennessee at Knoxville. Speakers were Jacob T. B. Beard, Joel V. Brawley, Wung-Seng Chou, Javier Gomez-Calderon, David R. Hayes, Joseph J. Liang, Robert M. McConnel, Gary L. Mullen, David R. Richman, Peter J. S. Shiue, Stephan J. Suchower, and Theresa P. Vaughan.


Topics in stochastic processes, BALRAM RAJSUT, University of Tennessee at Knoxville. Speakers included Ishwar Basawa, Richard C. Bradley, Kurt Helmes, Itaru Mitoma, Joanna B. Mitro, Arunava Mukherjea, Magda Peligrad, Loren...
AMS Reports and Communications


Contributed Papers
There was one session of eight contributed ten-minute papers on Friday afternoon, March 25.

Other Activities
In conjunction with the AMS sectional meeting, the University of Tennessee at Knoxville hosted a conference on probability and stochastic processes, coordinated by Balram Rajput. The conference was held on Thursday, March 24 and Friday, March 25. There were four one-hour invited addresses. The speakers and their affiliations were: Burgess Davis, Purdue University; Alejandro de Acosta, Case Western Reserve University; Olav Kallenberg, Auburn University; and Malcolm R. Leadbetter, University of North Carolina at Chapel Hill.

Local Arrangements
The local arrangements were handled by Barbara Jendrucko, Balram Rajput and John Bradley, ex officio.

Frank T. Birtel
Associate Secretary
New Orleans, Louisiana

The April Meeting in Las Cruces
The eight-hundred-and-forty-second meeting of the American Mathematical Society was held at the New Mexico State University in Las Cruces, New Mexico on Friday, April 8 and Saturday, April 9, 1988. There were 119 registered attendees including 63 members of the Society.

Invited Addresses
By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, there were three invited one-hour addresses. The speakers and their affiliations are as follows:

- **John L. Canny**, University of California, Berkeley, *Robot motion planning and real geometry.*
- **David Leigh Donoho**, University of California, Berkeley, *Geometrizing rates of convergence.*

Special Sessions
By invitation of the same committee, there were six special sessions of selected twenty-minute papers. A listing of topics and the names and affiliations of the organizers follows:

- **Applications of parallel computing**, Mary A. Maher, New Mexico State University. Speakers were Carol Burleson, Steven Castillo, Eric Johnson, Mary Anne Maher, and Robert Widlicka.


**Noncommutative rings and their applications**, Robert B. Warfield, Jr., University of Washington. Speakers were David M. Arnold, Allen D. Bell, William Chin, Carolyn Dean, K. R. Goodearl, Alfred W. Hales, Edward Letzter, Declan Quinn, and Birge Zimmermann-Huisgen.

Contributed Papers
There was a session for contributed ten-minute papers. Speakers were Una Bray, John Dauns, Michael Faulk, Allen Friedman, and Robert Stanton.

Social Events
A banquet was held at the Holiday Inn on Friday evening, April 8, to celebrate the centennials of New Mexico State University and the AMS. Elbert Walker spoke on the history of the NMSU mathematics department and William J. LeVeque, Executive Director of the AMS, spoke on AMS—Then, Now, and Soon.

Local Arrangements
The local arrangements were superbly handled by G. S. Rogers of the NMSU mathematics department.

Lance W. Small
Associate Secretary
La Jolla, California
The April Meeting in College Park

The eight-hundred-and-forty-third meeting of the American Mathematical Society was held at the University of Maryland, College Park, Maryland on Saturday and Sunday, April 23 and 24, 1988. There were 180 registered attendees including 143 members of the Society.

On April 21 and 22, the two days preceding the meeting, there was a conference on Nonlinear partial differential equations in honor of the 70th birthday of Avron Douglis.

Invited Addresses

By invitation of the Committee to Select Hour Speakers for Eastern Sectional Meetings, there were four invited one-hour addresses. The speakers, their affiliations, and titles were:

Kenneth S. Brown, Cornell University, Piecewise linear homeomorphisms of the line, introduced by Ross Geoghegan.

Thomas G. Goodwillie, Brown University, Fixpoint sets and traces in algebraic K-theory, introduced by Carlos Berenstein.

Tai-Ping Liu, University of Maryland, Recent progress in nonlinear hyperbolic waves, introduced by Pierangelo Marcati.

Leonard L. Scott, Jr., University of Virginia, Charlottesville, The isomorphism problem for finite group rings: progress and philosophy, introduced by Hyman Bass.

Contributed Papers

There were four sessions for twenty-minute contributed papers; twenty-nine papers were presented.

Sessions were co-chaired by Thomas E. Armstrong, Denis Blackmore, James D. Chandler, Jr., Carl Droms, Thomas Drucker, Charles E. Ford, John Hornstein, and Seymour Lipschutz.

Council Meeting

The Council of the Society met at 7:00 p.m. on Saturday, April 23, at the Quality Inn College Park. The report of the Council Meeting can be found on page 911 in the July/August issue of Notices.

Other Activities

The University of Maryland hosted a conference on Nonlinear partial differential equations in honor of the 70th birthday of Avron Douglis on Thursday and Friday, April 21 and 22. The speakers on Thursday were W. E. Kirwan, Vice-chancellor, University of Maryland, College Park; Cathleen Morawetz, Courant Institute; and Ronald J. DiPerna, University of California, Berkeley. Speakers on Friday included Luis A. Caﬀarelli, Institute for Advanced Study; Michael Crandall, University of Wisconsin; Hans F. Weinberger, University of Minnesota; Eugene B. Fabes, University of Minnesota; and Peter D. Lax, Courant Institute.

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Local Arrangements

The undersigned Associate Secretary is pleased to thank the local arrangements committee for extensive, effective service. The members of the committee were Joel Cohen, chairman and Nelson Markley.

W. Wistar Comfort
Associate Secretary
Middletown, Connecticut

1988 AMS-SIAM Summer Seminar on Computational Solution of Nonlinear Systems Equations

The American Mathematical Society and the Society for Industrial and Applied Mathematics sponsored the nineteenth AMS-SIAM Summer Seminar on applied mathematics at Colorado State University, from July 18-29, 1988. The topic of the seminar was Computational Solution of Nonlinear Systems Equations. The seminar was supported by the Air Force Office of Scientific Research and the National Science Foundation.

The AMS-SIAM Committee on Applied Mathematics selected the topic for this conference. Members of the committee at the time were Constantine M. Dafermos, James M. Hyman, George C. Papaniolaou (chairman), Francis E. Sullivan, Robert F. Warming, and Donald E. McClure.

There were 59 invited addresses. There were 67 mathematicians who registered for the seminar. According to the registration cards of those who attended, 9 attended for the first week only, 11 during the second week only, and 47 for up to the full period of the seminar. Six countries not in North America were represented by the following numbers of participants: Brazil (2), East Germany (1), France (1), Hungary (1), Israel (1), Japan (2), Netherlands (1), Norway (1), Scotland (1), Taiwan (1) and West Germany (5).

Forty papers were reproduced and distributed to participants during the seminar, totaling 777 pages of notes plus a two page Table of Contents.

As with previous summer seminars, the Society will publish formal proceedings in the series *Lectures in Applied Mathematics*.

The Council in Providence

The Council met on 7 August 1988 at 5:10 PM in the Bacchante Room of the Omni Biltmore Hotel in Providence. There were twenty-six members present. President G. D. Mostow was in the chair.

The Council voted to institute a lecture series with the formal title “Progress in Mathematics: AMS Lecture Series”. It was understood that the series would begin with two unrelated lectures at Summer Meetings. Each lecture, of perhaps eighty minutes duration with a brief intermission, would be devoted to a topic developed or coming into prominence within the last five years. The lecturer would ordinarily be different from the prime developer of the topic.

The Council made the following additional nominations for the election of 1988:

**Vice-President**

Melvin Hochster

**Member-at-large**

Melvyn S. Berger

James H. Curry

Michael C. Reed

**Editorial Committee of the Proceedings**

Palle E.T. Jorgensen

**Committee to Monitor Problems in Communication**

Paul Nevai

The Council considered several recommendations concerning the structure of the Joint Policy Board for Mathematics (JPBM). It approved a recommendation that the representation of the Society on the Board should consist of the President, the Executive Director, and a third member elected by secret ballot of the Council. The last is to be ordinarily a vice-president or member-at-large at the time of the initial election, with one re-election admitted. It endorsed recommendations (1) that the Society, through the Council and other bodies, re-examine its own policy with respect to JPBM to decide what it expects from JPBM and from the Office of Governmental and Public Affairs (an arm of JPBM) and (2) that the Society create a vehicle (perhaps an advisory committee for its representatives on JPBM or the Committee on Science Policy or the Council) to represent effectively the interests of the Society through its representatives on JPBM.

The Council endorsed the following resolution, which was recommended to the Society by the Conference Board of the Mathematical Sciences.

**Resolution**

*Minority Participation in the Mathematical Professions*

The current level of minority participation in the mathematical professions is inadequate. The Conference Board of the Mathematical Sciences believes it should be increased and encourages its supporting societies to work on increasing the number of minority participants by:

1. increasing efforts to recruit underrepresented minority students into graduate programs in mathematics and the sciences;

2. increasing efforts to recruit underrepresented minority students into undergraduate programs in mathematics and the sciences; and

3. encouraging greater participation by minorities in science and mathematics education as students and teachers at the pre-college level.

The Council made editorial changes in a proposed amendment to the bylaws, Article VII, Election of Officers and Terms of Office. The Council had previously recommended the amendment but it had not yet gone to the membership for approval. (The effect of the amendment, if it is approved by the membership in the forthcoming mail ballot, is to allow the appointment of members of editorial committees by the Council in place of their election in uncontested elections by the membership.)

The Council considered a letter from Serge Lang that was both addressed to the Council and offered as a Letter to the Editor of *Notices*. The Council passed a motion to deny request of Lang for action. In response to a request from the Chairman of the Editorial Committee, the Council
encouraged the publication of the letter. [See Letters to the Editor in this issue of Notices.]

When the Council had recessed for dinner at 6:15 PM a group picture was taken in recognition of the Centennial. The Council had reconvened at 8:00 PM and it adjourned at 10:59 PM.

Everett Pitcher
Secretary
Bethlehem, Pennsylvania

The Business Meeting in Providence

The Business Meeting of 12 August 1988 began about 3:45 PM and followed immediately upon the award of the Steele Prizes. President Mostow presided.

The Secretary informed the membership of items of business transacted by the Council since the last Business Meeting. (See Notices, July/August, pp. 911-912 and the above report.)

Pursuant to a recommendation of the Council, the Business Meeting approved an amendment to Article VIII, Section 4 of the bylaws, which now has the following wording:

Section 4. The minimum dues of an institutional member shall depend on the scholarly activity of that member. The formula for computing these dues shall be established from time to time by the Council, subject to approval by the Board of Trustees. Institutions may pay larger dues than the computed minimum.

The Business Meeting adjourned at 4:00 PM.

Everett Pitcher
Secretary
Bethlehem, Pennsylvania

Miscellaneous

Personal Items

Ronald D. Baker, of the University of Delaware, has been promoted to full Professor of Mathematics at that institution. He will be spending 1988-1989 as a Visiting Professor at Clemson University.

Lawrence H. Cox, Director, Board on Mathematical Sciences, National Research Council, was recently elected to the Board of Directors of the National Computer Graphics Association. He is also a member of the Board of Directors of the American Statistical Association.

Adragon De Mello, of Santa Cruz, California, received his B.A. in mathematics from the University of California, Santa Cruz, in June 1988 at the age of 11. Mr. De Mello is currently the youngest member of the Society.

Heinz W. Engl has been appointed Full Professor and holder of the Chair for Industrial Mathematics at the Johannes Kepler Universität in Linz (Austria).

Ian Iscoe, of McGill University, has been appointed Assistant Professor in tenure track at Case Western Reserve University, Department of Mathematics and Statistics.

Kathy Kime, of Princeton University, has been appointed Assistant Professor in tenure track at Case Western Reserve University, Department of Mathematics and Statistics.

Nessan Mhuiris, of Cornell University and ICASE, has been appointed Assistant Professor in tenure track at Case Western University, Department of Mathematics and Statistics.
Deaths
Margaret E. Kellar, of Providence, Rhode Island, died on August 2, 1988, at the age of 73. She was a computer programmer for the Society for 27 years, retiring in 1978.

Hans Lewy, Professor Emeritus of the University of California, Berkeley, died on August 23, 1988, at the age of 83. He was a member of the Society for 54 years. (See the News and Announcements section of this issue of Notices.)

Lewis E. Ward, Sr., of Escondido, California, died on August 6, 1988, at the age of 91. He was a member of the Society for 61 years.

Visiting Mathematicians
(Supplementary List)

Pawel Szeptycki (U.S.A.), University of Grenoble, France, August 1988 to December 1988, functional analysis and applications.

Georgious Akrevis (Greece), University of Tennessee, Knoxville, January 1989 to May 1989, numerical analysis.

Enrico Arbarello (Italy), Massachusetts Institute of Technology, September 1988 to May 1989, algebraic geometry.

Tomasz Bielecki (Poland), University of Kansas, August 1988 to July 1989, control theory, stochastic process.

Helen Cohen-Scali (France), Massachusetts Institute of Technology, July 1988 to June 1989, combinatorics.

Vassilios Dougalis (Greece), University of Tennessee, Knoxville, January 1989, numerical analysis.

Georgio Fusco (Italy), University of Tennessee, Knoxville, August 1988 to December 1988, differential equations.

Pavel Kindleman (Czechoslovakia), University of Tennessee, Knoxville, January 1989 to May 1989, mathematical ecology.

Kazuhiko Koike (Japan), Massachusetts Institute of Technology, August 1988 to September 1989, combinatorics, Lie groups.

Fugio Kubo (Japan), Massachusetts Institute of Technology, August 1988 to July 1989, Lie algebras.

Fernando Levstein (Argentina), Massachusetts Institute of Technology, September 1988 to May 1989, algebraic groups, Lie groups.

Witold Marciszewski (Poland), University of Kansas, August 1988 to July 1989, set theory, topology.

Kavi Rama Murthy (India), University of Tennessee, Knoxville, September 1988 to May 1989, probability.

Eric Opdam (Netherlands), Massachusetts Institute of Technology, September 1988 to September 1989, special function theory and Lie groups.

T. R. Ramadas (India), Massachusetts Institute of Technology, September 1988 to September 1989, string theory.

Megumi Saigo (Japan), University of Victoria, March 1988 to March 1989, analysis, applied mathematics.

Koichiro Yoneda (Japan), University of Tennessee, Knoxville, August 1988 to May 1989, analysis.
Application Deadlines for Grants and Assistantships

Many fellowship programs have deadlines for receipt of applications. These deadlines are noted in news items and in the Stipends Section of the December Notices. They are listed below for your convenience, and as a reminder since many of these deadlines occur before the publication date of the December issue. Dates taken from the December 1987 issue have been updated with information received in preparation for the December 1988 issue. For information about the various programs the reader is referred to the appropriate part of the Stipends Section of the December 1987 Notices as follows: [GS] = Graduate Support Section; [PS] = Postdoctoral Support Section; [TSA] = Travel and Study Abroad Section; [SFN] = Study in the U.S. for Foreign Nationals.

* Information from the December 1987 issue not yet confirmed this year.
* Refers to a news item in this issue of Notices.

October 1
- American Philosophical Society [PS]
- Bunting Institute of Radcliffe College (Science Scholar Fellowships) [PS]
- John Simon Guggenheim Memorial Foundation Fellowships [PS]

October 21
- Kennedy Scholarships [SFN]

November 1
- American-Scandinavian Foundation [TSA]
- Fannie and John Hertz Foundation Fellowships [GS]
- University of Michigan (Michigan Society of Fellows Postdoctoral Fellowships) [PS]

November 5
- North Atlantic Treaty Organization (Postdoctoral Fellowships) [TSA]

November 13
- NSF Graduate Fellowships [GS]
- NSF Minority Graduate Fellowships [GS]

November 14
- National Research Foundation (Ford Foundation Predoctoral and Dissertation Fellowships for Minorities) [GS]

November 15
- Committee on Scholarly Communication with the People's Republic of China (CSCPRC) [TSA]
- Kosciuszko Foundation [SFN]
- Los Alamos National Laboratory (J. Robert Oppenheimer Research Fellowship) [PS]
- NSF Mathematical Sciences Postdoctoral Research Fellowships [PS]
- NSF Visiting Professorships for Women [GS]
- Royal Norwegian Council for Scientific and Industrial Research (Postdoctorate Fellowships) [TSA]

November 30
- North Atlantic Treaty Organization [TSA]

December 1
- AMS Centennial Research Fellowships [PS]
- American Philosophical Society [PS]
- Argonne National Laboratory (James H. Wilkinson Fellowship) [GS]
- Lady Davis Fellowship Trust [TSA]
- Lady Davis Visiting Professorships [TSA]
- Sigma Delta Epsilon, Graduate Women in Science (Eloise Gerry Fellowship) [GS]

December 15
- IBM Thomas J. Watson Research Center (Postdoctoral Fellowships for Research in Mathematical Sciences) [PS]
- Mathematical Sciences Research Institute [PS]

December 31
- Institute for Advanced Study Memberships [PS]
- Massachusetts Institute of Technology (C.L.E. Moore Instructorships in Mathematics) [PS]
- University of Wisconsin, Madison (Van Vleck Assistant Professorship in Mathematics) [PS]
Application Deadlines

January 1
- Brown University (Jacob David Tamarkin Assistant Professorships) [PS]
- California Institute of Technology (Harry Bateman Research Instructorships) [PS]
- Courant Institute (Instructorships in Mathematics) [PS]
- Courant Institute (Postdoctoral Visiting Memberships) [PS]
- Harvard University (Benjamin Peirce Lectureships) [PS]
- Indiana University, Bloomington (Václav Hlavatý Research Assistant Professorships) [PS]
- University of California, Los Angeles (Earle Raymond Hedrick Assistant Professorships in Mathematics) [PS]
- University of Chicago (Leonard Eugene Dickson Instructorships in Mathematics) [PS]
- University of Texas (R H Bing Faculty Fellowships) [PS]
- Weizmann Institute of Sciences (Feinberg Graduate School Postdoctoral Fellowships) [TSA]
- Weizmann Institute of Sciences (Openings for Scientists) [TSA]

January 6
- Committee on Institutional Cooperation (Minorities Fellowships in the Sciences, Mathematics and Engineering) [GS]
- University of California, San Diego (S. E. Warschawski Assistant Professorships) [PS]
- University of Michigan, Ann Arbor (T. H. Hildebrandt Research Assistant Professorships) [PS]

January 13
- National Center for Atmospheric Research (Advanced Study Program) [PS]
- National Research Council (Postdoctoral Fellowships for Minorities) [PS]

January 15
- AAAS Science, Engineering and Diplomacy Fellowships [PS]
- Dartmouth College (John Wesley Young Research Instructorships) [PS]
- Institute for Mathematics and its Applications [PS]
- Kosciuszko Foundation [GS]
- Kosciuszko Foundation (Graduate and Postgraduate Exchange with Poland) [TSA]
- National Research Council (Research Associateship Programs) [PS]
- Purdue University (Research Assistant Professorships) [PS]
- Rice University (Griffith Conrad Evans Instructorships) [PS]
- Rutgers University (Hill Assistant Professorships) [PS]
- University of Pittsburgh (Andrew Mellon Postdoctoral Fellowships) [PS]

January 16
- Fulbright Program (Collaborative Research Grants) [TSA]

January 30
- Centro de Investigacion del IPN (Solomon Lefschetz Research Instructorships) [TSA]

January 31
- Yale University (Josiah Willard Gibbs Instructorships) [PS]

February 1
- AAAS Summer Fellowship [GS]
- American Philosophical Society [PS]
- American Society for Engineering Education (NASA-ASEE Summer Faculty Fellowships) [PS]
- American Society for Engineering Education (Navy and DOE-ASEE Summer Faculty Research Programs) [PS]
- American Society for Engineering Education (ONR Graduate Fellowship Program) [GS]
- Sigma Delta Epsilon, Graduate Women in Science (Grants-in-Aid) [GS]
- University of Cincinnati (Charles Phelps Taft Postdoctoral Fellowships) [PS]

February 11
- California State Graduate Fellowships [GS]

March 15
- Hubert H. Humphrey Doctoral Fellowships [GS]

March 31
- North Atlantic Treaty Organization [TSA]

April 1
- American Philosophical Society [PS]

May 15
- Weizmann Institute of Sciences (Feinberg Graduate School Postdoctoral Fellowships) [TSA]
- Weizmann Institute of Sciences (Openings for Scientists) [TSA]

June 15
- Indo-American Fellowship Program [TSA]

August 1
- American Philosophical Society [PS]

August 15
- North Atlantic Treaty Organization [TSA]
New Members of the AMS

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<th>ORDINARY MEMBERS</th>
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<td>University of North Carolina at Wilmington</td>
<td>Wilmington, North Carolina</td>
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### New Members of the AMS

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<td>Seyed Djalil Tabatabaei</td>
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<td>Xi Ping Zhu</td>
<td>Takeshi Sasaki</td>
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<td>Academia Sinica</td>
<td>Mathematical Society of the Republic of China</td>
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<td>Crakow, Poland</td>
<td>Wuhan, People's Republic of China</td>
<td>Hang-C Lai</td>
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<td>Norsk Matematisk Foreningros</td>
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<td>Newton, Massachusetts</td>
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<td>Société Mathématique Suisse</td>
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<td>Kevin Walker</td>
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<td>Berkeley, California</td>
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<td>Maria-Clara Nucci</td>
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<td>Eliano Pessa</td>
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### MATHEMATICAL QUANTUM FIELD THEORY AND RELATED TOPICS

Joel S. Feldman and Lon M. Rosen, Editors

(Conference Proceedings, Canadian Mathematical Society, Volume 9)

Aimed at researchers and advanced graduate students in mathematical physics, this book constitutes the proceedings of a conference on mathematical quantum field theory and related topics. The conference was held at the Centre de Recherches Mathématiques of the Université de Montréal in September 1987. With articles by some of the top researchers in the field, this book will bring readers to the leading edge of research in a number of areas of mathematical physics.

1980 Mathematics Subject Classifications: 81, 82
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STANFORD UNIVERSITY

Stanford University solicits application for one or more positions in theoretical computer science. Appointments in the Computer Science Department or, if appropriate, jointly or fully in a related department such as Mathematics, Operations Research, or Statistics, are possible. Persons at both junior and senior levels will be considered, and an outstanding record of achievement, commensurate with the proposed level, is expected.

Candidates are expected to have a commitment to excellence in teaching and a record of competence in at least one field of computation theory, including, but not limited to, such subjects as: Combinatorial optimization, Complexity theory, Computational geometry, Database and knowledge systems, Design and analysis of algorithms, Discrete mathematics, Distributed algorithms, Logic and its applications, Mathematical programming, Parallel algorithms and architectures, Principles of programming languages, or Security of protocols.

Candidates should send a vita and names of at least four references to: Prof. Jeffrey D. Ullman, Department of Computer Science, Stanford Univ., Stanford CA 94305. Stanford is an equal opportunity/affirmative action employer.

Carnegie Mellon University

Zeev Nehari Assistant Professorship in Mathematics

These positions have been instituted in the Department of Mathematics of Carnegie Mellon University to honor the memory of Professor Zeev Nehari, a member of the Department from 1954 to his death in 1978. Applicants are expected to show exceptional research promise as well as clear evidence of achievement. The position available is for two academic years, beginning in September, 1989, and extendable for one additional year when mutually agreeable. It carries a reduced academic year teaching load of six hours per week during one semester and three hours per week during the other. The applicant should have research interests which intersect those of current faculty of the Department. Applicants should send a vita, list of publications, and a statement describing current and planned research, and arrange to have at least three letters of recommendation sent to us. All communications should be addressed to: Zeev Nehari Assistant Professorship Committee, Department of Mathematics, Carnegie Mellon University, Pittsburgh, PA 15213. Carnegie Mellon University is an Affirmative Action/Equal Opportunity Employer.

University of Edinburgh

Chair in Applied Mathematics

The University invites applications for the Chair in Applied Mathematics, which will become available on 1st October 1989. Candidates should have a proven record of distinction in some application of mathematics. Both traditional and newer areas of application are appropriate. It is intended that the Professor will be able to interact successfully with members of the Mathematics Department and with others both within and without the University. There is considerable potential for interaction within the University in view of the acknowledged strength of the University’s research across a broad spectrum of subjects. The Professor would be expected to provide a general leadership role within the Mathematics Department.

Further particulars of the position and the department’s activity can be obtained by writing to the Secretary of the University (address below) or contacting the Head of the Mathematics Department, Tel. (44) 31-667-1081, Ext 2942.

Applications should include a Curriculum Vitae and the names of at least three referees; they should reach The Secretary, University of Edinburgh, 63 South Bridge, Edinburgh, EH1 1LS, Scotland, by 15th December 1988. Please quote reference 56/88.

University of Puerto Rico

Department of Mathematics

Faculty position at the Assistant Professor level in the Area of Category Theory. Responsibilities include research and teaching graduate and undergraduate courses. Applicants must possess a Ph.D. in Mathematics with specialization in Category Theory and have at least one (1) year of academic experience. A working knowledge of Spanish is required. Salary: $1,985 per month. Please send a complete resume and three letters of recommendation to Dr. Rafael Martinez, Acting Director, Department of Mathematics, U.P.R., P.O. Box 5000, Mayaguez, Puerto Rico 00709-5000. An affirmative action/equal opportunity employer.
STANFORD UNIVERSITY

Stanford University solicits applications for a tenured senior faculty person to lead a proposed new Stanford Institute of Computation Theory. The Institute will initially be a part of the Computer Science Department in the School of Engineering and will have the participation of the Departments of Mathematics, Operations Research, and Statistics. An appointment in the Computer Science Department or, if appropriate, jointly or fully in a related department such as Mathematics, Operations Research, or Statistics, is possible.

Candidates are expected to have a commitment to excellence in teaching and an outstanding record of research in at least one field of computation theory, including, but not limited to, such subjects as: Combinatorial optimization, Complexity theory, Computational geometry, Database and knowledge systems, Design and analysis of algorithms, Discrete mathematics, Distributed algorithms, Logic and its applications, Mathematical programming, Parallel algorithms and architectures, Principles of programming languages, or Security of protocols. In addition, demonstrated leadership abilities, administrative skills, and interpersonal skills are required for this position.

Candidates should send a vita and names of at least four references to: Prof. Jeffrey D. Ullman, Department of Computer Science, Stanford Univ., Stanford CA 94305. Stanford is an equal opportunity/affirmative action employer and energetically solicits applications from women and targeted minorities.

BOSTON UNIVERSITY DEPARTMENT OF MATHEMATICS

The Department of Mathematics at Boston University anticipates an opening for an Assistant Professor in Fall, 1989. Preference given to applicants in Applied Mathematics, Dynamical Systems, Computational Sciences, and related fields. Women and minorities are encouraged to apply. Send vita and three letters of reference to: Search Committee, Department of Mathematics, Boston University, 111 Cummington St., Boston, MA 02215. AA/EOE

NEW FACULTY in COGNITIVE AND NEURAL SYSTEMS at BOSTON UNIVERSITY

Boston University seeks a tenure track assistant professor starting in Fall, 1989, for its M.A. and Ph.D. Program in Cognitive and Neural Systems. This program offers an integrated curriculum offering the full range of psychological, neuro-biological, and computational concepts, models, and methods in the broad field variously called neural networks, connectionism, parallel distributed processing, and biological information processing, in which Boston University is a leader. Each faculty member will have a joint appointment in the Ph.D. program and in one or more of the departments of mathematics, biology, computer science, and psychology. Candidates should have extensive analytic or computational research experience in modelling a broad range of real-time nonlinear neural networks, especially in one or more of the areas: adaptive pattern recognition, speech and language, cognitive information processing, self-organization, and conditioning and attention. Send complete curriculum vitae and three letters of recommendation to: Cognitive and Neural Systems Program, Room 240, 111 Cummington Street, Boston University, Boston, MA 02215, preferably by November 15, 1988, but no later than January 1, 1989. Boston University is an Equal Opportunity/Affirmative Action employer.

Worcester Polytechnic Institute

The Department of Mathematical Sciences will have several tenure track positions at all levels for fall of 1988. These positions require a strong research record or potential and evidence of quality teaching. Fields of interest are numerical analysis, computational fluid mechanics, nonlinear PDE, optimization, control theory, dynamical systems, applied discrete mathematics, statistics/applied probability.

WPI, the nation's third oldest college of science and engineering, offers degrees through the Ph.D. The Mathematical Sciences Department currently offers an undergraduate and master's degree in applied mathematics. Worcester, Massachusetts is the second largest city in New England, approximately 40 miles west of Boston.

Interested applicants should send a curriculum vitae to: Samuel M. Rankin, III, Head, Department of Mathematical Sciences, 100 Institute Rd., Worcester, MA 01609. Applications will be accepted until the positions are filled. EOE/AA.

UNIVERSITY OF CALIFORNIA, LOS ANGELES

Department of Mathematics

REGULAR POSITIONS IN PURE AND APPLIED MATHEMATICS

Six to eight regular positions in pure and applied mathematics. Specific fields of interest include algebra/number theory (including algebraic geometry), analysis, applied and computational mathematics, differential equations, dynamical systems, game theory, logic, mathematical computer science, mathematical physics, probability and statistics. Very strong promise in research and teaching required. Positions initially budgeted at the assistant professor level. Sufficiently outstanding candidates at higher levels will also be considered. Teaching load: Averaging 1.5 courses per Quarter, or 4.5 Quarter courses per year. To apply, write to Alfred W. Hales, Chair, Department of Mathematics, University of California, Los Angeles, CA 90024-1555. Attn: Staff Search. UCLA is an equal opportunity/affirmative action employer.

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Head, Chemistry-Mathematics Library

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positions available

Canisius College
Department of Mathematics

A 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. The teaching load is twelve hours per semester. Salary and fringe benefits are competitive commensurate with credentials and experience.

Applicants should send resume, transcripts and three letters of recommendation to Dr. Richard H. Escobales, Chairman, Department of Mathematics, Canisius College, Buffalo, New York, 14208. AA/EEO.

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.

The Department of Mathematics is actively seeking applications in the area of discrete mathematics and combinatorics. We anticipate making several tenure-track appointments at the assistant professor level or above beginning in the fall of 1989. A Ph.D. is required. Applications will be accepted until March 15, 1989, or until a successful candidate is found. A formal letter of application expressing interest, a resume, and names, addresses, and telephone numbers of three references should be sent to Chairman, Discrete Mathematics Search Committee, Department of Mathematics, Virginia Tech, Blacksburg, VA 24061-0123. Virginia Tech is an Equal Opportunity/Affirmative Action Employer.

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The Department of Mathematics at Carnegie Mellon University anticipates an opening at the level of full Professor. Applications are invited from mathematicians and applied mathematicians with exceptionally strong accomplishments in research and considerable experience in teaching. Candidates' research interests should overlap significantly with those of Department members. Applications should be sent to: Senior Appointments Committee, Department of Mathematics, Carnegie Mellon University, Pittsburgh, PA 15213. Carnegie Mellon University is an Affirmative Action/Equal Opportunity Employer.

CARNEGIE MELLON UNIVERSITY
Department of Mathematics

The Department expects to make one or two tenure-track appointments, to begin in the Fall of 1989. Although these appointments are expected to be at the Assistant Professor level, we also solicit exceptionally well-qualified applicants for more advanced positions. We particularly seek candidates in the area of numerical analysis, but also will consider any areas of research which strongly intersect those of the current faculty of the Department. Candidates should send a resume to: Appointments Committee, Department of Mathematics, Carnegie Mellon University, Pittsburgh, PA 15213. Carnegie Mellon University is an Affirmative Action/Equal Opportunity Employer.

NEW SENIOR FACULTY
in
COGNITIVE AND NEURAL SYSTEMS
at
BOSTON UNIVERSITY

Boston University seeks a full professor or associate professor starting in Fall, 1989, to act as Co-Director for its M.A. and Ph.D. Program in Cognitive and Neural Systems. The Co-Director will play a major role in curriculum development, administration, and training of mathematically advanced graduate students. The program curriculum offers the full range of psychological, neurobiological, and computational concepts, models, and methods in the broad field variously called neural networks, connectionism, parallel distributed processing, and biological information processing, in which Boston University is a leader. The faculty member will have a joint appointment in the Ph.D. program and in one or more of the departments of mathematics, biology, computer science, and psychology. Candidates should have extensive analytic and computational research experience and an international reputation for modelling a broad range of real-time nonlinear neural networks, enabling them to teach graduate courses including the areas of adaptive pattern recognition and self-organization. Send a complete curriculum vitae and at least three letters of recommendation to Search Committee, Cognitive and Neural Systems Program, Room 240, 111 Cummingston Street, Boston University, Boston, MA 02215, preferably by November 15, 1988, but no later than January 1, 1989. Boston University is an Equal Opportunity/Affirmative Action employer.

THE UNIVERSITY OF FLORIDA
Department of Mathematics

The Department of Mathematics is in the third year of a five-year program to fill over 20 new tenure-track faculty positions with mathematicians of exceptional caliber. The Department invites applications for six tenure-track positions for the fall semester, 1989. Applications from junior candidates are especially welcome.

Outstanding candidates in all areas of applied and pure mathematics are invited to apply for these positions. Senior candidates should have distinguished research records, and junior candidates are expected to have made significant research contributions. Every candidate is expected to possess a strong commitment to teaching.

One position will be reserved for a senior candidate in Partial Differential Equations. Strong preference will be given to Arithmetic Geometers and Number Theorists in filling a second position. Among other areas of interest to the Department are Dynamical Systems, Algebraic Geometry and Harmonic Analysis.

Candidates should forward a resume (including a list of publications) and should arrange for at least three letters of recommendation to be sent to:

David A. Drake, Chair
Department of Mathematics
University of Florida
201 Walker Hall
Gainesville, Florida 32611

All applications for the academic year 1989–1990 should be complete by December 31, 1988. The University of Florida is an equal opportunity employer.
### Classified Advertisements

#### POSITIONS AVAILABLE

**Department of Mathematics**  
University of Alberta

Applications are invited for tenure-track positions, subject to budgetary approval, in Approximation Theory (File AP-1), Numerical Optimization or Partial Differential Equations (File NP-1), in Number Theory (File NT-1), or closely related areas and Algebraic or Differential Topology (File AT-1) at the Assistant Professor level, beginning July 1, 1989. Requirements are a Ph.D. and proven ability or demonstrated potential for research and teaching. Current salary range is from $33,144 (Canadian) per annum depending upon qualifications. Send vitae and arrange for three letters of reference to be sent to: Professor L. H. Erbe, Department of Mathematics, University of Alberta, Edmonton, Canada, T6G 2G1. In accordance with Canadian Immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada. Closing date for applications is October 31, 1988. Please quote file numbers when responding to this advertisement. The University of Alberta is committed to the principle of equity in employment.

#### Tennessee Technological University

Department of Mathematics  
Cookeville, Tennessee 38505

Applications are invited for a tenure-track position in Statistics at the rank of Assistant Professor, available 1 January 1989. Ph.D. in Statistics, or equivalent, experience in both Applied and Mathematical Statistics, evidence of excellent teaching ability at all levels, and strong interest in research are required. Duties include teaching undergraduate and graduate courses, directing graduate students, consulting and research activities, and helping develop Statistics courses for science and engineering students. Position is open until filled. Send transcript and curriculum vitae, and have three letters of recommendation sent, as soon as possible, to: Chairman, Search Committee, Department of Mathematics, Box 5054, TTU, Cookeville, TN 38505. EOE/AA.

#### SMU

Tenure-track or Full-time Visiting Lecturer position in the Department of Mathematics beginning September, 1989.

Earned doctorate and excellence in teaching required. Research potential/experience is expected. The selected candidate will join an established program with traditional and computer-oriented degrees and will have the opportunity to participate in the development of mathematics courses for growing undergraduate and graduate programs in the Department of Mathematics and in the Department of Computer and Information Sciences.

Application deadline: January 15, 1989. Applications, including resume, transcript, and three letters of reference should be sent to:

Rufus A. Winsor, Chairperson  
Department of Mathematics  
Southeastern Massachusetts University  
North Dartmouth, MA 02747  

SMU IS AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER. APPLICATIONS FROM MEMBERS OF MINORITY GROUPS AND WOMEN ARE PARTICULARLY ENCOURAGED.

#### MICHIGAN TECHNOLOGICAL UNIVERSITY

Department of Mathematical Sciences

Three tenure-track assistant professor positions are expected starting September, 1989. Applications in all areas of mathematics are invited. Candidates in computational mathematics or statistics are particularly encouraged to apply. A commitment to research and excellent teaching are required.

MTU is a state supported institution emphasizing science and engineering. The Department of Mathematical Sciences offers B.S. and M.S. degrees and is considering a Ph.D. program. There are 36 full time faculty with active programs in Mathematics, Applied Mathematics, Computational Mathematics, and Statistics.

To apply, send a curriculum vitae and arrange to have three letters of recommendation sent to Recruitment Committee, Department of Mathematical Sciences, Michigan Technological University, Houghton, MI 49931.

Michigan Technological University is an equal opportunity educational institution/equal opportunity employer.

#### ILLINOIS INSTITUTE OF TECHNOLOGY

The Department of Mathematics invites applications for a tenure-track faculty position at the Assistant Professor level, beginning August, 1989. Requirements: a Ph.D. degree in an area of applied mathematics; evidence of strong research potential and teaching ability; U.S. citizenship or resident status. Preference will be given to candidates who specialize in numerical analysis or differential equations and who are interested in solving scientific or engineering problems.

Submit a letter of application and a curriculum vita, and arrange for three letters of recommendation to be sent to:

Professor M. J. Frank, Chairman  
Department of Mathematics  
Illinois Institute of Technology  
Chicago, Illinois 60616

The closing date is January 31, 1989. IIT is an Equal Opportunity/Affirmative Action Employer.
POSITIONS AVAILABLE

THE OHIO STATE UNIVERSITY
DEPARTMENT OF MATHEMATICS

The Department of Mathematics of The Ohio State University hopes to fill several positions, both visiting and permanent, effective Autumn Quarter, 1988. Candidates in all areas of applied and pure mathematics are invited to apply. Significant research accomplishments or exceptional research promise, and evidence of good teaching ability, will be expected of successful applicants.

Please send credentials and have letters of recommendation sent to Professor Joseph Ferrar, Department of Mathematics, The Ohio State University, 231 W. 18th Avenue, Columbus, Ohio 43210. Review of resumes will begin immediately.

The Ohio State University is an Equal Opportunity/Affirmative Action Employer.

BROWN UNIVERSITY. Providence, RI 02912. Two professorships at the Associate Professor level or above, with tenure, to begin July 1, 1989. Salary to be negotiated. Preference to be given to applicants with research interests consonant with those of the present members of the Department; in particular, for one of the positions preference will be given to those with research interests in Algebraic Geometry or related fields. Candidates should have a distinguished research record and a strong commitment to teaching. Qualified individuals are invited to send a vita and three to five letters of recommendation, no later than November 1, 1988, to Professor Brian Cole (Senior Search), Executive Officer, Department of Mathematics, Brown University, Providence, Rhode Island 02912. Brown University is an Equal Opportunity/Affirmative Action Employer.

The Department of Mathematics, University of California, Santa Barbara, is planning to make a tenure-track assistant professor appointment in Differential Geometry, effective July 1, 1989. Ph.D. required by the time of appointment. Preference will be given to applicants who have held the doctorate for at least two years. Evidence of excellence or potential for excellence in research and teaching required. Applicants should send their vita, publication list, and arrange to have three letters of recommendation on their research and one letter on their teaching sent to: Geometry Committee, Department of Mathematics, UC Santa Barbara, CA 93106, by December 15, 1988. Proof of U.S. citizenship or eligibility for U.S. employment will be required prior to employment (Immigration Reform and Control Act of 1986.) Equal Opportunity/Affirmative Action Employer.

ASSISTANT PROFESSORSHIPS

University of California
Department of Mathematics
Berkeley, CA 94720

We invite applications for one or more positions effective July 1, 1989, at the tenure-track Assistant Professor level, subject to budgetary approval, in the areas of algebra, analysis, applied mathematics, foundations, or geometry and topology. Applicants are expected to have demonstrated outstanding research potential, normally including major contributions beyond the doctoral dissertation. Send by November 1, 1988 a curriculum vitae, list of publications, a few selected reprints or preprints. Ask three people to send letters of recommendation to Marc A. Rieffel, Vice Chair for Faculty Affairs, at the above address. The University of California is an Equal Opportunity, Affirmative Action Employer.

UNIVERSITY OF WAIKATO
Hamilton, New Zealand

UGC POSTDOCTORAL FELLOWSHIP
IN COMPUTING
AND MATHEMATICAL SCIENCES

The University of Waikato invites applications for a University Grants Committee Postdoctoral Fellowship for research on Mathematical Software. The position will be available for a period of up to two years. Applicants with training in one or more of the fields of symbolic computation, numeric computation, computer algebra or parallel processing may be preferred.

Enquiries of an academic nature may be made to Dr. K. A. Broughan, Department of Mathematics and Statistics. The emolument payment to the fellow is currently NZ$35,000 per annum.

Details of the conditions of appointment and method of application are available from the Appointments Officer, Association of Commonwealth Universities, 36 Gordon Square, London WC1H OFF, or from the Registrar, University of Waikato, Private Bag, Hamilton, New Zealand. The reference is A88/36. Applications close on 30 November 1988. Equality of employment opportunity is University policy.
POSITIONS AVAILABLE

NEW MEXICO STATE UNIVERSITY, DEPT. MATH. SCI.
LAS CRUCES, NM 88003
Visiting positions and possible tenure-track, assistant professor positions in mathematics and statistics, including numerical analysis. Start August 21, 1989. Salary competitive. Ph.D. (or equivalent) and strong commitment to teaching and research essential. Applications are kept on file through hiring period and positions filled as openings occur. Send vita and arrange for three reference letters to be sent to: Carol L. Walker, Head, Department of Mathematical Sciences, New Mexico State University, Las Cruces, NM 88003. An Equal Opportunity/Affirmative Action Employer.

UNIVERSITÄT BONN
Research Inst. of Discrete Mathematics
Director: Professor Bernhard Korte
Postdoctoral Fellowships on Discrete Mathematics

The Research Institute of Discrete Mathematics announces the availability of two Postdoctoral Fellowships beginning with the academic year 1989-1990.

These awards are intended for young mathematicians and computer scientists with exceptional research promise in Discrete Mathematics and its applications. The postdoctoral fellows are invited to take part in all research activities of the Institute, however, teaching of one graduate course per semester is expected.

An award for a full academic year will range between DM 32,400 and DM 42,000 depending upon qualifications and experiences. The awards are not subject to German income tax.

Applications should include a vita, a bibliography, two letters of reference, and a research plan. To be eligible for the 1989-1990 competition, a complete application should be on hand by December 31, 1988.

Send application to: Dr. Hans Jürgen Prömel, Research Institute of Discrete Mathematics, University of Bonn, Nassesstrasse 2, D-5300 Bonn 1, W. Germany.

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM
DEPARTMENT OF MATHEMATICS

The Department of Mathematics has faculty positions at all ranks. The department is especially interested in establishing a group in Numerical PDE/Scientific computation over the next five years. Access to the Alabama Super Computer (using a Sun Station and a T-1 line to a Cray X-MP/24) will be available in the near future. Other areas which will enhance our proposed Ph.D. in Applied Mathematics will be seriously considered. Applicants for senior positions must demonstrate excellence in research, while applicants for junior positions must exhibit the promise of excellence. Send as soon as possible a curriculum vitae, list of publications, a few selected reprints, and the names of three references to Search Committee, Department of Mathematics, University of Alabama at Birmingham, Birmingham, AL 35294. UAB is an Affirmative Action/Equal Opportunity Employer.

UNIVERSITY OF CALIFORNIA AT DAVIS
DEPARTMENT OF MATHEMATICS

Applications are invited for three or more anticipated tenure track positions in the Department of Mathematics, University of California, Davis, effective 7/1/89. Appointments will be made at rank and salary commensurate with qualifications. Qualifications include a Ph.D. and an outstanding record or great promise in teaching and mathematical research. We are particularly interested in applicants with a distinguished research record in Applied Analysis, Mathematical Physics, or Mathematical Biology, but outstanding candidates in other fields will be given full consideration. Postmarked deadline for applications is January 16, 1989. An application consists of a curriculum vitae, list of publications, and at least three letters of reference sent to: Chair of Search Committee, Department of Mathematics, University of California, Davis, CA 95616. The University of California is an Equal Opportunity/Affirmative Action Employer.

BOSTON UNIVERSITY
DEPARTMENT OF MATHEMATICS

The Department of Mathematics at Boston University anticipates an opening for Visiting Assistant Professor in Fall, 1989. Preference given to applicants in Number Theory and Algebraic Geometry. Women and minorities are encouraged to apply. Send vita and three letters of reference to: Search Committee (Visiting Professorship), Department of Mathematics, Boston University, 111 Cummington St., Boston, MA 02215. AA/EOE.

FACULTY POSITION IN ROBOTICS

Qualified people are invited to submit applications for a tenure-track faculty position in Robotics. The appointment may be made at either the junior or senior level depending on the qualifications of the applicants.

Applicants for a tenured position must have strong records of achievement both in research and in teaching and have demonstrated potential for research leadership and future accomplishments.

Applicants for a junior, tenure-track position must have a Ph.D. in Computer Science and have demonstrated competence in one or several areas of Robotics research and must have demonstrated potential for excellent teaching.

Outstanding candidates in all areas of Robotics will be considered, with preference to those in Advanced Control or Computer Vision.

Depending on specific background and interests, there is a strong possibility of joint appointments with the Mechanical Engineering or Electrical Engineering Departments.

Please send applications with curriculum vitae and names of at least four references to: Professor Jean-Claude Latombe, Chairman of Robotics Search Committee, Department of Computer Science, Stanford University, Stanford, CA 94305.

Stanford University is an Equal Opportunity/Affirmative Action employer and actively solicits applications from qualified women and targeted minorities.

EO/AA EMPLOYER. WOMEN AND MINORITIES ARE ENCOURAGED TO IDENTIFY THEMSELVES VOLUNTARILY.

OREGON STATE UNIVERSITY
Assistant Professor position in Algebra, (Number Theory), Numerical Analysis, or Geometric-Topology will become available September, 1989. Salary depends on qualifications. Closing date January 20, 1989. Write to:
Professor Bent Petersen
Staff Selection Committee
Department of Mathematics
Oregon State University
Corvallis, Oregon 97331
Oregon State University is an Affirmative Action/Equal Opportunity Employer and complies with Section 504 of the Rehabilitation Act of 1973. OSU has a policy of being responsive to the needs of dual-career couples.

TRINITY UNIVERSITY
SAN ANTONIO, TEXAS
ASSISTANT/ASSOCIATE PROFESSOR OF MATHEMATICS

Trinity University invites applications and nominations for a tenure-track position in mathematics, appointment beginning August, 1989. The appointment will be made at the rank of Assistant Professor or Associate Professor, depending on qualifications. Responsibilities include teaching nine credit hours per semester, including scholarly activity, assisting in curriculum development as appropriate to the needs of the department and the university, advising and committee service.

Minimum qualifications are the Ph.D. in Mathematics or Applied Mathematics with excellence in and strong commitment to teaching. Preference is given to candidates with teaching and research interests in one or more of the following areas: applied mathematics, numerical analysis, classical analysis, differential equations. Founded in 1869, Trinity University occupies a modern campus overlooking the San Antonio skyline. Purposely small and selective, with about 2700 students, Trinity stresses a high quality, undergraduate liberal arts and science program. San Antonio is a city of approximately 850,000 people situated in a metropolitan area of 1.2 million.

Closing date for applications is January 27, 1989. Send vita, transcripts and three letters of reference to:
Dr. Donald F. Bailey, Chairman
Department of Mathematics
Trinity University
715 Stadium Drive
San Antonio, Texas 78284

Trinity University is an equal opportunity affirmative action employer.

WILLIAMS COLLEGE
DEPARTMENT OF MATHEMATICS
WILLIAMSTOWN, MASSACHUSETTS 01267

We anticipate three positions, probably at the rank of assistant professor, for Fall, 1989. For one position, there is a preference for statistics or operations research.

Strong commitment to both teaching and scholarship is essential. The teaching load is five 1-semester courses per year, plus a "Winter Study" in alternate Januaries, beginning in the second year.

Please send a vita and three letters of recommendation on teaching and research to Frank Morgan, Chair. Evaluation of applications will begin November 15 and continue until positions are filled.

Since Williams is an affirmative action/equal opportunity employer, we encourage applications from women and minorities.

University of Georgia
Department of Mathematics
Athens, GA 30602

The department may have some tenure-track positions available for the 1989-90 academic year at the assistant and associate professor levels. The rank and salary will be commensurate with the applicant's abilities and experience. The principal requirement is excellence in teaching and research. Some preference will be given to areas in which the department is already well represented. Some 3-year postdoctoral research positions may also be available. Send curriculum vitae and four letters of recommendation to Ray A. Kunze, Head (address above) by January 5, 1989. UGA is an Equal Opportunity/Affirmative Action Employer.
POSITIONS AVAILABLE

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY—DEPARTMENT OF MATHEMATICS. We anticipate making one or more tenure-track appointments at the assistant professor level or above beginning in the fall of 1989. A Ph.D. is required. Very strong research potential required for junior-level appointments and demonstrated outstanding record for senior-level appointments. Applications will be accepted until March 15, 1989, or until the positions are filled. Applicants should send vita and three letters of reference to: Chairman, Search Committee, Department of Mathematics, Virginia Tech, Blacksburg, VA 24061-0123. Virginia Tech is an Equal Opportunity/Affirmative Action Employer.

The Ohio State University
Department of Mathematics
Research Instructorships in Mathematics

Applications are invited for the position of research instructor in mathematics for the academic year 1989-90. Candidates should hold a Ph.D. (or equivalent) in mathematics and show strong research promise.

Please send credentials and have letters of recommendation sent to Professor Joseph Ferrar, Department of Mathematics, The Ohio State University, 231 W. 18th Avenue, Columbus, Ohio 43210. The Ohio State University is an Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF PITTSBURGH
DEPARTMENT OF MATHEMATICS AND STATISTICS

invites applications for the following positions:

1) Full Professor specializing in partial differential equations or a related area.
2) Two positions, one at a senior level, in pure mathematics other than differential equations.

Applicants should have outstanding research accomplishment or potential. Excellence in teaching is also required. The teaching load is six hours per week. Positions are contingent upon available funding. The University of Pittsburgh is an Equal Opportunity/Affirmative Action Employer.

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
Dhahran – Saudi Arabia

DEPARTMENT OF MATHEMATICAL SCIENCES

Needs

Faculty members for teaching graduate and undergraduate courses in all areas of Mathematical Sciences. Ph.D. in Mathematics is required. Candidates must have strong research potential or accomplishments and demonstrated excellence in teaching. Preferred areas of research are Applied Mathematics and Numerical Analysis.

The University offers attractive salary and benefits plus air conditioned furnished housing and air transportation to and from Dhahran each year. Ten months duty each year with two months vacation salary. Minimum regular contract for two years, renewable.

Apply before December 31, 1988, with complete resume and supporting documents to:

Dean of Faculty & Personnel Affairs
KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
DEPT. NO. MATH/540-A
DHAHRAN — 31261, SAUDI ARABIA
**POSITIONS AVAILABLE**

**ENDOWED POSITION IN APPLIED MATHEMATICS**

Nominations and applications are sought for an endowed position in applied mathematics. The position (yet unnamed) is permanently funded by an endowment and is expected to lead to tenure. Other attractive features of the position include a reduced course load and the possibility of budget supplements for travel and secretarial support. A specific responsibility of the holder of this position will be the establishment and supervision of a Center for Applied Mathematics within the Department of Mathematics, focused on the preparation of undergraduates for work in applied mathematics, including opportunities for undergraduate research and for collaboration with the region's profit and non-profit institutions on specific problems.

The successful applicant for this position will hold a Ph.D. in mathematics or applied mathematics, have a recognized program of research in one or more areas of applied mathematics, demonstrate good organizational and interpersonal skills, and share a commitment to quality teaching in a liberal arts environment. The salary and rank of appointment will be appropriate for the candidate selected.

The College of St. Thomas, the largest private college in Minnesota, is located one block from the Mississippi River in the heart of the attractive and dynamic Twin Cities metropolitan area. For over a century the college has provided a strong program of liberal arts education in the Catholic tradition of service to the greater community. The Department of Mathematics has a current faculty of 12, representing a variety of mathematical interests.

Application materials, including a letter of interest, curriculum vita, and three letters of recommendation (including comments on the applicant's experience and promise in the areas of teaching, research, and leadership) will be accepted until December 31, 1988, and, thereafter, until the position is filled. Applications, nominations, and inquiries should be sent to John T. Kemper, Chair, Department of Mathematics, College of St. Thomas, St. Paul, MN 55105. Individuals from both academic and industrial backgrounds whose interests and credentials are compatible with the requirements of the position are encouraged to apply. The College of St. Thomas is an equal opportunity/affirmative action employer.

**UNIVERSITY OF UTAH**

**DEPARTMENT OF MATHEMATICS**

invites applications for the following positions:

1. At least one full time tenure-track appointment on either the Assistant Professor, Associate Professor or Professor level. The Department is particularly interested in applicants who work in the areas of algebra, applied mathematics, geometry and group representation theory. Selection will be based on research expertise and teaching ability. Applications will be accepted until January 31, 1989, or until the positions are filled.

2. Two or more nonrenewable three-year Instructorships. Persons of any age receiving Ph.D. degrees in 1988 or 1989 are eligible. Applicants will be selected on the basis of ability and potential in teaching and research. Starting salary this academic year is $28,000 and cost of living increases are contingent on action by the State Legislature. Duties consist of teaching two courses through the academic year. Applications will be accepted until December 31, 1988, or until the positions are filled.

3. One or more visiting positions of one year or less. Selection criteria are teaching ability and potential contribution to our research environment. Applications will be accepted until January 31, 1989, or until the positions are filled.

Applications must include curriculum vitae, bibliography and three letters of reference. (Instructorship applications must also include an abstract of thesis and a list of graduate courses completed or transcripts.)

Please send your application to:

COMMITTEE ON STAFFING
DEPARTMENT OF MATHEMATICS
UNIVERSITY OF UTAH
SALT LAKE CITY, UTAH 84112

The University of Utah is an equal opportunity-affirmative action employer.

**MICHIGAN TECHNOLOGICAL UNIVERSITY**

**DEPARTMENT OF MATHEMATICAL SCIENCES**

F.R.O.G. Director

The Department of Mathematical Sciences is seeking a director for the Fluids Research Oriented Group (F.R.O.G.). F.R.O.G. is an interdisciplinary group, involving Departments of Mathematical Sciences, Mechanical Engineering, and Chemical Engineering, engaged in an active program of research in Fluid Mechanics. Primary areas of interest are turbulence, non-Newtonian flows, heat and mass transfer, and geophysical fluid mechanics. This position will carry an appointment as Associate Professor or Professor. Candidates should have an active research record in Fluid Mechanics or Computational Mathematics. A good funding record and experience with Ph.D. students is required. The position starts in September, 1989.

MTU is a state supported institution emphasizing science and engineering. The department offers B.S. and M.S. degrees and is considering a Ph.D. program; the Mechanical Engineering-Engineering Mechanics Department offers a Ph.D. program suitable for fluid mechanics studies. Send a curriculum vitae and three letters of recommendation to Recruitment Committee, Department of Mathematical Sciences, Michigan Technological University, Houghton, MI 49931.

Michigan Technological University is an equal opportunity educational institution/equal opportunity employer.

**BOSTON UNIVERSITY**

**DEPARTMENT OF MATHEMATICS**

Position for Full or Associate Professor of Mathematics for Fall, 1989. Record of distinguished achievements in research and commitment to excellence in teaching required. Preference to candidates in Number Theory and/or Algebraic Geometry. Women and minorities are encouraged to apply. Send nominations and applications to: Search Committee, Department of Mathematics, Boston University, 111 Cummington St., Boston, MA 02215. AA/EOE.
RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY, Department of Mathematics, New Brunswick, NJ anticipates the following open positions beginning September, 1989.

(1) TENURE-TRACK AND TENURE POSITIONS. The Department anticipates several openings. Depending on the qualifications of the applicants, appointments may be as tenure-track assistant professorships or as tenured associate, full, or special professorships. Candidates must have Ph.D., outstanding research ability in pure or applied mathematics and concern for teaching. Normal course load now averages 5 hours. Preference given to applicants working in differential geometry, Lie theory, logic, numerical analysis, topology, and ring theory (ideally interacting with algebraic geometry). However, exceptionally strong candidates in all fields are encouraged to apply and will be given careful consideration.

(2) HILL ASSISTANT PROFESSORSHIP. These are three-year non-renewable positions. Candidates should have recently received the Ph.D., show outstanding promise in research ability in pure or applied mathematics, and have concern for teaching. Normal course load approx. 6 hours but one course teaching reduction provided in two of the three years.

(3) LECTURESHIPS. (Assistant Professor level and above.) Normal course load approx. 6 hours. Candidates must have Ph.D., show outstanding promise in research ability in pure or applied mathematics and have concern for teaching. These are one or two year non-tenure-track positions.

(4) INSTRUCTORSHIPS. Responsible for teaching mainly at the level of precalculus and below. Normal course load 12 hours. Candidates must have masters degree or equivalent related experience and provide evidence of teaching ability. These are one or two year non-tenure-track positions.

(5) VISITING POSITIONS; part-time and full-time. Normal full-time course load approx. 6 hours. These positions are intended to permit individuals with regular appointments elsewhere to visit Rutgers for the purpose of engaging in joint research with members of the faculty. Candidates must have Ph.D., proven record of outstanding research accomplishments in pure or applied mathematics, and concern for teaching. These are one or two year non-renewable positions.

(6) PART-TIME POSITIONS (all levels). These may be used both for candidates with primary responsibility for teaching and for candidates of outstanding promise for research activity.

Send resume and at least three letters of recommendation to SEARCH COMMITTEE, Department of Mathematics, Rutgers University, New Brunswick, NJ 08903 as soon as possible. Indicate position desired and give # of your area of speciality according to AMS Mathematics Subject Classification. RUTGERS UNIVERSITY IS AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER.

UNIVERSITY OF CALIFORNIA, LOS ANGELES
Department of Mathematics

TEMPORARY POSITIONS
(1) One or two E. R. Hedrick Assistant Professorships. Applicants must show very strong promise in research and teaching. Salary $36,000. Three year appointment. Teaching load: four quarter courses per year, which may include one advanced course in the candidate’s field. Preference will be given to applications completed by January 1, 1989.

(2) Two or three Research Assistant Professorships in Computational and Applied Mathematics. Applicants must show very strong promise in research and teaching. Salary $36,000. Three year appointment. Teaching load: four quarter courses per year, which may include one advanced course in the candidate’s field. Preference will be given to applications completed by January 1, 1989.

(3) One or two Assistant Professorships in the Program in Computing (PIC). Applicants must show very strong promise in teaching and research, preferably in the general area of Logic, Language and Computation. Teaching load: four quarter programming courses and an advanced quarter course of the candidate’s choice per year. Two year appointment, renewable once or twice. Salary range: $36,000-$42,000. Preference will be given to applications completed by January 1, 1989.

(4) One or two Lectureships in the Program in Computing (PIC). Applicants must show very strong promise in the teaching of programming. Teaching load: five quarter programming courses per year. One year appointment, renewable up to four times. Salary depends on experience, begins at $30,300.

(5) Subject to administrative approval, a few adjunct assistant professorships. Two year appointments. Strong research and teaching background required. Salary $31,500-$35,400 per year. Teaching load: five quarter courses per year.

(6) Several positions for visitors and lecturers...

To apply, write to Alfred W. Hales, Chair, Department of Mathematics, University of California, Los Angeles, CA 90024-1555. Attn: Staff Search. UCLA is an equal opportunity/affirmative action employer.

WEST VIRGINIA UNIVERSITY
Department of Mathematics

The Department of Mathematics expects to make several Assistant/Associate level faculty appointments that will commence August, 1989. Candidates are expected to have a Ph.D. in mathematics or equivalent with a strong record or demonstrated potential in both research and teaching. Preference will be given to applicants whose research interests are in areas of algebra, analysis, combinatorics, applied mathematics, and numerical analysis. Normal responsibilities of the position include research and teaching of programming. Teaching load: five quarter courses per semester at the graduate or undergraduate level.

Applicants should submit a vita and have three letters of reference sent to James Lightbourne, Department of Mathematics, West Virginia University, Morgantown, WV 26506. To insure consideration all application materials and letters of reference should be received by January 15, 1989.

WVU is an affirmative action/equal opportunity employer. Qualified women and minorities are encouraged to apply.
Positions Available

Financial Editor

Editor needed to originate materials dealing with comprehensive analysis of real estate investments. Teaching experience, strong academic background in economics, statistics, or math and excellent writing skills required. Experience developing college-level textbooks, instructor manuals or corporate training programs preferred. Competitive salary, downtown Chicago location, good benefits. Respond, with salary history, to:

Mary E. Herrmann
Human Resources Coordinator
Institute of Real Estate Management
430 N. Michigan Avenue
Chicago, Illinois 60611

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Journals from 1961, American Mathematical Monthly, Bulletin AMS.

For detailed information write
Professor Bert Ross
Mathematics Dept.
University of New Haven
West Haven, Conn. 06516

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Prize ($1,000) for Philosophy Mathematica (circulating in some 50 nations since 1984) on such topics as: 1. Ethics and Mathematics (in particular, Morals of Knowledge in general); 2. Sociology or Social Theory of Mathematics; 3. The Topological vs the Algebraic; 4. Others, related to the study on the Nature of Mathematics (definitely not via Logic alone). For details, write to: [Prof.] J. Fang, ODU (Phil), Norfolk, VA 23529-0083.

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Tenured Position

University of California
Department of Mathematics
Berkeley, CA 94720

We invite applications for one or more positions effective July 1, 1989, at tenure level (Associate or full Professor), subject to budgetary approval, in the areas of algebra, analysis, applied mathematics, foundations, or geometry and topology. Demonstrated leadership in research is expected of applicants. Send by November 1, 1988 a curriculum vitae, list of publications, a few selected reprints or preprints, and the names of three references, to Marc A. Rieffel, Vice Chair for Faculty Affairs, at the above address. The University of California is an Equal Opportunity, Affirmative Action Employer.
The Supercomputer Computations Research Institute (SCRI) invites applications for a Visiting (or Sabbatical) Professor.

We are seeking a mathematician who is an internationally recognized scholar with an outstanding research record and with considerable experience in the practical large-scale computing applications of mathematics to scientific and technological problems. Specialization expected in at least one major area of applied mathematics such as numerical analysis and in one major application area. Interest in multidisciplinary interaction with SCRI scientists is highly desirable. Experience and interest in working in large-scale parallel and vector computing is a requirement. Targeted areas of current active research include (1) numerical solution of partial differential equations; (2) computational fluid dynamics, and (3) development, implementation, and application of novel algorithms for scientific computing on vector and parallel computers.

We are willing to consider a number of appointment options, e.g., Spring 1989, calendar year 1989 or academic year 1989-90. The appointment may include an invitation to teach an advanced topics course. Salary will be competitive and commensurate with experience and qualifications. Extensions beyond one year are possible.

Florida State University has 24,000 students and is located 20 miles from the Gulf of Mexico in Tallahassee, the Capital of Florida. SCRI is located mid-campus on the top floor of the Paul A.M. Dirac Science Library. The university houses and operates two supercomputers—a CYBER 205 and a four processor cryogenic ETA 10—together with a variety of other DEC, IBM and CDC mainframes, which are connected to major communications networks.

Deadline for receipt of applications is October 31, 1988. Applicants should send resumes and the names of at least three references to:

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One of the greatest mathematicians in the world, Michael Atiyah has earned numerous honors, including a Fields Medal, the mathematical equivalent of the Nobel Prize. While the focus of his work has been in the areas of algebraic geometry and topology, he has also participated in research with theoretical physicists. For the first time, these volumes bring together Atiyah's collected papers—both monographs and collaborative works—including those dealing with mathematical education and current topics of research such as K-theory and gauge theory. The volumes are organized thematically. They will be of great interest to research mathematicians, theoretical physicists, and graduate students in these areas.

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COORDINATORS: Shui-Nee Chow, Martin Golubitsky, Richard McGehee, and George R. Sell


September 5-15, 1989
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206 Church St. S.E.
Minneapolis, MN 55455-0436

The University of Minnesota is an equal opportunity educator and employer, and specifically invites and encourages applications from women and minorities.

IMA PARTICIPATING INSTITUTIONS: Indiana University, Iowa State University, Michigan State University, Northern Illinois University, Northwestern University, Ohio State University, Purdue University, University of Chicago, University of Cincinnati, University of Houston, University of Illinois (Chicago), University of Illinois (Urbana), University of Iowa, University of Michigan, University of Minnesota, University of Notre Dame, University of Pittsburgh, Wayne State University.

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CENTENNIAL GROUP PHOTO

This photo was taken on the steps of the Rhode Island State House, a historical landmark itself and the site of the gala Opening Reception of the Centennial. The photo, which shows over 1,000 Centennial participants, is in full color with a dull gloss finish. It measures 16x20 inches, with an image area of 8x20 inches.

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CENTENNIAL PROGRAM

The Centennial program will serve as a reminder of all the exciting mathematical and social events during the meeting. The bright red cover is embossed with a shiny gold medallion showing a copy of a portrait study of the Society's founder, Thomas Scott Fiske. The same portrait adorned the cover of the program at the Semicentennial banquet in 1938. The program contains an article providing a perspective on the growth of the AMS, written by Everett Pitcher.

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SEMICENTENNIAL PICTURE

This delightful piece of memorabilia shows the group of almost 450 people who attended the Semicentennial in 1938. Taken in front of the Low Library of Columbia University, the Society's home at that time, the photo shows such legendary mathematicians as Norbert Weiner, G. D. Birkhoff, J. W. Tukey, Eric Temple Bell, E. J. McShane, A. W. Tucker, Hassler Whitney...the list goes on. The matte finish photo measures 16x20 inches and carries the names of all the individuals photographed. It's a snapshot in time of the American mathematical community of 50 years ago.

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These tiles display the original "Call to Mathematicians" issued by the Society's founder and his two friends on Thanksgiving Day in 1888. Made of ceramic with a cork backing, the tiles, which can be used as coasters, are attractively decorated in the Centennial colors of red on beige. The tiles measure 4 1/2 inches square.

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Preregistration/Housing Form, Phoenix, Arizona
January 11-14, 1989

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- Room Lottery Qualification: October 31, 1988
- Preregistration/Hotel Reservations: November 10, 1988
- Housing Changes/Cancellations: December 14, 1988
- Preregistration Changes/Cancellations: December 30, 1988
- 50% Refund on Preregistration/Banquet/Hike: December 30, 1988 (no refunds after this date)
- Deadline for Preregistration/Housing Form: January 11, 1989
- Must be received in Providence no later than November 10, 1988

REGISTRATION FEES
- Preregistration by mail by November 10, 1988:
  - Member of AMS, CMS, MAA, NCTM, SMM: $63
  - Nonmember: $98
  - Student, Unemployed, or Emeritus: $18
- AMS Short Course:
  - Member/Nonmember: $40
  - Student or Unemployed: $15
- Joint Meetings fee:
  - Employer fee (1st Interviewer): $75
  - Employer fee (2nd/3rd Interviewer): $35
  - Applicant fee: $15
  - Posting fee for job descriptions for noninterviewing employers: $10
- At Meeting:
  - Joint Meetings fee: $82
  - AMS Short course fee: $127

PREREGISTRATION SECTION: Please check the function(s) for which you are preregistering:
- Joint Meetings
- AMS Short Course (January 10-11, 1989)
- Employer
- Applicant
- Posting

1) (Please print) Surname First Middle Telephone:

2) (Mailing address)


4) I am a student at ________________________________

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6) Accompanied by spouse _______ Number of children ______ (Enumerate only if accompanying to meeting)

7) Member of AMS ☐ CMS ☐ MAA ☐ NCTM ☐ SMM ☐ Nonmember ☐ [Member discount applies only to members of AMS, CMS, MAA, NCTM, and SMM]
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For office use only:

Codes: Options: Hotel: Room type:

Dates: Hotel Deposit Total Amt. Paid:

Special Remarks:
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Please rank hotels in order of preference by writing 1, 2, 3, etc. in the spaces at the left on form, and by circling the requested room type and rate. If the rate requested is no longer available, you will be assigned a room at another hotel at the next available rate. If not all hotels are ranked, and all rooms have been filled at the ranked hotels, the assignment will be made at an unranked hotel with the next available rate. Rates listed below are subject to 9.1% sales/occupancy tax.

GUARANTEE REQUIREMENTS: $50 by check OR a credit card guarantee with VISA, MasterCard, or American Express (for housing only). No other credit cards will be accepted. PLEASE SUPPLY THIS INFORMATION ON THE REVERSE, together with mailing address for confirmation of room reservation.

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<th>Order of choice</th>
<th>Single</th>
<th>Double</th>
<th>Twin</th>
<th>Triple double</th>
<th>Triple 2 beds</th>
<th>Triple 2 beds w/cot</th>
<th>Quad 2 beds</th>
<th>Quad 2 beds w/cot</th>
<th>Suite</th>
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<td>Hyatt Regency Phoenix (Headquarters Hotel)</td>
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<td>Sheraton Phoenix</td>
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<td>Holiday Inn-Financial Center</td>
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<td>69</td>
<td>N/A</td>
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<td>N/A</td>
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<td>Holiday Inn-Airport East</td>
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<td>Days Inn San Carlos</td>
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Special housing requests: __________________________________________________________________________________________

I will arrive on (date) _______________________ at _______________________ a.m./p.m., and depart on (date) _______________________ at _______________________ a.m./p.m.

Please list other room occupants; indicating ages of children.

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<th>FULL NAME</th>
<th>ARRIVAL DATE</th>
<th>DEPARTURE DATE</th>
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MAA Minicourse and Workshop Preregistration Form, Phoenix, Arizona
January 11-14, 1989

NOTE: This is not an AMS Short Course Form. Please use the Joint Meetings Registration/Housing Form to preregister for the AMS Short Course.

To register for MAA Minicourse(s) and/or Workshop, please complete THIS FORM or a PHOTOCOPY OF THIS FORM and return it with your payment to:

Minicourse: Susan Wilderson
Mathematical Association of America
1529 Eighteenth Street, N.W.
Washington, DC 20036
Telephone: 202-387-5200

Workshop: Alicia Bennett
Mathematical Association of America
1529 Eighteenth Street, N.W.
Washington, DC 20036
Telephone: 202-387-5200

(Please print) Surname First Middle

Street address City State Zip

Deadline for MAA Minicourse and Workshop preregistration: November 10, 1988
Deadline for cancellation in order to receive a 50% refund: December 30, 1988 (No refunds after this date)
Registration for the Joint Meetings is a requirement in order to participate in the MAA Minicourses and/or Workshop. Complete the Preregistration/Housing Form included in the meeting announcement and return it to Providence with the applicable Joint Meetings preregistration fee. DO NOT SEND MAA MINICOURSE/WORKSHOP FORM OR FEES TO PROVIDENCE.

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Please complete the following and send both form and payment to Susan Wilderson OR Alicia Bennett at the above address:

I would like to attend  ☐ 1 Minicourse  ☐ 2 Minicourses  ☐ Workshop on Teaching Assistants and Part-Time Instructors

Please enroll me in MAA Minicourse(s):  #__ and #__ In order of preference, my alternatives are: #__ and #__

For my two workshop discussion groups, my preferences are (please list three or more) #__ #__ #__ #__ #__

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Minicourse Number and Name
1. Computer graphics in elementary statistics  
2. Using computer graphing to enhance the teaching and learning of calculus and precalculus mathematics  
3. Using history in teaching calculus  
4. Applications of discrete mathematics  
5. Writing in mathematics courses  
6. Surreal numbers  
7. Computer based discrete mathematics  
8. Teaching mathematical modeling  
9. Learning math through discrete dynamical systems  
10. Applied mathematics via classroom experiments  
11. Modeling with the Poisson process  
12. muMATH workshop  
13. Applications of the HP28S supercalculator for more experienced users  
14. Creating order out of chaos in freshman mathematics: instituting a mathematics placement program  
15. Ada for mathematicians

Workshop on Teaching Assistants and Part-Time Instructors: Responses to the Challenge

Discussion group choices:
A. Administrative support for programs  
B. Lecture/recitation and multi-section formats  
C. Part-time instructors at two- and four-year colleges  
D. Academic concerns of TAS  
E. International TA concerns  
F. TAs in master's-only departments  
G. University-wide TA training programs  
H. Departmental TA training

☐ I plan on preregistering for the Joint Meetings only in order to attend the MAA Minicourse(s) and/or TA/PTI Workshop indicated above. It is my understanding that, should the course(s) of my choice be filled, full refund of the Joint Meetings preregistration fee will be made.

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Organised by: Bettye Anne Case
Fee: $15
The tradition of the International Congress of Mathematicians began in Zurich, Switzerland in 1897. Since then, the Congress has been held every four years, except during the first and second world wars. In a time when increasing specialization has divided mathematics into many subfields, ICM serves an important role. Its purpose is to foster personal relationships between mathematicians from different countries and to present a survey of the current state of mathematical research. In addition, the Congress has provided the occasion for awarding the prestigious Fields Medals and Nevanlinna Prize.

In August 1986, more than 3500 mathematicians gathered in Berkeley, California for the nineteenth ICM. These proceedings, printed in two volumes, represent a complete account of the activities of the Berkeley Congress. Volume 1 contains the official record of the ICM, the list of members, presentations made on the work of the Fields medalists and the Nevanlinna Prize winner, and the 15 one-hour plenary session addresses. More than 140 45-minute invited lectures were given, and these have been grouped into 19 mathematical sections which are listed below. Those addresses from sections 1-8 appear in Volume 1, with the remaining 11 sections in Volume 2. More than 400 short communications were presented at ICM, and the names of the communicators and the titles of their papers appear in the proceedings.

1980 Mathematics Subject Classification: 00
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Instructions for Applicant’s Form on facing page

The form. Applicants’ forms submitted for the Employment Register will be photographically reproduced in the December 1988 issue of Employment Information in the Mathematical Sciences. Résumés of those attending will be posted at the meeting.

The forms must be carefully typed using a fresh black ribbon. The best results are obtained with a carbon-coated polyethylene film ribbon, but satisfactory results may be obtained using a ribbon made of nylon or other woven fabric if suitable care is exercised. It is important that the keys be clean and make a sharp, clear impression. Do not erase—it causes smudges which reproduce when photographed. Use a correcting typewriter or correction tape or fluid if necessary. Submit the original typed version only. Copies will not reproduce properly and are not acceptable. Hand lettered forms will be returned.

Applicants’ forms must be received by the Society by November 10, 1988 in order to appear in the special issue of EMS, and must be accompanied by the Preregistration/Housing Form printed in this issue, if attending the meeting. Forms received past the deadline or not completed will be returned.

The summary strip. Information provided here will be used to prepare a printed list of applicants for distribution to employers. Please supply all information requested, and confine your characters to the boxes provided. Use the codes below. Circled letters identify corresponding items on the form and the strip.

A Specialties

| AL = Algebra          | AN = Analysis          |
| BI = Biomathematics   | BS = Biostatistics     |
| CB = Combinatorics    | CM = Communication     |
| CN = Control          | CS = Computer Science  |
| CT = Circuits         | DE = Differential Equations |
| EC = Economics        | ED = Mathematical Education |
| FA = Functional Analysis | FI = Financial Mathematics |
| FL = Fluid Mechanics  | GE = Geometry          |
| HM = History of Math  | LO = Logic             |
| MB = Mathematical Biology | ME = Mechanics        |
| MO = Modelling        | MP = Mathematical Physics |
| MS = Management Science | NA = Numerical Analysis |
| NT = Number Theory    | OR = Operations Research |
| PR = Probability      | SA = Systems Analysis  |
| ST = Statistics       | TO = Topology          |

B Career Objectives

| AR = Academic Research | AT = Academic Teaching |
| NR = Nonacademic R&D   | NC = Nonacad. Consulting |
| NS = Nonacademic Supervision |

C Duties

| T = Teaching         | U = Undergraduate     |
| G = Graduate         | R = Research          |
| C = Consulting       | A = Administration    |
| S = Supervision      | IND = Industry        |
| GOV = Government     | DP = Data Processing  |

Location

| E = East             | S = South             |
| C = Central          | M = Mountain          |
| W = West             | O = Outside U.S.      |
| I = Indifferent      |

L U.S. Citizenship Status

| C = U.S. Citizen     | P = Permanent Resident |
| T = Temporarily in U.S. | N = Non-U.S. Citizen |

Please supply all information requested and confine your characters to the boxes provided.

Applicants’ forms must be received by the Society by November 10, 1988 in order to appear in the special issue of EMS, and must be accompanied by the Preregistration/Housing Form printed in this issue, if attending the meeting. Forms received past the deadline or not completed will be returned.

The summary strip. Information provided here will be used to prepare a printed list of applicants for distribution to employers. Please supply all information requested, and confine your characters to the boxes provided. Use the codes below. Circled letters identify corresponding items on the form and the strip.
The form must be typed. (Please see instructions on facing page)

APPLICANT: Name.-----------------------------------------------------
Mailing address (include zip code) ___________________________________

A Specialties._______________________________________________________

B Career objectives and accomplishments
ACADEMIC: ☐ Research, ☐ Teaching
NON-ACADEMIC: ☐ Research and Development, ☐ Consulting, ☐ Supervision

Near-term career goals:______________________________________________

Significant achievements or projects, including role:____________________

Honors and offices:__________________________________________________

Other (e.g., paper to be presented at this meeting):______________________

Selected titles of papers, reports, books, patents:_______________________

C Degree Year Institution

☐ No. of abstracts, internal reports.
C No. of papers accepted.
F No. of books and patents.

EMPLOYMENT HISTORY:

Employer. Present Previous Previous

Position ____________________________________________________________

Duties _____________________________________________________________

Years to. to. to.________________________________________________________________

DESIRED POSITION:

Duties _____________________________________________________________

Available mo./yr. Location ______________________ Salary

References (Name and Institution)

____________________________________________________________________

E Citizenship:_______________________________________________________

F AVAILABLE FOR INTERVIEWS:

(Interviews for Session 4 scheduled on the basis of employer’s request only.)

Session 1 ☐ Session 2 ☐ Session 3 ☐ Session 4 ☐
Thurs. AM 9:30-11:45 Thurs. PM 1:15-5:00 Fri. AM 9:30-11:45 Fri. PM 1:15-5:00

I do not plan to attend the Winter Meeting ☐

SUMMARY STRIP

Family Name First Name Mailing Address

Address (cont’d.) Address (cont’d.) State & Zip Code Specialties

Career objectives Highest Degree Yr. Institution

Most recent employer

Present duties Desired duties Available mo./yr. Sessions

____________________________________________________________________
EMPLOYER FORM  

INSTRUCTIONS: Please read carefully before completing form below. Circled letters identify corresponding items in the FORM and the SUMMARY STRIP; abbreviations to be used are provided in the notes below. Please print or type in black ink. Block capitals are suggested. The FORM itself will be placed on display at the Register exactly as submitted. The SUMMARY STRIP (be sure to complete) will be used to prepare a computer printed list of summaries for distribution at the Register sessions. Employers are encouraged to provide more than one interviewer when they are able to do so, in order to increase the number of interviews which may be scheduled. Please take care to indicate on the FORM the number of interviewers for whom simultaneous interviews may be scheduled. (If all interviewers will be interviewing for the same position, or for the same set of positions, only one form should be submitted and only one employer code number will be assigned; therefore, each interviewer would then receive a separate computer schedule and separate table number.) More than one employer code will be required if some interviewers will not interview for all positions. Thus, if there are two disjoint sets of positions, two forms are required and two employer codes will be assigned. (Please refer to the section on the Employment Register following the Phoenix meeting announcement.)

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<th>Experience</th>
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<th>Session 2 ( )</th>
<th>Session 3 ( )</th>
<th>Session 4 ( )*</th>
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<th>Duties</th>
<th>Experience</th>
<th>Sessions</th>
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NOTES: A Inst, Lect, Asst Prof, Assoc Prof, Prof, Dean, Open, MTS (Member Technical Staff), OPAN (Operations Analyst), PREN (Project Engineer), RESE (Research Scientist); B Date 01/89, e.g.; C Possible-P, Impossible-I; D Algebra=AL, Analysis=AN, Biomathematics=BI, Biostatistics=BS, Combinatorics=CB, Communication=CM, Control=CN, Computer Science=CS, Circuits=CT, Differential Equations=DE, Economics=EC, Mathematical Education=ED, Functional Analysis=FA, Financial Mathematics=FM, Fluid Mechanics=FL, Geometry=GE, History of Mathematics=HM, Logic=LO, Mathematical Biology=MB, Mechanics=ME, Modeling=MO, Mathematical Physics=MP, Management Science=MS, Numerical Analysis=NA, Number Theory=NT, Operations Research=OR, Probability=PX, Systems Analysis=SA, Statistics=ST, Topology=TO; E Bachelor=B, Master=M, Doctor=D; F Teaching=T, Undergraduates=U, Graduates=G, Research=R, Consulting=C, Administration=A, Supervision=S, Industry=IND, Government=GOV, Date Processing=DP, No experience required=N; G U.S. Citizen=C, U.S. Citizen or permanent resident=CP, No restriction=NR; H Periods available for interviews: List 1, 2, 3, and/or 4, see the FORM above.

* Interviews are scheduled in this session on the basis of employers request only.
AMERICAN MATHEMATICAL SOCIETY

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03 Set theory
04 Combinatorics
05 Order, lattices, ordered algebraic structures
06 General mathematical systems
11 Number theory
12 Field theory and polynomials
13 Commutative rings and algebras
14 Algebraic geometry
15 Linear and multilinear algebra; matrix theory
16 Associative rings and algebras
17 Nonassociative rings and algebras
18 Category theory; homological algebra
19 K-theory
20 Group theory and generalizations
22 Topological groups, Lie groups
26 Real functions
28 Measure and integration
30 Functions of a complex variable
32 Several complex variables and analytic spaces
33 Special functions
34 Ordinary differential equations
35 Partial differential equations
39 Finite differences and functional equations
40 Sequences, series, summability
41 Approximations and expansions
42 Fourier analysis
43 Abstract harmonic analysis
44 Integral transforms, operational calculus
45 Integral equations
46 Functional analysis
47 Operator theory
49 Calculus of variations and optimal control; optimization
50 Global analysis, analysis on manifolds
51 Geometry
52 Convex and general geometric topics
53 Differential geometry
54 General topology
55 Algebraic topology
57 Manifolds and cell complexes
58 Global analysis, analysis on manifolds
59 Probability theory and stochastic processes
60 Statistics
62 Numerical analysis
68 Computer science
69 Mechanics of particles and systems
70 Mechanics of deformable solids
71 Fluid mechanics
72 Optics, electromagnetic theory
73 Relativity and gravitational theory
74 Quantum theory
75 Statistical mechanics, structure of matter
76 Thermodynamics, heat transfer
77 Mechanics of particles and systems
78 Fluid mechanics
79 Optics, electromagnetic theory
80 Classical thermodynamics, heat transfer
81 Quantum theory
82 Statistical mechanics, structure of matter
83 Relativity
84 Astronomy and astrophysics
85 Geophysics
86 Information and communication, circuits
87 Computer science
88 Operations research, mathematical programming
89 Game theory, economics, social and behavioral sciences
90 Mechanics of particles and systems
91 Fluid mechanics
92 Optics, electromagnetic theory
93 Relativity
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1988 Dues Schedule

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Joint family member (reduced rate) ......................... $46 $66
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 ........................................ $66 for 2 years

1 Student Verification (sign below)
I am a full-time student at ........................................ currently working toward a degree.

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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.

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- Deutsche Mathematiker-Vereinigung e.V.
- Edinburgh Mathematical Society
- Gesellschaft für Angewandte Mathematik und Mechanik
- Glasgow Mathematical Association
- Indian Mathematical Society
- Iranian Mathematical Society
- Irish Mathematical Society
- Islenzka Stærdfraedafelagid
- Israel Mathematical Union
- Korean Mathematical Society
- London Mathematical Society
- Malaysian Mathematical Society
- Mathematical Society of Japan
- Mathematical Society of the Philippines
- Mathematical Society of the Republic of China
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R. Abraham, J. Marsden and T. Ratiu
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Y.A. Mazur
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P.A. Lagerström
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S. Wiggins
Describes the mechanisms which give rise to chaotic dynamics and develops techniques for detecting these mechanisms in a large class of dynamical systems. Chapter 1 provides an introduction covering background for ordinary differential equations and dynamical systems. Topics include structure of solutions, existence and uniqueness, phase flows, stability, conjugacies, invariant manifolds, transversality, bifurcations and Poincaré maps. The following chapter describes chaos and the conditions for its existence. Focus is on the two-dimensional Smale horseshoe, symbolic dynamics, and the criteria for chaos. Chapter 3 illustrates homoclinic and heteroclinic motions — the dynamical consequences of orbits and normally hyperbolic invariant tori in ordinary differential equations. Smale’s theorems in arbitrary dimensions are covered, as well as more specialized results for Hamiltonian systems. The last chapter offers the development of a variety of perturbation methods which enables the determination of complicated dynamical phenomena in specific systems. Melnikov type theories are instated for three distinct types of multi-dimensional systems; Arnold diffusion is defined; new results concerning exponentially small Melnikov functions are introduced. Numerous examples are included throughout the book.

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