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Calendar of AMS Meetings and Conferences

This calendar lists all meetings approved prior to the date this issue went to press. The summer and annual meetings are joint meetings of the Mathematical Association of America and the American Mathematical Society. The meeting dates which fall rather far in the future are subject to change; this is particularly true of meetings to which no numbers have 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, insofar as is possible. Abstracts should be submitted on special forms which are available in many departments of mathematics and from the headquarters office of the Society. Abstracts of papers to be presented at the meeting must be received at the headquarters of the Society in Providence, Rhode Island, on or before the deadline given below for the meeting. The abstract deadlines listed below should be carefully reviewed since an abstract deadline may expire before publication of a first announcement. 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 special sessions.

Meetings

Meeting #		Date	Place	Abstract Deadline	Program Issue
867	*	August 8–10, 1991	Orono, Maine	Expired	July/August
	†	(94th Summer Meeting)			
868	*	October 12–13, 1991	Philadelphia, Pennsylvania	August 1	October
869	*	October 25–26, 1991	Fargo, North Dakota	August 1	October
870	††	November 9–10, 1991	Santa Barbara, California	August 1	October
871	*	January 8–11, 1992	Baltimore, Maryland	October 2	December
		(98th Annual Meeting)			
872	*	March 13–14, 1992	Tuscaloosa, Alabama	January 2	March
873	*	March 20–21, 1992	Springfield, Missouri	January 2	March
874	*	April 11–12, 1992	Bethlehem, Pennsylvania	January 30	April
875	*	June 29–July 1, 1992	Cambridge, England	February 28	May-June
		(Joint Meeting with the London Mathematical Society)			
876	*	October 30–November 1, 1992	Dayton, Ohio	August 3	October
		January 13–16, 1993	San Antonio, Texas		
		(99th Annual Meeting)			
		March 26–27, 1993	Knoxville, Tennessee		
		May 21–22, 1993	DeKalb, Illinois		
		August 15–19, 1993	Vancouver, British Columbia		
		(96th Summer Meeting)			
		(Joint Meeting with the Canadian Mathematical Society)			
		October 22-23, 1993	College Station, Texas		
		January 12–15, 1994	Cincinnati, Ohio		
		(100th Annual Meeting)			
		March 18–19, 1994	Lexington, Kentucky		
		March 25–26, 1994	Manhattan, Kansas		
		January 25–28, 1995	Denver, Colorado		
		(101st Annual Meeting)			
		January 10–13, 1996	Orlando, Florida		
		(102nd Annual Meeting)			

* Please refer to page 631 for listing of Special Sessions.
† Preregistration/Housing deadline was June 6.
†† These dates are earlier than previously published.

Conferences

June 22–August 2, 1991: Joint Summer Research Conferences in the Mathematical Sciences, University of Washington, Seattle, Washington.

August 6–7, 1991: AMS Short Course on The Unreasonable Effectiveness of Number Theory, University of Maine, Orono, Maine.

August 8, 1991: AMS-SIAM-SMB Symposium on Some Mathematical Questions in Biology, Theoretical approaches for predicting spatial effects in ecological systems, San Antonio, Texas.

Deadlines

	September Issue	October Issue	November Issue	December Issue
Classified Ads*	August 1, 1991	August 27, 1991	September 30, 1991	November 7, 1991
News Items	July 17, 1991	August 12, 1991	September 20, 1991	October 24, 1991
Meeting Announcements**	July 18, 1991	August 15, 1991	September 23, 1991	October 28, 1991

* Please contact AMS Advertising Department for an Advertising Rate Card for display advertising deadlines.
** For material to appear in the Mathematical Sciences Meetings and Conferences section.

NOTICES OF THE AMERICAN MATHEMATICAL SOCIETY

ARTICLES

545 Moving Beyond Myths *Revitalizing Undergraduate Mathematics*

The Committee on the Mathematical Sciences in the Year 2000, known as MS2000, was charged by the National Research Council with charting a course for revitalizing undergraduate mathematics education. "Moving Beyond Myths," the committee's final report, is sure to spark debate within the mathematical science community. Virtually the entire report is reprinted in this issue of *Notices*.

FEATURE COLUMNS

562 Computers and Mathematics *Keith Devlin*

This month Robert D. Silverman of the MITRE Corporation writes an article surveying computational number theory and Thomas Scavo of the University of Oregon reviews the mathematical typesetting system *MathWriter* 2.0.

573 Inside the AMS

Since late last year, the AMS has engaged in a period of strategic planning. The report of the Strategic Planning Task Force (SPTF), which will serve as a template for developing a three- to five-year action plan, is reproduced here for the information of the membership. Also, the Society announces a reduced subscription rate for a new journal, *Experimental Mathematics*, and provides an update on some e-MATH initiatives.

584 Washington Outlook

How will academic research fare in the fiscal 1992 federal budget? Lisa A. Thompson surveys the Congressional atmosphere in this month's column.

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SUBSCRIPTION INFORMATION
Subscription prices for Volume 38 (1991) are $121 list; $97 institutional member; $73 individual member. (The subscription price for members is included in the annual dues.) A late charge of 10% of the subscription price will be imposed upon orders received from nonmembers after January 1 of the subscription year. Add for postage: Surface delivery outside the United States and India—$15; to India—$27; expedited delivery to destinations in North America—$28; elsewhere—$67. Subscriptions and orders for AMS publications should be addressed to the American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571. All orders must be prepaid.

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

The paper used in this journal is acid-free and falls within the guidelines established to ensure permanence and durability. ∞ Most of this publication was typeset using the TEX typesetting system.

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From the Executive Director . . .

PLANNING REPORT

This issue of *Notices* brings to its readers the Report of the Society's Strategic Planning Task Force (SPTF), completing a stage in the strategic (or long-range) planning process in which the Society has been engaged since last year.

Early in the process, the AMS appointed the SPTF to conduct a detailed audit of the Society's mission, its programs and services, its structure, its environment, and its constituencies. From the issues identified by this audit, the SPTF fashioned its report to the Executive Committee of the Council and the Board of Trustees (ECBT).

In addition to interpreting and clarifying the Society's purpose of furthering mathematical scholarship and research, the Report sets forth six overarching goals and the reasons for pursuing those goals. The Report also states a number of objectives the SPTF felt were central for achievement of its recommended goals. Potential strategies, which appear as an appendix to the Report, were not fully developed by the Task Force, but are included to communicate the deliberations that were part of the SPTF's work and to clarify what the Task Force might expect as the planning process continues.

In addition to accepting and endorsing the SPTF Report, the ECBT explicitly considered and endorsed the Report's recommendations for the "next steps" in the planning process. Beyond communicating the Report to the membership and other constituents of the Society for their discussion and input, the ECBT charged the executive director and staff to develop and implement a feasible, effective plan of operation. The next steps are to take the overarching goals of the Report—the template setting forth the direction for the Society over the next three to five years—and put together an operational plan.

This process is now under way. The goals and objectives are being carefully considered and clarified. Strategies to achieve the goals are being evaluated and detailed action plans will be developed. This process is ongoing and will be open to constant review and revision. An operational plan is to be presented to the ECBT at their November 1991 meeting.

In many ways, this process is extraordinary. Numerous issues are facing the Society and the mathematical sciences community. The AMS must have an understanding of these issues, along with well-conceived, clearly-stated, and accepted goals, so that its decision-making and actions will be worthwhile and effective. To understand the issues and identify goals, the Society has taken a very open route. The Task Force was appointed to provide broad representation from the many constituencies of the Society. From interviews, surveys, and articles in *Notices*, opinions and information have been received from the mathematical sciences community, and a consensus has evolved on the mission of the Society and its goals over the next three to five years.

The interpretation of the mission makes explicit the commitment of the Society to the furtherance of mathematical research, while also addressing the importance of applications of mathematics, mathematics education, and professional development. The statement of the mission expresses clearly the Society's role in encouraging and facilitating full participation of all individuals and the Society's responsibility to foster an awareness and appreciation for mathematics.

This Report provides the leadership and staff of the Society with a clearly defined direction for action. More work is still needed to identify specific actions and incorporate mechanisms for constant review and revision. However, we are excited by the progress made to this point and the promise of a more dynamic Society that is better able to respond to current and emerging needs.

William Jaco

Letters to the Editor

Strategic Planning

Just what is Strategic Planning?

The March 1991 issue (Vol. 38, No. 3) of *Notices* starts with an essay on the current "strategic planning" effort, observing that there are "forces" affecting the mathematical community, without specifying these forces or distinguishing those which might be helpful from those which might better be resisted. Put differently, some social "forces" may be inimical to mathematical research.

"Strategic planning" also involves a recent survey questionnaire to members of the Society. Item 8 of this questionnaire invites the respondents to "CHOOSE FOUR of the following issues which you feel the AMS should address. . . ." The issues begin with slogans such as "Promote. . . Advocate. . . Develop. . . Improve. . . Take a stand. . . foster. . . facilitate. . . ," and so seem chiefly concerned with lobbying. Mathematical research was mentioned only in connection with institutions, federal support, "importance" and "communicating research findings prior to publication." One may recall that the *New York Times* published prior news of the solution of the Poincaré conjecture in dimension 3, a "finding" subsequently "lost." These twelve issues do not mention that the research is done by people and that it is still hard to do well.

None of the 12 issues dealt with jobs and employment, except for the now conventional "opportunities for women and minorities." The hard fact of the matter is that the job market for young mathematicians, minority or not, is in total disarray—as is suggested by other letters in *Notices*. This spring, for example, one college had 600 applicants for one position. Colleges and Universities face budget constraints which mean that new Ph.D.s compete for fewer and fewer jobs with eager and more experienced would-be immigrants from the USSR and the P.R.C. Those strategic issues in the survey might well have included:

Problems of jobs.

- Persuading universities to replace teaching assistantships and temporary jobs by tenure track jobs.
- Establishing a national archive for current letters of reference. (Each of those 600 could then submit one reference, and cite the archive for the others).

Encouragement of research.

The sometime concern of the AMS for the prosecution of mathematical research might also have been represented by issues such as:

- *Solicit more survey articles* on current research.
- Establish an archive for preprints.
- Is research publication sufficiently rapid?
- Are there adequate avenues for publication; for announcements?
- Are the AMS special sessions at meetings the right vehicle?
- Are there too many conferences on isolated specialties; what might replace them?

Saunders Mac Lane
University of Chicago
(Received March 26, 1991)

Professor Mac Lane was thoughtful enough to provide an advance copy of the preceding letter to me. I have shared it and my response with the members of the Strategic Planning Task Force. What follows is the text of that response:

Thank you for your letter of March 26, and the advance copy of your letter to the Editor of *Notices*. It is unfortunate that we were unable to get together at San Francisco; I would have liked to talk to you at length. In another sense, however, it is fortunate: This way we can share that conversation with a larger audience. Needless to say, many of the members of our committee were also skeptical, and some still are, about this way of strategic planning. However, my own concerns are not objections to principle; I look forward to a further explanation of your objection. I disagree that the present preliminaries are wholly (or even in part) misdirected and misconceived as you affirmed in your cover letter to me; let me explain my disagreement.

Last year the long range planning committee recognized that there are "forces" affecting the mathematical community (some of which you accurately identify later in your *Notices* letter) with which the Society was not dealing effectively. To plan a course of action to do so, we felt, required stepping back and taking as objective a look at the Society and its membership as possible to better understand its role and capabilities. We felt it was presumptuous for the six of us to speak for the Society and excessive work for us to find the voice of the membership without assistance. This was the

Policy on Letters to the Editor

Letters submitted for publication in *Notices* are reviewed by the Editorial Committee, whose task is to determine which ones are suitable for publication. The publication schedule normally requires from one to two months between receipt of the letter in Providence and publication of the earliest issue of *Notices* in which it could appear.

Publication decisions are made by a letters editor who is appointed by the Editorial Committee from among its members and who is accountable to the committee for those decisions. There is provision for discussion among committee members, by mail or at meetings, before decisions are made by the letters editor. Letters requiring collateral correspondence and/or revision may require several months to process. Letters which have been, or may be, published elsewhere will be considered, but the Managing Editor of *Notices* should be informed of this fact when the letter is submitted.

The committee reserves the right to edit letters.

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

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

Letters should be mailed to the Editor of *Notices*, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, or sent by email to notices@math.ams.com, and will be acknowledged on receipt.

conception of the present preliminaries.

These preliminaries are directed toward discovering and then concisely articulating the ambitions and needs of the mathematical community which the Society represents, and to formulate a set of goals and strategies to achieve those goals, based on that information. I find it hard to accept your assertion that such a direction is wholly wrong. My reservations, which still trouble me, are that this process may not produce sufficiently accurate, or meaningful, information to do the job. We do not know how to gather such information accurately, and perhaps KPMG Peat Marwick knows no better. Do we have an alternative approach?

The alternative you suggest, and in fact follow, is to set out some objectives as "the right thing to do" without having figured out (or told us) why. But then how do we know who this "we" represents? AND HOW DO WE KNOW WE ARE RIGHT? Is this really "Strategic Planning"?

Of course, in the process of formulating a statement of purpose, we find ourselves working out goals and strategies. Although our output will appear deductive: from "mission statement" to goals; it is, of necessity, partly inductive: from discussion of goals back to statements of purpose. We have discussed problems of jobs, encouragement of research and expository writing; there is a good chance that our work will converge toward your prescriptions. Our hope is to put it all in a coherent whole, so that the program of action contemplated follows from the ideals set forth.

Such a clear line of implication is, perhaps, much more than we can attain. But, as in creative research, if we set our goals high enough the outcome will have that much more value. At the minimal extreme, some issues need resolution no matter how we approach them. For example, are "opportunities for women and minorities" the conventional wisdom, political expediency, a viable, even necessary, way to enhance the profession, or indeed, all of these? When we work out the answer to that, then we can begin to set out a plan which is more than a knee-jerk reaction to a particular "social pressure".

Hugo Rossi
University of Utah
(Received April 13, 1991)

Editor's Note: Professor Rossi is chair of the Society's Strategic Planning Task Force.

Employment of New Ph.D.s

Prof. Lewis's suggestions (April 1991 *Notices*, pages 296-297) are predicated on there being a short-term mathematician glut along with a long-term shortage. If you accept his assumptions, then his suggestions are reasonable and should be implemented without haste. I am not convinced that there is a long-term shortage of mathematicians and the following should be considered.

1. All the assumptions on the shortage are based on a one-to-one replacement of retiring faculty with new hires. Prof. Lewis notes that states have budget deficits—these are likely to have a profound effect on hiring for the next decade. (Politically, funding for state universities is at the bottom of the list.)
2. Faculty should seek out more industrial interaction to increase employment opportunities. This country is long overdue for serious industry-academia cooperation. (A good initial step is the Institute for Mathematics and its Applications (IMA) summer program on semiconductors, page 315, April 1991 *Notices*.)
3. Prof. Lewis is on target regarding the recruiting process. I only suggest that thesis advisors become more involved in the employment process for their students.
4. The great mathematical advances in the next 30 years are likely to be interdisciplinary (i.e. mathematical control theory, algebraic geometry and mathematical physics, differential equations and biophysics, number theory and computer science, etc.). Graduate students can enter these fields if they develop a broad education. One should attend as many professional meetings and join all relevant organizations during their graduate career.
5. Postdocs have a high chance of being in a "holding pattern"—there are many physicists with six plus years of postdoctoral experience who can not find tenured faculty positions. (Do we want this to happen to young mathematicians?)
6. More emphasis needs to be placed on teaching positions. The great need is for mathematical service courses (basic algebra, calculus, linear algebra, differential equations) rather than high level pure math.

I found Prof. Lewis's suggestions interesting and they should be considered despite my reservations.

Stephen M. Hohs
San Jose, CA
(Received May 14, 1991)

More Support for Research Unnecessary

Several articles (those by Allyn Jackson, William Jaco and D. J. Lewis) in the April 1991 issue of *Notices* indicate that we need to increase the number of mathematicians who receive research support. I strongly disagree with this viewpoint.

First, I believe there is no evidence that there is a shortage of mathematical research being done. The same issue of *Notices* contains a backlog list of mathematics research journals. This list indicates these journals publish at least 121,522 pages each year. Since many of these journals have sizable backlogs (and since the list by no means includes all mathematical journals) I think it is safe to conclude that there is no shortage of mathematical research being done.

Second, I believe that doing research takes away too much time from what should be our main job: Teaching. If one reads "Teaching Programs That Work" by Leonard Gillman in the January-February 1990 issue of *Focus*, one notices that all these programs demand that teachers spend a lot of time on their teaching duties. We cannot change calculus courses from filters to pumps by proving theorems about, say,

Banach spaces, but by spending a lot of time working with students.

Due to the facts that there is no shortage of research being done, that we need to spend more time on our teaching duties and that many schools and state and federal agencies are facing financial difficulties, I believe that we should not increase research funding, and that we could easily survive some modest cutbacks.

Dave Trautman
The Citadel
(Received April 11, 1991)

Problems with the Grant Process

In a footnote to his article in the July 1990 issue of the *Bulletin*, Serge Lang reports that due to continued inequities in the awarding of NSF [National Science Foundation] grants he will no longer apply for any form of support from the NSF. As Lang points out in an April 1987 letter to *Notices*, the main problem is the shortage of funds at the NSF. At the current level of NSF funding it may be quite difficult to have a truly viable system of awarding grants. However, it would certainly be beneficial to the entire mathematical community if we were able to reform the existing procedure. In light of this it seems like a good time to begin an open discussion of some of the problems with the grant process and to suggest possibilities for improving this process.

(1) Lang mentions in the footnote to his recent *Bulletin* article that "university administrators often interpret not having NSF support as making someone unsuitable for tenuring or promoting." This is certainly disasterous for the future of American mathematics. At the current level of funding at the NSF, there are several deserving mathematicians not being supported for each mathematician that is being supported. The interpretation by university administrators may very well drive these unsupported mathematicians out of mathematics. Part of this interpretation on the part of administrators is undoubtedly due to the fact that universities profit greatly (in the form of exorbitant overhead) from any grant award. Reducing the amount that a university takes as overhead to the actual cost of administering a grant would serve two purposes. First, it would free a great deal of money which could then be used for new grant awards. Second, it would reduce pressure by university administrators on untenured faculty since the university would no longer stand to profit excessively from a grant award.

(2) Avoid the possibility of support becoming entrenched by changing referees for grant renewals. This would eliminate the obvious problem of having someone's friends continually approve his/her grant proposal. Moreover, it would provide new feedback to both the proposer and the NSF.

(3) As a mathematician becomes more established and his/her salary rises, there should be a corresponding decrease (and, possibly, eventual complete cessation) in the level of summer salary and benefits support. This would make it easier for young researchers to obtain support by freeing relatively large sums of money, while continuing to support older researchers through travel awards and graduate student support.

(4) Establish a more viable appeals procedure for cases where awards have been denied. In connection with this, establish an independent committee to oversee the choice of reviewers, and to judge whether appropriate peer reviewers have been chosen. In July 1986, I received a letter from Richard S. Nicholson (who was then assistant director for mathematical and physical sciences at the NSF) in which he stated "the formal reconsideration process at NSF is intended to determine whether our policies and procedures were followed in the review and processing of the proposal. It is not an additional peer review, or "second-guessing" of the program officer's judgement." Thus, the appeals process was not intended to determine if someone was undeservedly denied an award, but rather was simply a bureaucratic review of procedures. I understand that the NSF has recently revised the appeals process to give the applicant a greater chance to challenge the peer-reviewers. Nonetheless, without an independent oversight committee to judge the merit of reviews, the decision concerning an appeal lies with the very people who denied the award to begin with, and the potential for abuse still exists. Moreover, in the case of a successful appeal, where will the funds for a grant award come from? The awards budget for the NSF is usually exhausted long before applicants receive their reviews, and can file their appeals.

(5) Change the current emphasis which concentrates funding in relatively few hands. Enormous grants for certain individuals, PYI [Presidential Young Investigators] awards, and large research institutes do serve a purpose, but when they exist at the expense of wide-spread, grass roots support for researchers then they may actually be doing more harm than good.

In closing I would like to point out that, in the current process, funding considerations tend to force researchers to concentrate on the ideas and methods used by the reviewers, rather than to encourage truly independent work. In this regard, the NSF may actually be discouraging original work, which is certainly quite contrary to the desired goals of the NSF. It is unfortunate that, for the past several years, many talented young mathematicians have been denied support at least in part because they are out of the "mainstream."

Sheldon Kamienny
University of Arizona
(Received March 28, 1991)

Undergraduate Mathematics Courses

I worry about the content of undergraduate mathematics; not just in Mathematics Departments, but throughout the technical curricula. I don't mean whether Calculus is taught first and foremost, or whether everyone should take a Modern Algebra course early.

My concern is that we've decided sometime during the past couple decades that those "only" seeking a B.S. won't "be able" to absorb the "important" stuff—so we don't see it included in undergraduate texts. There is a tacit goal lately of making textbooks "thin."

When I was studying, I figured everything in those old thick texts was fair

game; and any of the references at any of Portland's University libraries. Since I was the one seeking the education, I got a bit perturbed when a professor decided up front that we undergraduates weren't "cut out" to pick and choose extra material. Luckily, those kind were few twenty years ago—at least in Portland, OR.

Maybe the higher expectations back then were due to the greater number of those teachers having "worked their way" to the advanced degrees, i.e. gotten them in mid-career. I had very few professors who'd never worked outside Mathematics. That was good. They knew that the inspiration for their life in Mathematics came as undergraduates. We students could not presume that any middle-aged professor was "Doctor"—now we assume that of any 30 year old professor!

I don't expect breakthrough research to come from the Bachelors of Mathematics. But is it too much to expect that they be prepared to provide the underpinning of a wide variety of Engineering or Economics work? Research should not be the only route available for Mathematicians, or we'll continue to see higher dropout rates into fields which encourage undergraduates to stretch their minds.

Ronald C. Alexander
Sylmar, California
(Received March 18, 1991)

Mathematics in Other Sciences

The mathematics profession in this country faces a crisis. In recent years, we have at least to a certain extent responded to the cry for 'relevance' and renewed our traditional contact with the progress of science and engineering. However, the American scientific-political system apparently is not able to comprehend the nature of mathematics, whether 'pure' or 'applied'. We are the ultimate Little Science, utterly dependent for progress on small groups of well-trained mathematicians and their students thinking about an area for many years before 'progress' can be made. The Public responds to the Buzz Words—'chaos', 'fractals', and 'wavelets' are recent examples—but does not appreciate that there are many generations of serious mathematics in back of whatever scientific content is present in these bursts of hype and publicity.

Part of the problem seems to be a clash between the temperments of mathematicians and those in the engineering and scientific community who utilize mathematical research in their disciplines: The latter are usually looking for help with their immediate problems in the short-term, while we are best at the broader, long-term perspective. In an Ideal World, this would be a positive argument for a division-of-labor: Those who are trained directly in science and engineering can most successfully work on the immediate mathematical problems as they arise in their disciplines, while we professional mathematicians work on a longer timescale.

In the Real World of today, this common sense seems to fail, apparently because we have not made the case to the government science agencies for the need of our individualistic, future-oriented point of view in addition to the dominant Big Science modes of National Centers, Programs and Supercomputers. Perhaps the recently formed AMS Committee on Strategic Planning can make such an argument!

R. Hermann
Boston University
(Received May 10, 1991)

Collaborative Research

In a letter to [*Notices*] which appeared in Volume 36, Number 8 (1989), page 980, I requested that mathematicians let me know about successful and unsuccessful attempts they have made at collaborative research. Unfortunately, very few responses were received. It turns out that an interesting article on the same subject has recently appeared. The citation is "Comment on Violated Expectations: Collaboration among Mathematicians" by Victoria H. Bedford, *Creativity Research Journal*, 3 (1990) 334-335.

Robert A. Melter
Long Island University
(Received May 13, 1991)

Integer Sequences

For a second edition of "A Handbook of Integer Sequences," new sequences, extensions and corrections are requested. Please supply exact references if possible. N.J.A. Sloane, Room 2C-376, AT&T Bell Laboratories, Murray Hill, NJ 07974 U.S.A.; email: njas@research.att.com.

N.J.A. Sloane
AT&T Bell Laboratories
(Received May 10, 1991)

AMERICAN MATHEMATICAL SOCIETY

ASSOCIATE TREASURER

The American Mathematical Society is seeking applications and nominations for candidates for the position of **Associate Treasurer** of the Society.

The Associate Treasurer is an officer of the Society. The Associate Treasurer is appointed by the Council of the Society for a term of two years beginning on 31 January of each odd numbered year.

The primary responsibilities of the Associate Treasurer are to know and understand the budget of the Society, to monitor the financial condition of the Society, and to advise the Board of Trustees concerning the financial consequences of its decisions. The Associate Treasurer works in close cooperation with the Treasurer, and serves as Treasurer when necessary.

The Associate Treasurer is a member of the Board of Trustees, the Council, the Agenda and Budget Committee, and the Investment Committee and serves on several other committees of the Society. As a member of the Council, the Associate Treasurer serves a liaison function between the Board of Trustees and the Council and offers advice to the Council on the financial aspects of its deliberations.

There are two other areas of major responsibility: (1) The Associate Treasurer is delegated by the Board of Trustees to monitor staff appointments and promotions and to review staff raises. (2) The Associate Treasurer serves as liaison Trustee for *Mathematical Reviews* and, in this capacity, monitors the budget of *Mathematical Reviews*.

While the term of office is two years, it is anticipated that the person filling this office will be reappointed biennially for a number of terms, to insure continuity.

Applications and nominations can be sent to the chair of the search committee, Ronald L. Graham, or the Secretary of the Society, Robert M. Fossum.

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Applications or nominations received by **30 September 1991** will be assured full consideration. The newly appointed Associate Treasurer will take office formally on 31 January 1993, but should be appointed by the Council as early in 1992 as possible to permit a smooth transition.

All necessary expenses incurred by the Associate Treasurer in the performance of duties for the Society are reimbursed, including travel and communications.

Open Position

American Mathematical Society

Mathematical Reviews
EXECUTIVE EDITOR

Applications and nominations are invited for the position of Executive Editor of *Mathematical Reviews* (*MR*).

The Executive Editor is the chief executive officer at *MR* and is responsible for all phases of its operations. These duties include:

- **direction of the editorial and consulting staff and the administration of the non-editorial staff**
- **relations with reviewers and authors**
- **maintaining scientific and editorial standards**
- **budget planning and control**

The Executive Editor is assisted in administration by an Associate Executive Editor; the Executive Editor reports to the Executive Director of the American Mathematical Society. The *MR* Editorial Committee provides Society overview and support in maintaining the scientific and editorial standards of *MR*.

The *MR* editorial office is located in Ann Arbor, Michigan, near the campus of the University of Michigan, and the editors enjoy many faculty privileges at the University. *MR* employs twelve associate editors, several consultants, and over sixty-five other full-time personnel. It publishes *Mathematical Reviews, Current Mathematical Publications,* and various *Indexes.* The major activity is the creation and maintenance of the *MR* database from which these publications and the online and CD-ROM service, MathSci, are produced.

The appointment will be for a negotiable period of from two to five years and should commence by August 21, 1992. The appointment has the possibility of renewal. Applications are welcomed from individuals taking leaves of absence from other positions; however, the Executive Editor position is full-time. Salary is negotiable and will be commensurate with experience. Generous benefits are available including study leave.

Nominations and applications (including curriculum vitae, bibliography, data on experience and names and addresses of at least three references) should be sent on or before **October 1, 1991** to:

Dr. William Jaco, Executive Director
American Mathematical Society
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Moving Beyond Myths

Revitalizing Undergraduate Mathematics

The MS2000 Committee of the National Research Council has issued its final report, *Moving Beyond Myths*, which describes many serious problems in undergraduate mathematics education and which provides an action plan for attacking them. Because of its importance, the bulk of this report is reprinted in *Notices*.

Along with its predecessors, *Everybody Counts* and *A Challenge of Numbers*, *Moving Beyond Myths* is essential reading for all who are concerned with the directions the mathematical sciences community will take in coming years.

With its bold language and ideas, *Moving Beyond Myths* will spark healthy debate as the mathematical sciences community considers ways to face the issues the report raises. Included are specific recommendations to state and federal governments, professional societies, universities and colleges, and departments and faculty.

Michael Artin
AMS President

The Committee on the Mathematical Sciences in the Year 2000 (MS2000) was appointed by the National Research Council (NRC) at the beginning of 1988 as a three-year project of two NRC boards, the Board on Mathematical Sciences and the Mathematical Sciences Education Board. The purpose of MS2000 was to provide a national agenda for revitalizing undergraduate mathematics education.

 Copies of the report are available for $7.95 (plus $3.00 shipping and handling per order) from the National Academy Press, 2101 Constitution Avenue, NW, Washington, DC 20418; telephone 1-800-624-6242 (for orders only) or 202-334-3313 (for information). Quantity discounts are available. The Action Plan from the report is available from the Mathematical Sciences Education Board, 818 Connecticut Avenue, NW, Suite 500, Washington, DC 20006.

[The text that was presented as sidebar material in the original report is reproduced below, in smaller type at the end of each section, and is set off with thin rules.]

Preface

The national action plan presented in *Moving Beyond Myths: Revitalizing Undergraduate Mathematics* calls for dramatic change. Its implementation will tax the creativity, commitment, adaptability, and energies of mathematical sciences faculty and departments, college-university administrations and trustees, professional societies, and federal and state governments. Success will depend upon the cooperation of all these groups in a sustained effort lasting to the year 2000 and beyond. The plan challenges our institutions of higher education to bring their mathematics education efforts up to the standard set by the nation's mathematical research enterprise, which is preeminent in the world.

The President and the governors of the 50 states have set just such a standard of performance by U.S. schools, colleges, and universities as a national goal for mathematics and science education. Our report states what we think it will take for undergraduate mathematics to reach this ambitious goal.

The challenge is reminiscent of the one faced by the nation's universities at the middle of this century: To develop the infrastructure necessary to support scientific research of the highest quality. The response to that pressing national need was a post-World War II cooperative effort of the universities and government that produced the greatest scientific research enterprise in history, built upon a new kind of institution: the modern American research university.

As we enter the last decade of the century, the country's universities, colleges, and community colleges together face an even greater challenge: To sustain the research infrastructure and also develop the climate, the support structures, the people, and the modified institutions necessary for meeting today's major national need, education of the highest quality for all students.

A few comments are in order concerning how we have gone about our work. The Committee on the Mathematical Sciences in the Year 2000 was asked to: (i) review the status of undergraduate mathematical sciences education in the United States; (ii) develop a plan for the revitalization of mathematics education at our nation's colleges and universities; and (iii) delineate responsibilities for the implementation of the plan. Appropriately, committee membership reflects a wide variety of perspectives and experience. Over the last three years we benefited from the extensive data gathering done by Bernard Madison in preparing our earlier publication, *A Challenge of Numbers*, and from the advice and opinions of thousands of mathematicians, scientists, and engineers. We are grateful to them for sharing their ideas through a variety of means: (i) two large national symposia

we organized: *Calculus for a New Century* in late 1987 and *Mathematical Sciences: Servant to Other Disciplines* in 1989; (ii) two national meetings of department chairs, one organized by the Joint Policy Board for Mathematics and the other by the NRC's Board on Mathematical Sciences; (iii) discussions with the science policy committees of the American Mathematical Society (AMS) and the Mathematical Association of America (MAA) as well as the MAA Committee on the Undergraduate Program in Mathematics; (iv) dozens of presentation/discussion sessions at professional society meetings across the country including national meetings of AMS-MAA and the American Mathematical Association of Two-Year Colleges (AMATYC); (v) two MS2000 workshops on human resources and curriculum; (vi) testimony presented at MS2000 Committee meetings; and (vii) hundreds of individual discussions conducted by committee members and staff interviews with selected department chairs and administrators.

Two circumstances have combined to enable *Moving Beyond Myths* to be a shorter report than might be expected from a three-year project. First, our Committee presented an overview of undergraduate mathematics education as part of *Everybody Counts — A Report to the Nation on the Future of Mathematics Education* (NRC 1989). Second, most of the supporting data for our work were presented in our 1990 report, *A Challenge of Numbers*. It might properly be viewed as an appendix to this final report, just as *Everybody Counts* might be considered its introduction.

We hope that the many groups to whom we have addressed our recommendations will move quickly to keep up the momentum of mathematics education change that has been building up over the last few years, and that a strong role will be played in the effort by our Committee's two NRC parent bodies: the Board on Mathematical Sciences and the Mathematical Sciences Education Board.

William E. Kirwan
Chairman, MS2000 Committee
President
University of Maryland at College Park

Committee on the Mathematical Sciences in the year 2000

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Bernard L. Madison, Project Director through December 1989

James A. Voytuk, Project Director

Theresa A. Hart, Research Associate through November 1989

Craig E. Hicks, Project Assistant

The Challenge

Prosperity in today's global economy depends on scientific and technological strength, which in turn is built on the foundation of mathematics education. It is no wonder, therefore, that mathematics is in the spotlight. As the foundation of science and engineering, mathematics offers a key to our nation's future.

At the college and university level—the focus of this report—mathematics forms the core of the quantitative skills needed by our nation's scientific, technical, and managerial work force, including the nation's future mathematics teachers. Yet even this system—the linchpin of mathematics education in the nation—is beset by weaknesses that threaten the health of U.S. science and technology:

- Interest in majoring in mathematics is at an all-time low among entering freshmen.
- Too few students study advanced mathematics.
- Major segments of our population are significantly underrepresented in mathematically-based fields.

- Fewer than 10 percent of students who complete calculus are Blacks, Hispanics, or disabled.
- Retirements from college and university mathematical sciences faculties will soon exceed current U.S. doctoral degree production.
- Women receive only one in five doctorates in mathematics.

In a technologically driven economy, mathematically literate employees more readily achieve positions of influence, whereas those who remain innumerate are often denied the economic and social benefits of productive jobs and stable employment. Far from achieving its ideal as an agent for social equalization, undergraduate mathematics education as currently practiced bestows uneven benefits on different groups within our society—white males learn much more, women and many minorities much less. The result has been a growing polarization of society along the dimension of mathematical power that will, if left unchecked, exacerbate social and economic tensions by widening disparities in opportunities and earning capacities.

Most faculty who teach mathematics in colleges and universities are dedicated teachers. Many have written textbooks and helped lead curriculum development. Nevertheless, deficiencies in mathematics education are pervasive throughout the U.S. system of education. The size of undergraduate mathematics by itself creates tremendous inertia which impedes reform.

Some of the most entrenched problems are being successfully attacked through local action—one project and one campus at a time:

- Pilot projects to reform the way calculus and other introductory courses are taught and learned.
- Professional development initiatives that launch underprepared students on successful college careers in science and mathematics.
- Talented youth programs that excite students for careers in mathematics and science.
- Programs for mathematics majors that address student needs and build personal self-confidence.
- Calculator methods and computer labs that transform traditional courses to meet the needs of a technological age.
- Networks, collaboratives, and workshops that enhance the professional competence of school teachers.

Initiatives such as these provide both grounds for optimism and models for more widespread improvement. Their successes help dispel common myths that impede reform. They demonstrate that we know how to do better. For those who have worked hard on educational issues, it is time for redoubled effort; for those who have not, it is time to begin.

Just as U.S. mathematics has achieved worldwide preeminence, so now we are called on to achieve the same stature in mathematics education. The nation's reward will be sustained health in science, industry, and the economy.

The Myths

Mathematics education cannot be effective without strong support from society. Unfortunately, misconceptions about mathematics are deeply rooted in school and society, in home and family. From students' early years colleges inherit an enormous deficit of scholarly maturity. Interest payments on this deficit balloon college enrollments in remedial and school-level mathematics courses. Indeed, about two-thirds of all college mathematics enrollments are in school-level courses (below the level of calculus). In America today, the profile of mathematics in higher education is not much different from that of mathematics in high school.

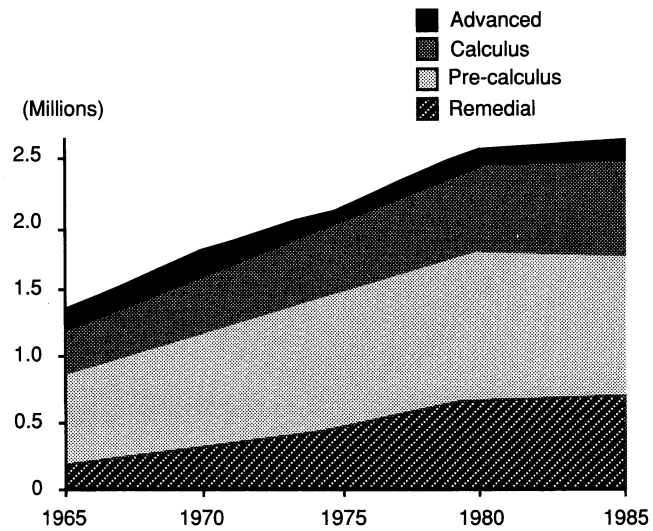

*Figure 1. Total undergraduate enrollment in mathematical sciences departments at U.S. colleges and universities.

The source of many of these difficulties can be found in public (and parental) attitudes about mathematics that are rooted more in myth than in reality:

Myth: *Success in mathematics depends more on innate ability than on hard work.*

Reality: Sustained effort can carry most students to a satisfactory level of achievement in mathematics. Compare music and mathematics: although in both areas genetic factors clearly play a role at the very highest levels of creative achievement, parents and teachers generally believe that children can learn to play music at a reasonable level if only they exert sufficient effort. As a consequence, many students achieve success and personal satisfaction from their study of music. Whenever parents or teachers believe that genetic ability is the primary factor contributing to success in mathematics, students are likely to fail before they begin; when expectations of success are high, so is the resulting performance.

*All figures originally appeared in *A Challenge of Numbers.*

Myth: *Women and members of certain ethnic groups are less capable in mathematics.*

Reality: The popular notion that women, Blacks, and Hispanics "can't do math" is just an expression of ignorance or prejudice. Ample evidence shows such beliefs to be false. Experiences of countries such as Holland and Japan belie this myth, as do results from numerous innovative programs in the United States. Such examples demonstrate unequivocally that most college students can succeed in mathematics when learning takes place in an appropriate structure and context.

Myth: *Most jobs require little mathematics.*

Reality: The truth is just the opposite: more and more jobs—especially those involving the use of computers—require the capability to employ sophisticated quantitative skills. Although a working knowledge of arithmetic may have sufficed for jobs of the past, it is clearly not enough for today, for the next decade, or for the next century.

Myth: *All useful mathematics was discovered long ago.*

Reality: Mathematical discoveries are essential for industrial competitiveness. Without advances in mathematics we would have neither telephones nor computers, neither jet airplanes nor international banking. Technology depends on both old and new mathematics for innovation and power. Indeed, more new mathematics is being created and used each year than ever before in history.

Myth: *To do mathematics is to calculate answers.*

Reality: Rarely do workers or researchers confront mathematical problems requiring primarily calculation. Authentic problems are often ambiguous, admitting many forms and several answers. Mathematical power is revealed as much by the act of identifying and properly posing problems as by application of specific techniques and algorithms.

Myth: *Only scientists and engineers need to study mathematics.*

Reality: Mathematics is a science of patterns that is useful in many areas. Indeed, the most rapid areas of growth in applications of mathematics have been in the social, biological, and behavioral sciences. Financial analysts, legal scholars, political pollsters, and sales managers all rely on sophisticated mathematical models to analyze data and make projections. Even artists and musicians use mathematically based computer programs to aid in their work. No longer just a tool for the physical sciences, mathematics is a language for all disciplines.

If these myths were benign, with effects limited to the ignorance of those who believe them, they might be safely ignored. But ignorance in parents and teachers begets ignorance in students. Harmful myths about mathematics metastasize to the body politic, spreading ignorance and excusing underachievement throughout society. Efforts to eradicate these pernicious myths will require sustained support at all educational levels, but especially in colleges and universities where society's leaders are educated.

Building Confidence

At Spelman College in Atlanta, 8 percent of the graduates major in mathematics—a rate far greater than the national average of 1.6 percent.

The success of the mathematics and natural science program at Spelman is due to the special attention given to students that builds their confidence in their own ability to master mathematics. All natural science students participate in an eight-week summer program prior to the beginning of their first year, during which study skills are developed and role models are established. This careful mentoring is continued throughout the undergraduate program and develops into opportunities for research experiences and special honors sections. The faculty devotes a great deal of energy to advising, since student motivation is the most powerful factor in learning.

Not only does Spelman produce a large number of minority mathematicians and scientists, but its NASA Program for Women in Science and Engineering graduates a higher-than-average percentage of women mathematics majors who go on to pursue graduate studies in mathematics.

Mathematics in Action

One way to link undergraduate mathematics to industrial research and development is through student projects in mathematical modelling. Many such programs are patterned after the Mathematics Clinic, which began at Harvey Mudd College nearly twenty years ago. In these programs, which now operate in dozens of institutions, a team consisting of one or more faculty and several students works on an unsolved mathematically oriented problem that comes from a company or government agency.

The problems are usually open-ended and must first be cut down to a manageable size. Faculty leaders assist with the mathematical model and give "short courses" on the mathematics that seems to be needed. Different students work on different parts of the problem, parts that suit their interests and expertise, but teamwork is the mode of operation. Students must make formal oral presentations in terms understandable to the client; as a result, they develop strong expository skills. Written reports are submitted to the client at the end of the project, and so the writing involved in these reports is also a part of the students' education.

Texas Prefreshman Engineering Program

The Texas Prefreshman Engineering Program (TexPREP) was started in 1986 as a statewide expansion of the successful San Antonio PREP program begun in 1979 by Manuel P. Berriozabal, Professor of Mathematics at the University of Texas at San Antonio. The purposes of TexPREP are to recruit potential future scientists and engineers by identifying high-achieving middle school and high school students and by providing these students with academic reenforcement to pursue science and engineering fields. The program operates in 14 Texas cities on 19 college campuses.

Of the 4500 students who have participated in TexPREP, more than three-quarters have been minority students and half have been women. Of the college-age participants, nearly 90 percent either are attending college, plan to attend, or have graduated from college. Sixty percent of TexPREP graduates major in science or engineering fields. TexPREP features a strong academic component, with courses in logic, algebra,

probability and statistics, problem solving, engineering, computer science, physics, and technical writing. Other activities include field trips, guest speakers, and practice SAT examinations.

Behind the Myths

Undergraduate mathematics plays a pivotal role in our system of mathematics education. It is in college where our nation's engineers and technicians are educated, where future scientists are recruited, and where many of society's leaders acquire basic quantitative skills. In addition, the instructional traditions of undergraduate mathematics form the model for all future teachers of mathematics.

Undergraduate mathematics is also a source of much of the mythology about mathematics that pervades society. Adults' attitudes about mathematics are largely shaped by their own experiences as students in school or college and by images created by media leaders. School teachers, politicians, writers, editors—all those whose careers influence the public's image of mathematics—view mathematics through a lens that was polished by their own education. Important clues to the widespread public misunderstanding of mathematics can be found in the traditions and habits of mathematics departments in colleges and universities across the nation.

Departments Under Stress

In the last twenty years the demand for undergraduate mathematics courses has risen more than twice as fast as have faculty resources in departments of mathematical sciences. Increased demand is due both to demographic and social trends and to an increase in the use of mathematics in other disciplines. Consequently, today's students are much more diverse in mathematical preparation and needs. But since 1970, enrollments have increased by more than 70 percent while faculty size has increased by less than 30 percent. As a result, a faculty increase of more than 30 percent would be required today to recapture the student-faculty ratio of twenty years ago.

Rather than articulating forcefully the need to keep student-faculty ratios within reasonable bounds, the mathematics community sought to handle the increased workload in inexpensive ways, such as larger classes and increased use of graduate teaching assistants and part-time faculty. As a consequence, the image of mathematics as a low-cost, high-enrollment discipline became institutionalized on many campuses. It remains so today.

The last thirty years have also been a period of extraordinary achievements in mathematical research, during which time federal agencies and research universities elevated their research mission over their educational mission. Intensified competition for research funding created a climate in mathematics departments in which research accomplishments received increasing prestige, while contributions to improving education received lower priority. As a consequence, innovations in undergraduate teaching lag far behind advances in research. Both in instructional methodology and in curricular content, undergraduate mathematics is far below what it should be to best serve today's students. What is required is a balanced commitment to scholarship and instruction.

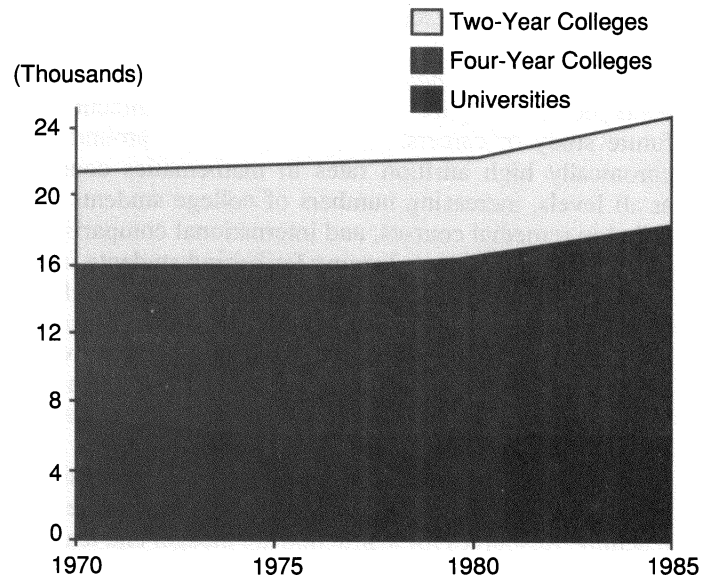

Figure 2. Number of full-time mathematical sciences faculty at colleges and universities.

For a variety of reasons, not least being the ambivalent atmosphere in many college and university mathematics departments, interest in teaching college mathematics has declined significantly at both undergraduate and graduate levels. This trend is compounded by projections of impending retirements that foretell a severe future shortage in the number of college mathematics teachers. This situation has serious implications for the quality of mathematics education at all levels and for the related human resource needs of our nation.

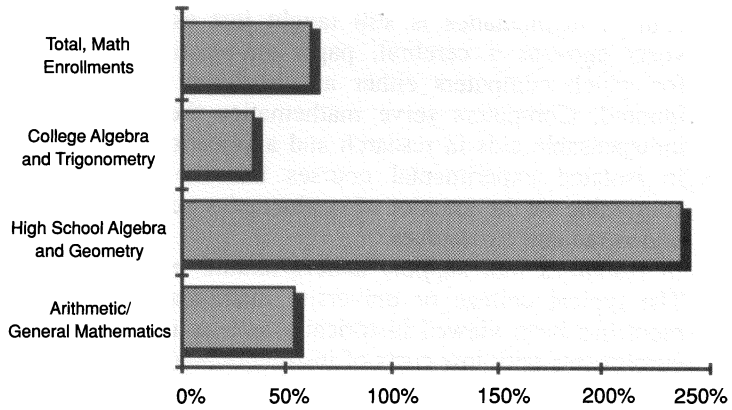

Figure 3. Percent increase in enrollments in selected mathematics courses in colleges and universities, 1965 to 1985.

Inadequacies and Deficiencies

For far too long, myth has substituted for reality in the U.S. approach to mathematics education. Mathematics de-

partments find themselves trapped in institutional structures that assume that the instructional practices that have evolved over the past thirty years in mathematics are appropriate and acceptable. The result is a dysfunctional system of undergraduate mathematics beset on all sides by inadequacies and deficiencies:

- *In mathematical preparation of students:* Most U.S. students do not acquire quantitative skills sufficient for future study or careers. The evidence is all around us: chronically high attrition rates in mathematics courses at all levels, increasing numbers of college students enrolled in remedial courses, and international comparisons that show U.S. students lagging far behind students from other countries. Although many students enter college having completed a year or more of calculus, a sizable proportion of undergraduates have difficulty even with elementary arithmetic. Many college students find themselves unready to begin standard college mathematics courses.
- *In support and reward for teaching:* Few universities offer much incentive for developing new approaches to teaching. Resources for instruction are meager and tend to reinforce reliance on large classes and packaged learning. The reward structure at most universities undervalues innovation in teaching or evidence of improved learning.
- *In teaching methods, course content, and instructional materials:* The way mathematics is taught at most colleges—by lectures—has changed little over the past 300 years, despite mounting evidence that the lecture-recitation method works well only for a relatively small proportion of students. Moreover, the syllabi of many undergraduate mathematics courses and the template-style textbooks are detached from the life experiences of students and are seen by many students as irrelevant.
- *In the use of computers in undergraduate mathematics:* Nothing in recent times has had as great an impact on mathematics as computers, yet in most college courses mathematics is still taught just as it was 30 years ago—as a cerebral, paper-and-pencil discipline for which computers either are irrelevant or can be ignored. Computers serve mathematics these days as indispensable aids in research and application. Yet only in isolated experimental courses has the impact of computing on the practice of mathematics penetrated the undergraduate curriculum.
- *In resources that support undergraduate mathematics:* The typical college or university mathematics department has been viewed historically as a source of large enrollments with low costs of instruction—a "cash cow" for institutional budgets. In contrast, departments of science and engineering have large budgets to support their established needs for instructional and research laboratories. Even though the role of technology—hence of computer labs—in mathematics has grown in recent years, most mathematics departments still operate with budget allocations that, when compared with those for other departments, are among the smallest per credit hour of instruction. The resources available to most departments of mathematics are insufficient to meet their responsibilities.

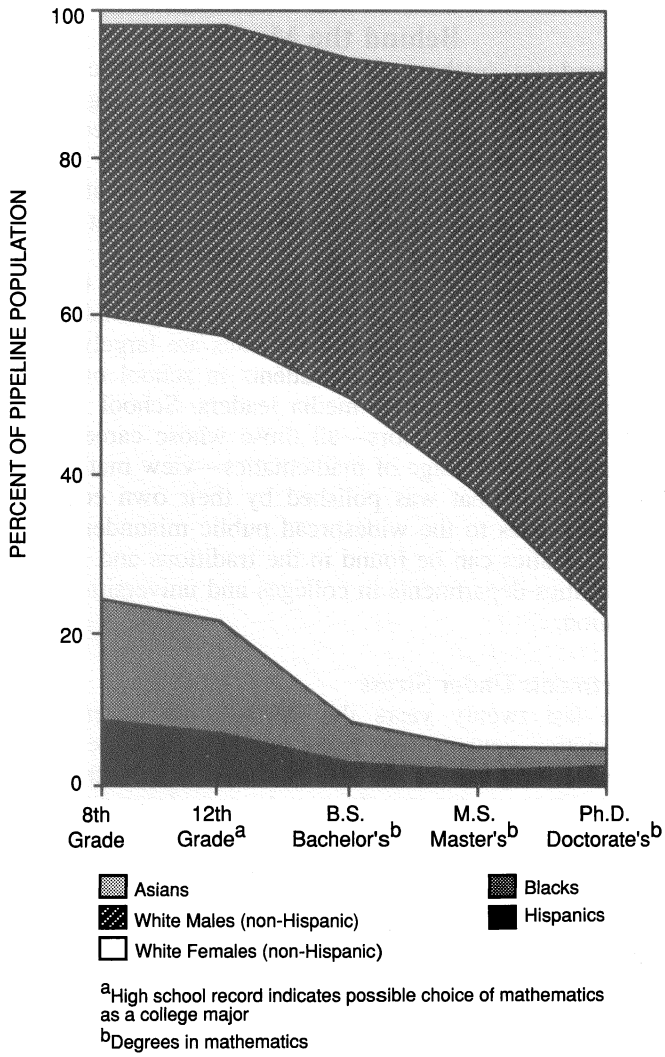

Figure 4. A representation of U.S. students in the mathematics pipeline.

- *In the number of minorities and women who study mathematics:* College mathematics attracts far too few Black and Hispanic students, and their attrition rates between high school and the sophomore year of college are much too high. Although the number of women enrolled in undergraduate mathematics courses is only slightly smaller than the number of men, the relative number of women drops dramatically in graduate enrollments. Only a small fraction of our population—consisting primarily of white males—complete a mathematics education that matches their potential and interests. The result is an appalling waste of human potential, denying to individuals opportunity for productive careers and to the nation the resources for economic strength.
- *In the number of students who study mathematics:* The number of students electing to take mathematics courses declines precipitously from ninth grade to graduate

school. Each year from high school through graduate school, on average, one of every two students stops taking mathematics courses.

- *In the number of new engineers and scientists:* As students discontinue prematurely their study of mathematics, the quantitative skills of our work force fall behind the requirements of an international economy. Moreover, the number of individuals in their mid-twenties will decline until the end of this century, making it increasingly difficult to sustain present production of new engineers and scientists.

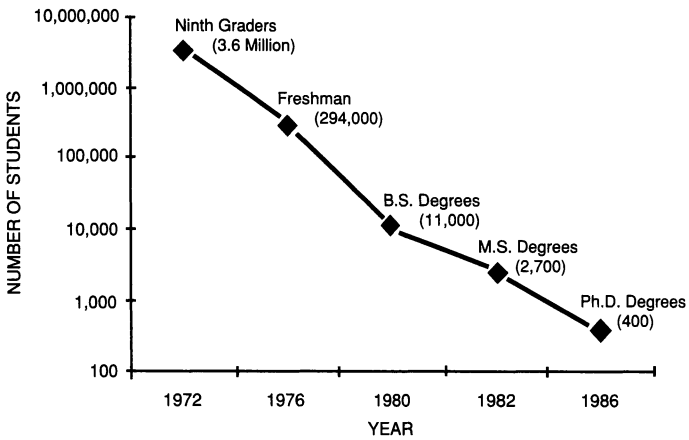

Figure 5. Students in the mathematical sciences pipeline—about half are lost each year.

- *In the number of qualified school mathematics teachers:* Although many teachers hold certificates, few school teachers meet the standards for curriculum and professional preparation set forth by the National Council of Teachers of Mathematics. In addition, half the nation's mathematics teachers will leave teaching by the year 2000.

- *In the number of U.S. mathematics graduate students:* The number of U.S. students who pursue graduate studies in mathematics is now much smaller than it was twenty years ago. Today only one in every ten thousand students enrolled in ninth grade mathematics will pursue and eventually earn a doctorate in the mathematical sciences, far too few to replace retiring faculty in coming decades. Although shortfalls in U.S. mathematics students can be mitigated to some extent by immigration, current trends portend a serious future shortage of mathematical sciences faculty.

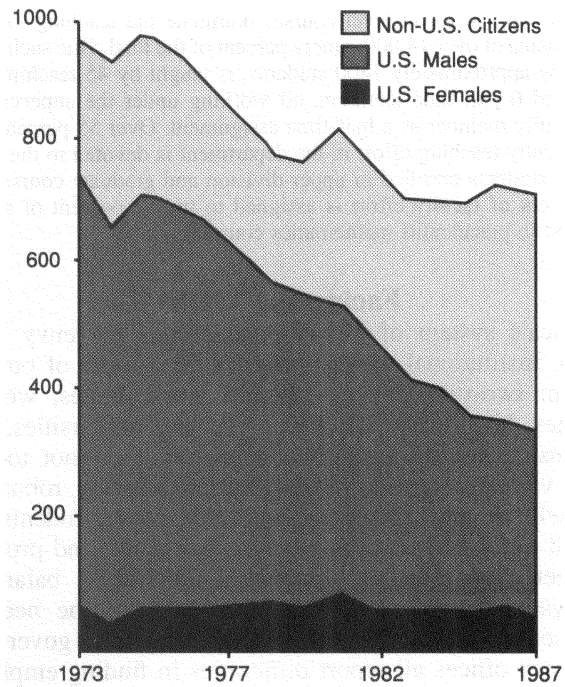

Figure 6. Ph.D. degrees in mathematics.

Quantitative Reasoning

The demands of today's technological society require a work force that can understand complex processes, develop and test hypotheses, and draw logical conclusions. Innovative courses, set in the context of students' interests, have proven far more effective as a means of teaching this type of quantitative reasoning than have traditional requirements such as college algebra or elementary statistics.

One successful course of this type was developed at Mount Holyoke College as part of the New Liberal Arts initiative supported by the Sloan Foundation. A collection of case studies allows students to develop an appreciation of graphical techniques, approximation methods, and statistical concepts. Using a combination of lectures, laboratory sessions, and small discussion groups, the students work on three case studies:

- Narrative and Numbers: Salem Village Witchcraft;
- Measuring and Modelling Difference: Aptitude and Achievement;
- Rates of Change: Population and Resources, Predation, and Disease.

Computers are used as the primary tool in the analysis of these case studies, and for writing papers, manipulating data, and creating graphical images. Although not required, the course is now elected by more than one-third of the students at Mount Holyoke.

Mathematics for the Masses

At a large midwestern state university with over 50,000 students, the average enrollment in mathematics courses during the fall term is approximately 16,000. The mathematics department has about 125 full-time (FTE) faculty members, 225 graduate teaching assistants (more than half of whom are foreign nationals, and a quarter of whom come from other departments), and 25 undergraduate instructional aides. The circumstances of mathematics instruction in this institution are typical of many major research universities.

Service and lower-level courses dominate the teaching load with enrollments of over 14,000, ninety percent of the total. One such course, taken by approximately 1400 students, is taught by 45 teaching assistants and 6 part-time lecturers, all working under the supervision of one faculty member as a half-time assignment. Over 55 percent of the total faculty teaching effort in the department is devoted to the 11 percent of students enrolled in upper-division and graduate courses; only 22 percent of faculty effort is assigned to the 67 percent of students enrolled in precalculus mathematics courses.

Facing the Myths

America's system of higher education is the envy of the world. Institutional variety matches the variety of our population: two-year colleges, liberal arts colleges, women's colleges, historically Black colleges and universities, comprehensive universities, research universities—not to mention a variety of specialized institutions. Diverse, robust, and infinitely varied, U.S. higher education offers students from around the world courses to suit every whim and programs to meet every need. Nevertheless, the overall balance of the system seems no longer to serve well the needs of U.S. society. Industry, education, military, and government personnel offices all report difficulties in finding employees with the skills required for productive work. The American public is now demanding accountability—both from schools and from higher education.

America's record in mathematical research is, likewise, the envy of the mathematical world. This preeminence is documented not only in objective measures (e.g., research productivity, international awards) but also in the steady stream of international students and researchers who visit our premier universities. The challenge we now face is to elevate U.S. mathematics education to the same high level of achievement and reputation as U.S. mathematical research.

To attack this problem successfully, mathematicians and university administrators need first to examine carefully the circumstances that give rise to inadequacies and deficiencies. Surely the twin burdens of increased enrollments and erosion of support have left many departments without the resources needed to fulfill their educational and intellectual responsibilities. But there is more to the problem than inadequate resources. A plan to revitalize mathematics education must be built on a careful analysis of current deficiencies.

Wasted Breath

Since virtually all mathematics teachers received the majority of their mathematics instruction in traditional lecture courses, it is not surprising that lecturing has continued to be the most common way that mathematics is taught, both in high school and in college. To believe that one can teach mathematics successfully by lectures, one must believe what most mathematicians know to be untrue—that mathematics can be learned by watching someone else do it correctly. Research shows clearly that this method of teaching does little to help beginning students learn mathematics, a fact underscored by the staggering rates of withdrawal or failure among students who take introductory college mathematics courses.

It is widely recognized that lectures place students in a passive role, failing to engage them in their own learning. Even students who survive such courses often absorb a very misleading impression of mathematics—as a collection of skills with no connection to critical reasoning. Yet despite its recognized ineffectiveness for most mathematics students, lecturing continues as the dominant form of instruction in mathematics classrooms because it is inexpensive: neither faculty members nor administrators have to invest heavily in mathematics courses taught in the traditional lecture style.

Perhaps even more mysterious is the virtual absence of computers from undergraduate mathematics. Computers have changed significantly the practice of mathematics at all levels, from routine application to advanced research. Computers also enhance student motivation, provide natural catalysts for teamwork, and focus faculty attention on the process of learning. Unless undergraduate mathematics courses are revised to reflect the impact of computers on the practice of mathematics, students will continue to perceive mathematics as a discipline disconnected from reality.

Missing Context

The unease with which many students regard mathematics begins early in their education and is all too regularly reinforced through their school years. The situation seldom improves, not even in college. Students often find themselves in classes in which little effort is made to place the subject matter in a context that is meaningful to the student. Mathematics becomes not a powerful tool but an overwhelming barrier that students must surmount to enter their chosen disciplines. For such students, undoubtedly the majority, mathematics continues to be a mystery unrelated to other subjects or problems in the real world.

Absent a conscious effort to set mathematics in the context of learners' experiences, mastery of skills (including vocabulary, notation, and procedures) serves no legitimate educational purpose. Students who endure such instruction come to regard mathematics as a ritual irrelevant to their own lives. Upon becoming parents, such students impart the same attitude about mathematics to their children.

It is virtually impossible to cover well in a single course both the many ways in which mathematics is applied and the range of topics needed to support authentic applications. As a result, many introductory college courses offer students—frequently with disastrous results—a distilled mathematical essence that is, from a student's perspective, devoid of meaning. Particularly at beginning levels, where students from various disciplines take the same courses, this common approach isolates mathematics from the very subjects for which mathematics students are preparing themselves.

Upper-division courses often exhibit a similar profile, albeit for different reasons. Many advanced mathematics courses are taught primarily in a style that will prepare students for graduate study in mathematics. Consequently, they address insufficiently the needs of the majority of students who intend either to enter the job market with a bachelor's degree or to pursue graduate work in another discipline.

From beginning to end, undergraduate mathematics has been relatively unresponsive to the changing role of mathematics in society and to the changing needs of students in our colleges.

Casual Teaching

In many university mathematics departments, mathematical stature is defined by research. Faculty play an effective role in mentoring graduate students from their role as student to the position of junior colleague. But undergraduate teaching, especially elementary teaching, can under these circumstances be too easily viewed as an ancillary responsibility. Because professional attitudes are shaped primarily while students are in graduate school, the culture of the leading research departments has a subtle but nonetheless very real influence even in the majority of institutions where teaching is unquestionably the primary institutional objective. Although some institutions have taken steps to increase the priority of undergraduate teaching, the overall effect of graduate education is to perpetuate a system of rewards that undervalues teaching.

Faculty attitudes towards teaching are both reflected and perpetuated by the role assigned to graduate teaching assistants. At most universities that have graduate programs, teaching assistants staff the majority of lower-division courses, often assuming virtually complete responsibility for instruction and evaluation. Indeed, the practice of using teaching assistants is a structural feature of graduate support so ingrained that without it most departments could not survive on their present budgets. Heavy reliance on the use of graduate teaching assistants, many of whom have limited experience or training for the responsibilities placed on them, has far-reaching consequences.

Approximately half of the graduate mathematics students in the United States are nonresident foreigners. These students both need and merit support for their graduate studies: they contribute much to the strength and sophistication of graduate programs, and many will contribute significantly to mathematics and to society after they finish their degrees.

Few graduate students, however, are ready to serve well the educational needs of first-year college students; teaching in a foreign culture is particularly difficult for those who were not themselves educated in U.S. schools. Experience in teaching, mathematical expectations, communication skills, cross-cultural sensitivity, and familiarity with technology are vitally important issues that frequently take considerable time to develop—especially among those who are new to this country. The special need for sensitivity toward all students that is required to attract more women and underrepresented minorities into mathematics underscores the important role that graduate teaching assistants play in nurturing students in the mathematical sciences.

Few universities recognize explicitly in the design of their graduate mathematics programs that the future careers of most of their doctoral students will be devoted primarily to undergraduate teaching. Few if any mathematics graduate programs attempt to familiarize graduate students with important curricular and policy issues of undergraduate education. Few graduate assistants undergo systematic training to prepare them for their lifelong role as teachers.

Our system of graduate education produces a cadre of college and university teachers who have little concept of teaching as a profession. Not only are mathematics graduate students denied significant opportunities to develop this aspect of professional competence, but their graduate training frequently conveys the subtle message that undergraduate teaching is a second-class activity rather than a critical aspect of the profession.

Flawed Models

From grade school to graduate school, mathematics education revolves around the hub of undergraduate mathematics. Unfortunately, few university mathematics departments maintain meaningful links with mathematics in school or with the mathematical preparation of school teachers. Although one in four mathematics majors eventually teaches in school, instructional methods that are widely used in undergraduate programs foster a model of teaching—blackboard lectures, template exercises, isolated study, narrow tests—that is inappropriate for elementary and secondary school teachers. Similarly, most graduate doctoral programs place scant emphasis on preparing students to be effective at what most of them will do for their entire career—undergraduate teaching. All too often, new teachers embark on their careers with serious deficits of preparation in broad areas such as curriculum development, problem solving, and connections between mathematics and other disciplines.

Despite widespread efforts to establish effective standards for curriculum and instruction in school mathematics, undergraduate mathematics programs frequently perpetuate modes of delivery that are ineffective for most students and choices of content that are inappropriate for most prospective teachers. Only when college faculty begin to recognize by deed as well as word that preparing school teachers is of vital national importance can we expect to see significant improvement in the continuity of learning between school and college.

Few college mathematicians pay as much attention to advances in the study of teaching and learning as to advances in mathematical research. It is rare to find mathematics courses taken by prospective teachers that pay equal attention to strong mathematical content, innovative curricular materials, and awareness of what research reveals about how children learn mathematics. Unless college and university mathematicians model through their own teaching effective strategies that engage students in their own learning, school teachers will continue to present mathematics as a dry subject to be learned by imitation and memorization.

A similar concern must be expressed regarding the experiences of the graduate students who will become the next generation of college teachers. Only infrequently—more by accident than by plan—does the education of our future college teachers provide models of appropriate instructional techniques as well as intellectually challenging opportunities

to address issues of how mathematics is taught and learned.

Outmoded Values

Because research institutions tend to establish values for the discipline, any reform of undergraduate mathematics education must address the question of how those values can be reshaped. Although attitudes are gradually changing on some campuses, it is still the case that at many institutions, teaching and research are viewed as competitive activities. In those universities whose basic charge is research and the granting of advanced degrees, academic survival depends on published research; in such institutions, undergraduate teaching offers few rewards. In contrast, at many colleges teaching loads are heavy and time for professional life is limited. The result is a schism in the profession that sunders the mathematical community into separate but decidedly unequal sectors.

Due to constraints on resources in many institutions, there is little mobility for faculty. Funding for research, which could support visits to other institutions, is very scarce. Financial support for activities that would contribute to the improvement of teaching is even more difficult to obtain. Thus many mathematics faculty members—especially those at smaller institutions—are professionally isolated, unable to keep abreast of modern developments in either teaching or research.

Invisible Instructors

The great majority of mathematics faculty in U.S. colleges view themselves primarily as teachers, not as researchers. Moreover, most of these teachers' time and energy is devoted to developing the mathematical power of students who never will use higher mathematics. What their students need is quantitative literacy sufficient for life—for trades and vocations, for public affairs and private lives. The mathematical education of the great majority of students in American higher education is confined to introductory courses taught most often in two-year colleges or in the margins of university departments of mathematics.

The infrastructure of U.S. business depends on the fruits of these instructors' efforts. Their students will become the technicians and practitioners that support American manufacturing and transportation, farming and commerce. More often than not, minority students get their first chance at higher education in a two-year college, or in a small regional college; many such students are first-generation college students. Their access to advanced degrees depends on the momentum provided by this initial experience with higher education.

Yet in the world of higher education, instructors who undertake these tasks are virtually invisible. With rare exceptions, no graduate programs in mathematics focus on the task of preparing individuals for careers of teaching introductory, vocational, and technical mathematics. Few natural career paths exist for those who teach in two-year colleges, nor is there any visible reward system for those who devote their lives to this most fundamental work. In reality, the "mathematical community" is not really a community at all, since many of those who do the most important instructional work feel like outsiders in their own world.

Calculus and Computers

An innovative calculus course at the University of Illinois uses the full symbolic, numeric, graphic, and text capabilities of a powerful computer algebra system. Significantly, there is no textbook for this course—only a sequence of electronic notebooks.

Each notebook begins with basic problems introducing new ideas, followed by tutorial problems on techniques and applications. Both problem sets have "electronically active" solutions to support student learning. The notebook closes with a section called "Give-it-a-try," where no solutions are given. Students use both the built-in word processor and the graphic and calculating software to build their own notebooks to solve these problems, which are submitted electronically for comments and grading.

Notebooks have the versatility to allow re-working of examples with different numbers and functions, to provide for the insertion of commentary to explain concepts, to incorporate graphs and plots as desired by students, and to launch routines that extend the complexity of the problem. The instructional focus is on the computer laboratory and the electronic notebook, with less than one hour per week spent in the classroom. Students spend more time than in a traditional course and arrive at a better understanding, since they have freedom to investigate, rethink, redo, and adapt. Moreover, creating course notebooks strengthens students' sense of accomplishment.

NSF Calculus Initiative

As the pivotal course in the scientific curriculum, calculus has long been a natural focus for debate when discussions turn to educational reform. In the mid-1980s, talk turned to action when the National Science Foundation launched a major initiative to foster improvement in the quality of calculus instruction on a national scale.

Begun in 1988, the program made over 50 awards totaling nearly $7 million during its first three years of operation. The results of the individual calculus projects are still to be evaluated, but one great benefit is already evident—the enthusiasm generated in hundreds of mathematical sciences departments for improvement in the teaching of calculus.

NSF expects to expand the scope of this initiative to eventually encompass the entire undergraduate curriculum.

Priming the Pump

In response to the growing concern in recent years about undergraduate mathematics, many projects have emerged to explore new approaches to instruction or to study particular issues in depth. Examples:

- Preparing Teachers. A guide for mathematics departments to curricula that will educate intending teachers in a way to meet contemporary standards is contained in the 1991 MAA report A Call for Change: Recommendations for the Mathematical Preparation of Teachers of Mathematics and the 1991 NCTM document Professional Standards for Teaching Mathematics.
- Undergraduate Research. Reports on a wide variety of effective programs that provide research experiences to undergraduate students of mathematics appear in the 1990 MAA volume Models for Undergraduate Research in Mathematics.
- Calculus Reform. Nearly one hundred projects, the tip of the iceberg, are presented in the 1990 MAA publication Priming the Calculus Pump: Innovations and Resources.

•Doctoral Study. The Board on Mathematical Sciences is conducting a study to identify features of successful doctoral and postdoctoral programs which contribute to the preparation of productive members of the mathematical community.

•Study in Depth. Advice for effective approaches to undergraduate majors is the focus of Challenges for College Mathematics: An Agenda for the Next Decade, a report prepared by a joint task force of the MAA and the Association of American Colleges as part of a multidiscipline study of undergraduate majors.

Linking with Schools

Many colleges and universities are developing outreach programs to help increase the professional competence of teachers of mathematics. Two examples:

•The Special Projects Office in the School of Mathematics at the University of Minnesota coordinates a variety of outreach projects that bring together business leaders, government officials, and educators from the elementary school level through the university level to discuss policy issues and to advocate change. The activities include direct service projects such as the University of Minnesota Talented Youth Mathematics Program (UMTYMP) and an NSF Teacher Renewal Project, as well as networking projects such as the Minnesota Mathematics Mobilization, the Twin Cities Urban Mathematics Collaborative, and the Mathematicians and Education Reform network. Each of these activities builds on the expertise of college and university mathematicians.

•The Bay Area Mathematics Project, now in its eighth year, brings school mathematics teachers to Berkeley for a four-week summer program designed to improve their effectiveness as teachers. To increase the scope of the program, participants serve as teachers of other teachers and administrators when they return to their schools. The program has grown each year with funding provided by local community and civic organizations. Teachers from different grade levels are selected as participants so that they can appreciate how their students are taught before and after they teach them. These teachers participate in hands-on problem sessions to learn how students learn, and they practice giving presentations that they can use to instruct their fellow teachers at their home schools. The success of the Bay Area Mathematics Project led to the American Mathematics Project, a collection of over 20 similar projects throughout the country jointly sponsored by the MAA and NCTM.

Effective Cooperation

At Austin Community College in Texas, nearly nine out of every ten students who transfer to public colleges and universities are still enrolled one year later. This measure of "one year survivability" of transfer students is nearly 40 percent higher than the state-wide average. Transfer success comes from paying attention to curriculum.

Almost every course at the college has been structured so that it will transfer directly to the two large neighboring state universities. The operative philosophy is that students should never find comparable courses at the community college easier because content is reduced or standards diluted. Classes should be easier only because they are smaller in size, because the faculty is more accessible and effective, or because the atmosphere is more supportive. The faculty is firm in its standards but caring in its approach to students.

College faculty have frequent contact with faculty at nearby universities, sometimes even influencing the university curriculum structure or choice of text. For example, a special program in mathematics, in place for over a decade, brings Austin Community College onto the University of Texas campus two nights a week to teach college algebra to university students. For these students, the university counts hours of enrollment at Austin Community College toward a student's minimum full-time enrollment obligation at the university.

Moving Beyond Myths

Responses to the problems facing undergraduate mathematics must occur on many fronts, including faculty members and their departments, colleges and universities, business and industry, professional societies, and government agencies. All those with a stake in mathematics must reassert the vital importance of effective undergraduate education in the mathematical sciences. Over the next decade, the mathematical community must restructure fundamentally the culture, content, and context of undergraduate mathematics education.

No one should underestimate the inertia that must be overcome in order to change the culture that controls undergraduate mathematics. Many agencies and constituencies must join the campaign, including business and industry, government at all levels (federal, state, local), scientists and engineers, college and university administrators, and public officials. Broad support is necessary if significant improvement is to be possible. But it will require leadership to marshal that support in consistent and constructive directions. Leadership for reform is the responsibility of the faculty—of mathematicians in every institution of higher education, from comprehensive universities to two-year colleges, from liberal arts colleges to research universities.

In particular, mathematical sciences faculty must assume full responsibility for the mathematics education of *all* students. They must change the way mathematics is taught; increase substantially the participation of women, minorities, and the disabled; and play a more substantial role in the preparation of mathematics teachers. In a world in which productivity depends so heavily on quantitative literacy, everybody does count.

Producing Mathematics Majors

Clarence Stephens created at SUNY Potsdam an undergraduate mathematics program that is difficult to overlook. For nearly two decades mathematics has dominated this regional public college of 4000 students, both in terms of quality and quantity of students. In 1985 the college graduated 184 mathematics majors, a total exceeded only by two campuses of the University of California. Approximately 24 percent of the bachelor's degrees at SUNY Potsdam are in mathematics and over 40 percent of the college's honor students are mathematics majors.

Mathematics at SUNY Potsdam does not rely on novel use of technology or innovative curricula to attract students. "We focus on the human factor," Stephens says, "to change students' perception that mathematics is an almost impossible subject for students to learn and that only the most gifted can be expected to achieve any degree of success." The atmosphere makes mathematics students feel good about themselves; as a result of a supportive environment, they want to learn.

Over half of the freshman class takes calculus as an elective, and post-calculus courses account for 50 percent of total mathematics enrollments. The program recognizes every student's accomplishments and stresses the development of successful role models; faculty present just enough in courses for students to learn essential ideas, not so much as to overwhelm them. Tests are viewed as milestones in learning, not as measures for setting high or low levels of achievement. The program depends on a faculty dedicated to teaching and committed to students. The rewards for faculty are students who learn.

Goals

- **Effective undergraduate mathematics instruction for all students.**
- **Full utilization of the mathematical potential of women, minorities, and the disabled.**
- **Active engagement of college and university mathematicians with school mathematics, especially in the preparation of teachers.**
- **A culture for mathematicians that respects and rewards teaching, research, and scholarship.**

An Action Plan

Develop and Promulgate Effective Instructional Models:

Faculty:

Learn about learning. • Think as deeply about how to teach as about what to teach. • Query unexamined assumptions about education. • Explore effective alternatives to "lecture and listen." • Involve students actively in the learning process. • Emphasize practices known to be effective with minority students. • Teach future teachers in the ways they will be expected to teach. • Exploit modern technology fully. • Teach the students you have, not the ones you wish you had.

Departments:

Develop effective programs targeting underrepresented groups. • Adapt tested and proven models. • Build a team of faculty to carry out experiments, and expose all faculty to the results. • Start a departmental seminar on issues of teaching and learning. • Assign the best teachers to introductory courses. • Employ varied instructional approaches: group methods, writing, investigative assignments, laboratory projects. • Recognize and support the extensive special effort required to introduce computers effectively into the curriculum. • Use knowledge gleaned from minority projects. • Sensitize teaching assistants to cultural impacts in the classroom. • Vigorously recruit women, minorities, and disabled students to pursue careers in mathematics and science.

Colleges and Universities:

Form an institutional task force in response to *Moving Beyond Myths.* • Work with other institutions of higher education to frame an initial state response. • Use both responses to stimulate mathematical sciences departmental efforts. • Provide resources for appropriate experimentation. • Stimulate use of computers in mathematics teaching. • Insist that departments mainstream rather than remediate students. • Emphasize effectiveness in teaching. • Begin an institutional effort to learn how to evaluate teaching properly. • Recognize and reward educational innovation.

Professional Societies:

Investigate and publicize successful instructional models, especially for underrepresented groups. • Launch nationwide programs to promulgate effective instructional models. • Intensify efforts to inform faculty of the nature, magnitude, and urgency of the problems in undergraduate mathematics. • Send peer consulting teams into departments. • Establish a journal of undergraduate educational research and practice. • Expand programs to educate the public on harmful effects of popular myths about mathematics. • Develop and disseminate information on careers in mathematics-based fields. • Encourage dialogue among school, college, and university faculty through joint meetings. • Stimulate local, state, and national networks. • Establish national mathematics education awards that recognize contributions in innovative curricular design, effective methods of teaching, and understanding of how mathematics is learned.

Government:

Give undergraduate mathematics high priority in education funding. • Focus first on introductory subjects as a key to opportunity for disadvantaged groups. • Support results-oriented experimentation. • Invest in dissemination and promulgation of successful models. • Broaden experimentation to encompass the full curriculum. • Provide resources to support effective instructional methods. • Augment graduate fellowship programs with a program of cash awards to undergraduate departments that produce the students. • Expand support for programs that retain women and minorities in the mathematics pipeline, keying on critical transition points. • Support efforts that ally groups in support of planned, systemic change.

Establish and Disseminate National Guidelines or Standards:

Professional Societies:

Develop and disseminate new advisory national guidelines for undergraduate and graduate programs dealing with curriculum, teaching, and evaluation. • Align these with national standards for school mathematics. • Focus on critical transitions: lower division to upper division, two-year college to university, undergraduate to graduate. • Set specific targets for achieving parity for underrepresented groups. • Relate guidelines to college and university accreditation. • Conduct an in-depth study of resources for departments. • Launch a visionary curriculum project aimed at the early decades of the next century.

Faculty:

Participate actively in professional societies' discussion and development of national goals and guidelines. • Support and implement emerging guidelines for undergraduate and graduate mathematics. • Become familiar with evidence that all students can learn mathematics. • Teach as if each

student is a national asset. • Reinterpret "high standards" to mean that many students learn rather than that most students don't. • Recognize that meeting such standards may require dramatic change in classroom practice. • Approach teaching as a profession, not as a task. • Set a stringent personal standard—that if my students don't learn, it is I (not my students or their previous teachers) who have failed.

Departments:

Develop a five-year plan to transform departmental instruction based on national guidelines. • Emphasize mathematics for all. • Be results-oriented: increase success rates. • Incorporate insights gained from departmental experimentation. • Include specific plans for using computers, improving numeracy, teaching teachers, and supporting majors. • Use national targets from professional societies for success of women and minorities. • Set department targets to reduce dependence on teaching assistants and part-time instructors. • Address the need to enlarge the scope of graduate programs in the mathematical sciences to include issues of curriculum, teaching, and learning. • Relate the departmental plan to the weak state of research funding and to changes in school mathematics programs. • Enlist the aid of professional societies in developing and implementing the departmental plan. • Take the departmental plan to the administration. • Offer higher success rates in exchange for resources needed to implement the plan.

Colleges and Universities:

Give top institutional priority to effective teaching. • Judge teaching by results, not by process. • Adopt a broad standard of professional responsibility encompassing teaching and scholarship as well as research. • Utilize this broad standard in decisions about hiring, retention, salary, promotion, and tenure. • Align institutional admissions and placement practices with contemporary standards for school mathematics. • Set high institutional expectations for the mathematics performance of all students. • Help develop a five-year state plan for undergraduate mathematics. • Involve state mathematics coalitions to ensure close coupling to national and state goals for school mathematics. • Help the mathematics department implement their five-year plan, injecting resources in planned stages as results become apparent.

Government:

Support the development of advisory national standards or guidelines. • As consensus emerges, encourage undergraduate mathematics plans, proposals, and projects based on these guidelines. • Develop governmental responses to revitalization of undergraduate mathematics. • Coordinate across agencies. • Recognize the key role played by professional societies, since changing values must be internalized over time by the mathematics community.

Build and Sustain Supportive Attitudes and Structures:

The President and Governors:

Expand efforts to inform the public of the importance of mathematics (and science) education. • Retain the national education goal of being "first in the world." • Emphasize that revitalization of undergraduate education is essential for reaching this goal. • Highlight mathematics education as a key to opportunity in our time. • Designate someone on the senior scientific and educational staff as responsible for implementing this Action Plan.

Congress, State Legislators, Regents:

Insist that plans for reforming mathematics (and science) education encompass the undergraduate level. • Put resources behind undergraduate revitalization. • Support planned, systemic change, not isolated projects and programs.

Federal and State Agencies:

Create a network of regional centers for excellence in the teaching of mathematics. • Support time spent at regional centers by teachers at all educational levels. • Initiate major programs of postdoctoral teaching fellowships to enable beginning faculty to develop expertise in curriculum, teaching, and learning. • Institute fellowship programs to enable faculty members to enhance teaching effectiveness through time spent at innovative centers and institutions. • Increase significantly the numbers of predoctoral fellowships and research assistantships in mathematics. • Work to reduce dependency on teaching assistants for undergraduate mathematics instruction. • Support effective programs of financial incentives for students planning on teaching careers, emphasizing especially minority teachers. • Significantly increase support for dissemination and public information activities. • Provide sustained financial support for working alliances and networks to implement parts of this Action Plan.

Universities and Colleges:

Fully fund the cost of effective undergraduate mathematics teaching. • Provide sufficient computer labs to enable mathematics courses to be taught with full computer support. • Speak out about the importance of research funding for healthy undergraduate education. • Support the concepts of predoctoral, postdoctoral, and mid-career fellowships for college and university teachers of mathematics.

Faculty and Departments:

Build faculty networks within institutions, linking user departments. • Connect to networks of mathematicians committed to educational reform. • Develop a strong presence in regional and national meetings of department chairs. • Forge professional alliances and initiate collaborative projects with mathematics teachers in local schools. • Offer regular enrichment programs that motivate school-age youth, especially minorities, to continue studying mathematics. • Speak to needs and accomplishments in a second five-year plan for undergraduate mathematics.

Professional Societies and National Organizations:

Involve the broad constituencies of mathematics education in discussions of goals and standards. • Sustain structures built to promulgate targeted minority programs. • Support national transformation based on new guidelines. • Establish structures linking corporations, minority action groups, and scientific societies to long-term revitalization effort. • Update this Action Plan regularly and coordinate implementation well into the next century.

Professional Development Programs

Achievement in mathematics is promoted by offering students an environment that fosters success. The Professional Development Program (PDP) at the University of California at Berkeley was developed ten years ago by Uri Treisman to redress excessive failure rates in calculus of Blacks with strong academic records. The program was developed in response to evidence that social isolation of minority students impeded their learning of calculus. It substituted for remedial efforts an approach to learning based on faculty involvement, academic challenge, collaborative learning, and growth of a student community. This approach to learning, which has always been a central part of the educational philosophy of the Historically Black Colleges and the private liberal arts colleges, has now been replicated in special programs in more than fifty universities.

One example is the Professional Development Program at California State Polytechnic University at Pomona. Another is the Emerging Scholars Program (ESP) at the University of Texas, Austin. In both cases the format is similar to that at Berkeley, with special recitation sections that meet for several two-hour sessions each week. Study groups integrate aspects of students' social and academic lives and encourage independent study habits. Key ingredients include high expectations of competence, strong academic components, capable instruction, cooperative learning, and commitment from students.

Undergraduate Research

Undergraduate research, in which students experience for themselves the open-ended exploratory nature of mathematical investigation, is one of the proven means of launching students on successful careers in the mathematical sciences. However, during the ten-year hiatus in NSF support of undergraduate research, few institutions managed to sustain these programs on their own.

One exception is the University of Minnesota at Duluth, where Joe Gallian has, since 1977, directed a summer research program for undergraduates in mathematics. Faculty and students are imbedded in an informal, nurturing environment that is conducive to research and provides for necessary special attention. Each student is given a problem that has been carefully selected to meet the student's background and to sustain the student's interest. A publishable result is the stated goal for each experience.

Discussion and interaction are encouraged through weekly meetings in which partial results are presented, and by having the participants share living quarters so that they can communicate and work at home. Outings and weekly luncheons bring students and faculty advisors together on a social basis, but the discussions normally turn to mathematics. Preparation of manuscripts for publication often takes a year or more following the summer session, but in many cases these papers do appear in a mathematical or scientific journal.

Making Mathematics Work

During the last decade, as mathematics majors climbed nationally from 1 to 2 percent of baccalaureate degrees, mathematics majors at St. Olaf College in Northfield, Minnesota, rose from 8 to 16 percent of the college's graduates. In the last decade, over 30 graduates have earned doctorates in the mathematical sciences—averaging three per year from each graduating class.

St. Olaf is a liberal arts institution of 3000 students. Mathematics is promoted and taught as an excellent liberal arts major—a subject that opens doors to many disciplines. As a consequence, each year from first year through senior year, the number of intending mathematics majors increases. Faculty enthusiasm for mathematics is conveyed both in the classroom and through various social activities designed to promote an image on campus that it is fun to major in mathematics.

Faculty standards are made clear in a written departmental statement of professional expectations given to every prospective faculty member: teaching is top priority, supported by an active but broad professional record of scholarship or research. Teaching is formally evaluated both by peers and students and contributes significantly to reappointment decisions. Professional activity is defined in broad terms and is supported through a strong sabbatical program and other college funds for professional development.

Mathematics faculty are professionally very active, both in research and in education. In the last twelve years, members of the Mathematics Department have received nearly $2 million in grants for projects related to undergraduate curriculum development, school outreach, faculty professional activity, and computer labs. One recent grant from the Fund for the Improvement of Post-Secondary Education (FIPSE) supports an innovative "teaching post-doc" program that provides new Ph.D.s with a two-year mentored transition to undergraduate teaching that provides time for research and for seminars on teaching and learning.

SUMMA's Action Plan

To provide national leadership in addressing problems that result in the under-representation of minorities in mathematics, the Mathematical Association of America has established project SUMMA—Strengthening Underrepresented Minority Mathematics Achievement. SUMMA is designed to stimulate fundamental changes in attitude and practice of the collegiate mathematics community in regard to the education of minority students. The project is organized around five key components:

- Intervention projects for middle and secondary school students, using the MAA sections to develop and replicate effective intervention programs.
- Mainstreaming projects for college and university students, working in collaboration with the Dana Center at the University of California, Berkeley to assist mathematics departments in setting goals for minority participation and establishing programs that will achieve these goals.
- School and college mentorship programs, providing opportunities for minority professionals in the mathematical sciences to serve as mentors in communities, schools, and on campuses.
- Development assistance programs, informing mathematicians and minority students about funding opportunities for minority projects and providing technical assistance for the development of proposals.
- Programs to attract minorities into teaching, disseminating information to students, teachers, and advisors at the high school and college levels, and encouraging the expansion of scholarship programs for promising minority students interested in teaching.

Curricular Innovation

For the past several years the Exxon Foundation has helped Cornell University develop a series of innovative general education courses in

mathematics. For example, a mathematician and an artist team-teach a course entitled "Mathematics and Art" that deals with the influence of mathematical ideas on art through concepts such as proportion, perspective, and projective geometry. Another course introduces students to the intellectual history of calculus by helping them read parts of the original classic mathematical treatises of the Greek philosophers, of Newton, and of Gauss, among others.

A third course, "From Space to Geometry," explores the ways in which geometry has been used throughout the centuries to try to explain the universe in which we live. Two other courses integrate the use of personal computers in novel ways. One of these developed a new collection of computer software to enable students to interactively understand important mathematical concepts at their own pace and from their own perspective.

Minority Access to Research Careers

Since 1975 the National Institutes of Health (NIH) have been administering a program dedicated to increasing the number of scientists in biomedical research who are members of minority groups. The program, Minority Access to Research Careers (MARC), supports biomedical research training for students and faculty members at colleges and universities with substantial minority enrollments. It operates through four programs:

- Honors Undergraduate Research Training Grants: Designed to assist minority institutions in developing strong undergraduate science curricula, this program makes awards directly to minority institutions to support science courses and individual students. The student awards cover tuition and fees and carry a stipend of $8,500 per year; awardees are required to participate in two off-campus summer research experiences that often lead to publication of a scientific paper. Because of the recognition received through these research activities, many students are recruited for graduate study and are awarded support. In 1989 the program supported the equivalent of 410 full-time undergraduate students.
- Honors Predoctoral Fellowships: This program is designed to provide a further incentive to graduates of the Honors Undergraduate Program to obtain research training. Fellowships carrying tuition, fees, a stipend of $8,500, and $2,000 for supplies and travel are awarded each year for three years to students that enter Ph.D. or M.D.-Ph.D. programs. In 1989 there were 53 such awards.
- Faculty Fellowships: This program provides opportunities for advanced research training to selected full-time faculty at four-year colleges, universities, and health professional schools with substantial minority enrollments. Fellows are nominated by their employing institution and may pursue the Ph.D. degree or obtain postdoctoral research training in the biomedical sciences. In 1989 there were 7 predoctoral and 5 postdoctoral awards.
- Visiting Scientist Program: This program provides support for periods of 3 to 12 months to outstanding scientist-teachers who serve as visiting scientists at eligible minority institutions. The intent of the program is to help strengthen research and teaching in the biomedical sciences at these institutions by allowing visiting scientists to draw on the special talents of experts.

Statewide Mathematics Articulation

Approximately every five years, the Illinois Community College Board invites the Illinois Mathematical Association of Community Colleges and the Illinois Section of the Mathematical Association of America to form a joint task force to revise and update the Illinois Curriculum Guide for Courses in Mathematics and Computer Science in Colleges and Universities. This document contains the minimum content, range of credit hours, and suggested prerequisites for transfer-level courses in mathematics and computer science as well as pretransfer-level mathematics courses.

Each joint task force includes a mathematics faculty representative from each major state university and a like number of community college mathematics faculty representatives. The purpose of the Guide is to assist in the articulation of mathematics and computer science courses between community colleges, from any community college to any four-year college or university, and between four-year colleges and universities.

Mathematics Beyond Myths

The United States stands at the threshold of a century that will test the national genius for scientific innovation and social adaptation. Our nation faces many urgent tasks, not least among them to revitalize undergraduate mathematics. Although the educational process is long and the pace of educational change slow, the time is ripe for reform of undergraduate mathematics. There is substantial consensus in the mathematics community on broad goals for mathematics education and on salient methods of achieving them. Professional organizations and federal agencies are supporting a variety of projects that stimulate effective change. On campuses across the nation, exemplary programs are taking root and changing the landscape of undergraduate mathematics.

The evidence from exemplary programs is clear: In mathematics, the American dream of equal educational opportunity for all need not be a myth. The dream can be achieved. We know how to do it. We know where it is being done. And we know why it must be done. The nation cannot afford to ignore this opportunity. The resources needed are not negligible, but the cost of ignoring the opportunity is incalculable. The national revitalization of mathematics is within our reach, if only we are prepared to make a serious intellectual and financial commitment to our children's and our nation's future.

Summary

- **Elevate the importance of undergraduate teaching.**
- **Engage mathematics faculty in issues of teaching and learning.**
- **Teach in a way that engages students.**
- **Achieve parity for women and minorities and the disabled.**
- **Establish effective career paths for college teaching.**
- **Broaden attitudes and value systems of the mathematics profession.**
- **Increase the number of students who succeed in college mathematics.**
- **Ensure sufficient numbers of school and college teachers.**
- **Build better curricular links with business and industry.**
- **Elevate mathematics education to the same level as mathematical research.**
- **Link colleges and universities to school mathematics.**
- **Provide adequate resources for undergraduate mathematics.**

Forum

The Forum section publishes short articles on issues that are of interest to the mathematical community. Articles should be between 1000 and 2500 words long. Readers are invited to submit articles for possible inclusion in Forum to:

Notices Forum Editor
American Mathematical Society
P.O. Box 6248
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Should You Prepare Differently for a Non-academic Career?

Fan R. K. Chung
Bellcore

By choice or karma, many graduate students in mathematics will eventually have non-teaching careers. Perhaps, then, it is not a bad idea to have some basic preparation in order to broaden one's perspectives as well as to anticipate the new and exciting mathematics out in the "real world". It is equally useful for a teacher or a teacher-to-be to have some understanding about non-academic jobs in order to help the students. Because of the tremendous variety and diversity of non-academic professions, it is almost impossible to paint a general picture. However, it is quite feasible to make some simple preparation along the lines described in the following:

Communication Skills

I have often heard, "My student can't lecture so he/she should consider an industrial job." This is perhaps the biggest misconception about a non-academic career. Communication skills are even more important outside of classrooms. An industrial researcher interacts with a wide variety of people including engineers, computer scientists, physicists, chemists and business people. The effectiveness of one's work depends on the ability to convey the power and impact of mathematics as well as its beauty and elegance. It is quite possible to explain mathematics in general terms to non-experts. Even a good colloquium talk involves several different levels of depth. Successful communication not only transfers knowledge and insight helpful to others but also brings up good problems, new directions and interesting ideas. Of course, not everyone is gifted with good communication skills. However, preparation and work can help make up the difference.

For foreign students, it is particularly important to try as early as possible to gain proficiency in English, both in speaking and writing. Although it is desirable to preserve and cherish one's own ethnic heritage, it is essential to avoid cultural isolation and to thrive in both worlds (or even to consider the possibility of assimilation) when planning a career in this country. A good measure in this regard is to count the number of English-speaking friends one has, just as the number of academic friends is a very useful indicator of research activities.

Depth Versus Breadth

Graduate study and the dissertation usually focus on very special topics. Typically, in-depth research leads to original and ground-breaking contributions. Although many feel that the antonym of "depth" is "breadth", I would like to argue that breadth can in fact enhance depth. It happens increasingly often that various concepts and tools are borrowed from one area to solve problems in another area. Sometimes, it is hard to tell if a piece of work belongs to, say, topology, geometry, analysis, number theory or algebra. As a combinatorialist, some of my recent work depends on homology theory, which I took in graduate school years ago without knowing it would be of use today. The boundaries between many areas are rapidly vanishing. Above all, almost all branches of mathematics are connected in one way or another. Although it is hard to know which topic will eventually be useful, it is helpful to pay attention to the interconnections and relations among different topics. Especially in non-academic work, there is no textbook to follow and you will never know from which hat the rabbit is going to be pulled.

Impact of Mathematics in This Changing World

In the past twenty years, we have been in the midst of a technological revolution. The performance of computers has been nearly doubling every year. Vast amounts of information are now being transmitted and processed. While tremendous progress has been made in computer hardware, the development in computer software has comparatively

lagged behind. To deal with problems of astronomical size and complexity, clever methods and powerful tools are in great need. Similar to the profound influence of physics in many areas of mathematics, computers will be a major motivating force for mathematics. Conversely, mathematics will have significant impact over the entire spectrum of developments in the next round of the technological revolution, from establishing information infrastructures to software research.

What should a graduate student do to get ready for the interesting and exciting period of mathematics lying ahead of us? In addition to learning as much mathematics as you can, there are areas which deserve special attention. Discrete mathematics, the study of fundamental properties of discrete structures, has now evolved into a rich and dynamic discipline with growing connections to other areas of mathematics and computer science. It would be advantageous for a graduate student (including those majoring in areas of continuous mathematics) to have some exposure to discrete mathematics such as combinatorics, graph theory and number theory, preferably beyond the introductory level. In addition, there are several other courses worth recommending such as geometry with a computational flavor (or with imagination), probability (or combinatorial probabilistic methods), numerical methods or even interdisciplinary courses in algorithms and data structures. However, it is sad to note that very few universities offer many of the courses mentioned above.

Henry Pollak once said," There is no real distinction between pure mathematics and applied mathematics. There is only a difference between good mathematics and uninteresting mathematics." These words have had a lasting influence on my career and I hope they will be helpful to the readers, especially for those who will have non-academic careers.

[1] John Conway, Peter Doyle, and Bill Thurston, "Geometry and the Imagination," in *Geometry's Future*, Conference Proceedings sponsored by COMAP, Inc., Arlington, MA (1990) pp. 37-80.

Computers and Mathematics

Edited by Keith Devlin

This month's column

Derrick Henry Lehmer, considered by some to be the father of computational number theory, passed away on May 21.

Most mathematicians, and a great many non-mathematicians, are fascinated by number theory, which deals with the most fundamental mathematical notion there is, that of whole numbers. Many of the greatest problems in number theory are easy to state and can be understood by anyone with a high school education. And yet many of these simply-stated problems require a whole powerhouse of deep techniques for their solution (or attempted solution).

In recent years, developing computer technology has led to an intriguing interplay between mind and machine, with the evolution of what is generally known as computational number theory. What is particularly fascinating about this branch of mathematics is that there is a genuine two-way traffic of ideas. On the one hand, the computer is used as an experimental tool to generate and test number-theoretic hypotheses. On the other hand, the need for ever more efficient number-theoretic algorithms has led to several deep new mathematical results.

Some months ago, I asked Bob Silverman to write an article surveying this field. He delayed sending me his article for a short while so that he could show the draft to a number of colleagues. D. H. Lehmer was one of those he contacted. He died shortly thereafter. Silverman has asked that his article, which appears below, be dedicated to Lehmer's memory.

Dr. Lehmer was one of the earliest pioneers in the science of computing and in the field of computational number theory. Even before the era of today's digital computers, he designed and built special purpose hardware for solving problems in number theory. Most of these devices were special sieves, designed to aid in the solution of various diophantine problems, including factoring. Some of this custom purpose hardware even outperformed the digital computers of the early 1960s. In particular, his photoelectric sieve, designed and built in 1932, was a marvel of engineering. In the 1960s, he designed and built another remarkable sieve machine, using delay lines, whose performance was truly amazing for its time. These machines were able to find some extraordinary factorizations. They can be seen in the Computer Museum in Boston.

For over 40 years, Lehmer had been a leader of the Cunningham project, described by Silverman in his article. Indeed, he had been a major driving force behind that project. Silverman writes of Lehmer that "His work was and is a source of personal inspiration to me and I am deeply saddened by his passing."

The very existence of a column entitled "Computers and Mathematics" in the *Notices* stems in part from the work of Lehmer and his colleagues, so we too mourn his passing.

That the work begun by Lehmer continues to flourish is indicated by another recent announcement: a new factor of the Fermat number F_{13} has been found. In May, Richard Crandall of NeXT Computers discovered the factor

$$3603109844542291969$$

It is now known that

$$F_{13} = 2710954639361 * 2663848877152141313 * 3603109844542291969 * C$$

where C is composite. The new factor has been verified (as new and correct) by Sam Wagstaff of Purdue University.

Following Silverman's piece, Tom Scavo reviews the mathematical typesetting system *MathWriter* 2.0.

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A Perspective on Computational Number Theory

Robert D. Silverman*

Dedicated to D. H. Lehmer

I. Introduction

In past issues of *Notices*, much of the emphasis of this column has been on computer algebra packages; their syntax, their peculiarities, and their capabilities. The use of the computer purely as a computing engine has received scant attention. This paper will focus upon how purely

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numerical calculations have led to a number of results in number theory. This includes discovery of numerical patterns that have led to theorems or conjectures, numerical proofs or disproofs of outstanding conjectures, and numerical verification of conjectures up to specific (and often very high) bounds. Some of the projects discussed herein have in fact used *massive* amounts of computer time. The examples presented here are not intended to be an exhaustive list, but merely to illustrate the usefulness of number crunching.

Of course in some areas of number theory, such as integer factorization and primality testing, the computer is an indispensible tool. Indeed, these two areas of study in particular would have very limited appeal without the computer. Several mathematicians and computer scientists have even designed custom-purpose computer hardware to aid in the study of factoring algorithms.

Computational (or Algorithmic) Number Theory is a relatively new discipline. It is a debatable question as to whether it is properly a field of mathematics or whether it is a part of computer science. Certainly, it contains elements from both fields of study, and I have heard opinions expressed in both directions. Part, perhaps even most, of the discipline is concerned with the study of the algorithms themselves. However, part of the discipline also includes use of the tools to study more theoretical questions. It has even been argued that mathematics itself is not a "science" in the strictest definition of "science" in which theories are proposed and then tested by experimentation. I disagree with this viewpoint. It may be strongly argued that the computer *is* the experimental research tool of mathematics. When viewed in this light, it is apparent that the use of computers to find numerical patterns that lead to new conjectures and theorems should be viewed as more important than using it to extend a bound or find a numerical counter-example. This is more in keeping with the scientific method.

Unfortunately for us as mathematicians, we are not a large market for computer vendors. Early computers were designed by mathematicians essentially for their own use. The design of those early computers reflected the types of computations needed by mathematicians. Recently, however, the advent of RISC processors into the computer market has not boded well for number theorists. Number-theoretic computer programs are among the most computationally intense programs being run today among ALL computers. For example, I estimate that well in excess of several **million** CPU hours has been spent on the "Cunningham Project," discussed below. These calculations very frequently require much multiple precision arithmetic. Such arithmetic is facilitated by the presence of computer instructions that produce exact double length products and instructions that can produce both integer quotient and remainder simultaneously. The lack of such instructions can slow down a number-theoretic program tremendously, to the point where one can obtain only a small fraction of a computer's theoretically rated speed. RISC processors and modern computers are leaning more and more away from hardware support for integer multiplication and division. The argument is that most general purpose computing does not require these instructions, so there is little point in making them available. Integer multiplication and division require a lot of gates to implement in hardware and, even then, they cannot usually be executed in a single cycle. This is contrary to the general RISC philosophy of trying to make all instructions execute in a single cycle. Furthermore, even when such instructions are present, most programming languages are not equipped to access them, forcing one to call assembler routines. The mere process of calling a routine to perform basic arithmetic can introduce a lot of overhead, especially if the routine is called frequently, and hence slow a program down. Vendors are aiming their products towards more general computing needs than those of mathematicians.

There is some small hope that this trend may be reversed. As more small workstation owners tie into large networks, computer security and software products to aid computer security may become more in demand. Cryptographic applications are among the heaviest users of integer arithmetic instructions, the RSA encryption scheme being a notable example. Perhaps the demand for such things in the future will force hardware manufacturers to more closely tune their instruction sets to support these kinds of applications.

II. Numerical Counter-Examples to Conjectures

An attempt to discuss even a small fraction of numerical counter-examples that have been found in number theory would run to many pages. Space allows the discussion of just a few of the more significant ones.

The earliest computer disproof of a conjecture that is known to me is a 1953 result due to John Selfridge. A long standing open conjecture was whether $2^{2^2} + 1$ was always prime. Dickson's *History of the Theory of Numbers* cites the conjecture as arising from an anonymous source in 1828. Selfridge found a small prime factor of $2^{2^{16}} + 1$ using the SWAC (Standards Western Automatic Computer) [12]. This interesting machine was blessed with a total memory of 256 words of 37 bits each and multiplied numbers at the phenomenal rate of 2,600 per second. This machine was the first large electronic computer installed in the western United States [UCLA 1950] and was used for much early exploration in computational number theory. This machine was also used to discover the Mersenne primes $M_p = 2^p - 1$ for $p = 521, 607, 1279, 2203, 2281$. It used a program written by Raphael Robinson that is said to have run correctly the very first time it was tried, despite the fact that Prof. Robinson had never before programmed a computer.

Oddly enough, the first published instance of a Symbolic Computation System also dates from 1953. J.F. Nolan and H.G. Kahrimanian independently wrote computer programs to perform symbolic differentiation [21, 28]. The discussion of symbolic systems would lead away from the main ideas of this paper, but a quote of Odlyzko is noteworthy: "In other words the main role of these [symbolic] systems is to obtain mathematical insight. Once that insight is obtained, one can then go on and construct canonical mathematical

proofs, in which there might not be any traces of the use of computer algebra" [30]. I should like to point out that this comment also applies equally strongly to purely numerical calculation.

Whether finding this sort of numerical counter-example represents "significant mathematics," I leave to the reader to decide. There are many such conjectures that might be disproved with the use of computer calculations. For example, one such conjecture (which is probably false) is that the number of distinct prime divisors of Fermat numbers, $2^{2^n}+1$, is increasing. It is very easy to construct conjectures of this type, but it is also possible that they can be disposed of with a little bit of luck. Selfridge puts such things in perspective by quoting a philosphical conjecture of his own: "There will always be more open conjectures about Mersenne Primes than there are known Mersenne Primes."

A more significant conjecture that might be disproved with a bit of luck deals with $\pi(x)$, the prime counting function. The conjecture is that $\pi(x+y) \leq \pi(x)+\pi(y)$. This conjecture is also likely to be false, since Hensley and Richards have shown that it contradicts the prime K-tuples conjecture [19]. The point is that if one is just a little bit lucky, the first counter-example might lie within computing limits and thus be found.

A much more spectacular and significant contribution of this type has been made by Odlyzko and te Riele. Mertens' conjecture stated that $\sum_{x<M} \mu(x) < \sqrt{M}$ where $\mu(x)$ is the Möbius function. Odlyzko and te Riele used a new algorithm for finding short vectors in a lattice and extensive computations to show that there exists an M for which the conjecture is false [29]. They did not actually exhibit a specific M, however. This result is significant because the truth of Mertens' conjecture would have implied the Riemann Hypothesis. The algorithm that they used, called the L^3 algorithm for its discoverers, Lenstra, Lenstra, and Lovasz, has found many other important applications; from factoring polynomials to integer programming. Odlyzko and te Riele used it to solve a system of simultaneous Diophantine equations.

A very old and well known conjecture due to Euler was very recently laid to rest by Noam Elkies [13]. The conjecture was concerned with a generalization of Fermat's Last Theorem: that the sum of $k-1$ kth powers could not equal a kth power. It is known to be true for $k=3$ and direct computer searches had found a small solution for the sum of four fifth powers equal to a fifth power, but extensive searches had failed to turn up a solution for $k=4$. Elkies translated the problem into one involving elliptic curves, was able to find a rational point on a corresponding elliptic curve, then backtrack to the original equation. He was also able to show that there were an infinite number of solutions. Subsequent to Elkies' discovery, Roger Frye of Thinking Machines turned a Connection Machine to the problem of finding the smallest solution and was able to find one after fairly extensive computation [13].

III. Extending Bounds on Conjectures

From a purist point of view, simply extending an upper bound on a known conjecture does little to improve our understanding of the underlying mathematics. In many cases, the limits of what actually can be computed are very small with respect to infinity (of course, any finite number is) and the result of extending computations may do little to increase our confidence. Daniel Shanks has been known to express exactly this point of view [33]. Indeed, numerical examples can be very misleading. There was a classic conjecture, disproved by Littlewood, that $Li(x)$ is always greater than $\pi(x)$. The numerical evidence, from tables of $\pi(x)$ alone is overwhelmingly in support of such a conjecture. The problem is that one has to go very far out to reach the first crossover point. In 1955, Skewes found an upper bound on the crossover point equal to $exp(exp(exp(exp(7.705))))$ which for many years held the record as being the largest number ever to appear in a paper. Work done by Sherman Lehman and improved upon by Herman te Riele has shown that the first crossover occurs at less than 10^{370} or so, but that is way beyond what can be computed [24, 35]. Their work relied heavily upon computation of zeros of the Zeta function. It may never be known exactly where the first crossover point is. A similar question has been posed by Shanks: where is the first prime gap of length 1 million? Heuristics suggest that it should occur somewhere less than $exp(1000)$, but again this is hopelessly beyond computational reach.

Nevertheless, the extension of bounds can be useful. It can serve as a check on the sanity of more speculative conjectures. It can improve one's confidence that a conjecture is correct [but see section VII].

Here is a brief list of some famous conjectures along with bounds to which they have been verified. In many instances, new mathematics has been learned in the course of doing the computations. Often new computational methods and relationships must be devised to allow bounds to be extended. In the summary below, I give a brief synopsis when this occurred.

1. Goldbach's Conjecture — Has been verified to $2 \cdot 10^{10}$ by Granville, van de Lune, and te Riele [16]. There has been a good match between the number of representations found and the number predicted by a theoretical formula of Hardy and Littlewood.
2. Fermat's Last Theorem — Wagstaff and Tanner have verified that the general case is true up to 150,000 [36]. They developed some new congruence formulae satisfied by Bernoulli numbers as a necessary part of the computation. Richard Crandall has extended their computation up to 1,000,000 [11]. The first case, where the product of the summands is relatively prime to the exponent is known to be true up to $7.568 \cdot 10^{17}$. This is based on the work of many people. Just a few of these have been Wieferich, Gunderson, Granville and Monegan, Shanks and Williams, Wagstaff and Tanner, and Coppersmith. The techniques involved

generalization of a criterion first found by Wieferich. Gunderson presented a combinatorial expression that used these criteria to get a lower bound. Gunderson's work was subsequently improved upon by the others.

3. Odd Perfect Numbers — Based upon the work of Brent, Cohen, and te Riele [5] we know that there are no odd perfect numbers less than 10^{250}. Their work relied heavily upon integer factorizations found by the "Cunningham Project" (see below).
4. Mersenne Primes — There are now 31 known Mersenne primes. The largest known is $2^{216091} - 1$. This work has been carried on by many people. Most recently Colquitt and Welsh have been extending the search up to 400,000.
5. The Waring Problem — Thanks to Kubina and Wunderlich [22] we now know that Waring's conjecture about representing integers as a sum of like powers is true to 471,600,000. Waring's conjecture states that every integer can be written as the sum of $g(k)$ kth powers, where $g(k) = q + 2^k - 2$, with $3^k = q * 2^k + r$.
6. The Riemann Hypothesis — The first billion and a half zeros of the Zeta function have been calculated in work done by van de Lune, te Riele, and Winter [26]. All have been found to be simple and to lie on the critical line. New techniques to quickly calculate the Zeta function arose from this work. There is a somewhat speculative conjecture that the distribution of the zeros should be the same as the distribution of eigenvalues of large, random, Hermitian matrices. Odlyzko has compared the actual data with this conjecture and found a good match [31].
7. Primes in Arithmetic Progression — It is conjectured that there should be arbitrarily long arithmetic progressions of primes. The longest one currently known has length 21 and was found by direct search by Paul Pritchard.
8. Calculation of π — By using an analytic extension of a formula of Ramanujan, David and Gregory Chudnovsky have calculated π to just over one billion decimal places [8]. Statistical studies of this data have suggested that the digits are evenly distributed (that π is simply normal to the base 10) and that every block of b digits occurs with the right frequency (that π is normal to the base 10).
9. Transcendental Constants — Work performed by David Bailey has succeeded in showing that a number of well known constants, suspected to be transcendental, but whose true nature is unknown, do not satisfy various polynomials. These polynomials are of degree 8 or less and Bailey succeeded in showing that if these constants satisfied such polynomials then there were rather large lower bounds on the Euclidean norm of the coefficients. The work was made possible by an algorithm of Ferguson and Forcade for finding integer relations among sets of constants [1].

IV. Numerically Aided Proofs

The use of a computer to aid numerically in the proof of a new theorem is still as yet rather rare. There have been a number of remarkable successes, however.

The earliest occurrence of the words "computer proof" or "computer-aided proof" in an actual journal article, that I have been able to find, is a 1962 article by D.H. Lehmer, E. Lehmer, W.H. Mills, and J.L. Selfridge [25]. It is entitled "Machine Proof of a Theorem on Cubic Residues." They proved that except for a small exceptional set, every prime of the form $6m+1$ has a triplet of successive cubic residues that does not exceed $(23532, 23533, 23534)$. They further proved that there were an infinite number of primes whose smallest triplet was this set, so that the result is the best possible. There were a number of remarkable things about this work, the first being that the authors were not even sure that there was such a bounded triple before they began. While the proof did not consume much machine time (several hours on a variety of IBM machines—701, 704, 709, and 7090), the calculations themselves were an essential part of the proof. While such calculations can, in principle, be carried out by hand, they are simply too lengthy to be practical. Since then, other authors, notably John Brillhart, have pursued similar programs for pairs of higher degree residues. Finally, quite recently, A. Hildebrand has succeeded in proving that for any fixed degree d, all primes must have a bounded consecutive pair of dth power residues [20]. As far as I know, however, computer calculations were not required in this proof. If one should want to *find* the bound for a particular d, however, computer calculation will probably be necessary.

A striking example of the usefulness of machine calculation arises in a paper of major importance by Rosser and Schoenfeld [32]. In this paper, they used the results of computing a large number of zeros of the Zeta function in proving a number of remarkable (and sharp) inequalities for a number of arithmetic functions. These functions included p_i (the ith prime), $\theta(x) = \sum_{i \le x} \log(p_i)$, and $S(x) = \sum_{p_i \le x} p_i$. Typical of such formulae are the following: $p_k \le k(\log k + \log\log k)$ for all $k \ge 6$, $p_k \ge k(\log k + \log\log k - 1.00287329)$ for all $k \ge 2$ and a number of other striking results. Recently, by using the calculation of the first billion and a half zeros mentioned above, J.-P. Massias and G. Robin have improved some of these inequalities [27]. The use of the Zeta function zeros was an essential part of this work and therefore these remarkable inequalities would not be available without the use of a computer. These inequalities have proved to be very useful to number theorists.

Another interesting example arises from the work of Bailey. It had been known that the third bifurcation point of the chaotic iteration $x_{k+1} = rx_k(1 - x_k)$, was an algebraic number satisfying a polynomial of degree 256 or less. Bailey discovered, using his integer relation finding code, that this number actually satisfied a monic polynomial of degree 12. The lowness of the polynomial degree came as a big surprise [2]. Again, this result probably would not have been discovered without a computer.

V. New Conjectures

Before discussing more modern examples, I would like to observe that the Prime Number Theorem itself was originally suggested by Gauss and Legendre as the result of looking at tables of prime numbers [15, 23]. There are some conjectures about Mersenne primes that have been put forth as a result of looking at their distribution, even though currently we know only a scant few. There are undoubtedly many more such examples whereby theorems that are known today were originally suggested by examining numerical patterns. The construction of tables of number fields, class groups and units, elliptic curves, modular forms, finite groups, the Cunningham factorizations, and many other tables have proved to be an indispensible tool to researchers.

One of the most important unsolved problems in mathematics today is the Birch and Swinnerton-Dyer conjecture about elliptic curves. Briefly stated, this conjecture says that the rank of an elliptic curve over a number field K is equal to the order of vanishing of a certain L-function, associated with the curve, evaluated at 1. Its proof would have many wide-ranging and important consequences. What is relevant for this discussion is that the conjecture was put forth as the result of some very extensive computations on elliptic curves [3, 4]. Without these calculations, the relationship might have gone unnoticed.

Calculations carried out by a very large number of researchers have turned up the extraordinary fact that the class groups of quadratic number fields tend to be cyclic, or very nearly cyclic. It has also been observed that the class numbers h are more often divisible by small prime numbers than are random integers of comparable size. H. Cohen and H. Lenstra have published some heuristic explanations and conjectures as to why these and certain other related oddities should be true [9]. These conjectures, if true, would do much to enhance our understanding about the structure of algebraic number fields. Some of the predictions of Cohen and Lenstra have been tested in computations carried out by A. Stephens and H. Williams [34] and have also been found to match well some earlier statistical data of D. Buell [7]. Since then, F. Gerth and L. Washington have come out with further arguments in support of these conjectures. Once again we notice that these speculations were put forth after significant machine calculation.

Cohen and Martinet have put forth a similar set of heuristics for cubic and higher degree fields [10]. Some of these were invalidated as the result of computations performed by Gilbert Fung [14]. Subsequently, Cohen and Martinet have modified their heuristics. This clearly shows mathematics to be a science: create a theory, test that theory through experimental computation, then modify the theory accordingly.

VI. The Cunningham Project

Papers about factoring and primality testing justify the subject matter by quoting from Gauss or some other mathematician about what an important and fundamental problem it is. John Brillhart (one of the early researchers in factoring methods) has been quoted as saying that factoring used to be the hallmark of an eccentric. However, the need for such justification changed dramatically with the introduction of the RSA cryptosystem. This system depends on the difficulty of factoring very large numbers for its security and has turned out to be one of the more important applications of number theory to real-world problems.

In 1925 Colonel Allan J.C. Cunningham and H.J. Woodall published a small book of factorizations of $b^n \pm 1$ for the non-square bases $b = 2...12$. The tables had collected, from scattered sources, the results of many years of diligent hand calculation by many people. Since then, this project has become known as the "Cunningham Project" and has been worked on by many people. A book about this project has been published by the AMS [12] and it conveys much interesting history about the early days of number-theoretic computing. The project has caused several researchers to build custom purpose computers, specially tailored towards specific algorithms. Many of the early efforts by D. H. Lehmer predate electronic digital computing. Professor Lehmer built many interesting mechanical sieve machines, some driven by paper tape, another by bicycle chains, yet another from a special gear system, and all were designed to help factor numbers, mostly from the Cunningham Project. More recently, S. S. Wagstaff, Jr., and J. Smith built a special machine (affectionately called the Georgia Cracker) to speed the Continued Fraction factoring method. C. Pomerance and Smith are currently building a special daisy-chained pipelined siever to speed the Quadratic Sieve algorithm and perhaps the Number Field Sieve as well. It may be safely said that this project is the longest ongoing computation project in history and [in my opinion] has probably used more CPU cycles than any other project in history. The Cunningham numbers, and to a lesser extent Fibonacci numbers and similar sequences, have become benchmark numbers for testing factoring algorithms. There are many reasons why factoring these particular numbers is interesting. I will not state them here except to note that these numbers pop up in many areas of mathematics and that the work of Brent on odd perfect numbers gives just one example of why they might be useful.

To give a brief perspective of the amount of computation that has taken place in this project, I simply note that the factorization of an average 100-digit number with no small prime factors takes several MIP-years of computation time, where a MIP-year is one MIP machine running for one year. Currently all numbers up to 93 digits in the project have been factored and there are only 16 numbers left unfactored from the original 1925 book. Since 1982, when the AMS published the first edition of the book, approximately 3000 new factors have been found. I personally have spent somewhere in excess of 1 million CPU hours on multiple SUN workstations in the last 6 years working on this project and have contributed over one-third of the new factorizations. There are about 1800 numbers yet unfactored in the current tables, varying from 94 to 355 digits. Many of these are beyond the range of current methods. Wagstaff

sends out a page of new factors every few months detailing progress on the project. He also coordinates activities and invites anyone who might be interested in working on this project to contact him.

VII. Caveats and Pitfalls

It can be very difficult, when trying to judge the order of growth of some function by numerical means, to distinguish between similarly shaped curves. This is especially true in number theory where many arithmetic functions grow as some iterated logarithm function, e.g. $\log\log\log x$. Current computer speeds do not allow us to carry computations far enough to discern a triple log rate of growth. It can even be very hard to distinguish between (say) $\log\log N$ and $\log^{\epsilon} N$. Conjectures suggested from numerical results must be backed by some theory or heuristics. Littlewood's theorem about $Li(x) - \pi(x)$ is just one example where numerical evidence can lead to a false conjecture.

Another such example arose in a paper of Brent and Kung [6]. Let ϕ_n be the set of all integers with exactly two distinct prime factors, each less than n, and let $\mu(n)$ be the cardinality of that set. Based on strong numerical evidence, they conjectured that

$$\lim_{n\to\infty} \frac{\mu(n)\log\log n}{n^2} = 1.$$

However, it was later pointed out that Erdös had shown that for some positive $\alpha \leq 1$,

$$\mu(n) = \frac{n^2}{\log^{\alpha+o(1)} n},$$

thus contradicting the conjecture. This example shows that it can be difficult to distinguish between a double log and a fractional power of log.

Richard Guy, in several articles, has presented examples of patterns that seem to be true [17]. Many of them are true. Many of them follow a pattern for a very long time, then diverge from that pattern. The examples are taken from many areas of mathematics and clearly point out the pitfalls that can await a researcher who draws a conclusion from a (even very extensive) set of calculations.

Acknowledgments

I would like to thank John Selfridge, D. H. Lehmer, Hugh Williams, and Henri Cohen for providing insightful comments and knowledge concerning some of the work described herein. I would also like to thank Richard Brent for calling [6] to my attention and providing me the information about Paul Pritchard's work.

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Reviews of Mathematical Software

MathWriter 2.0
A Software Review

Reviewed by Thomas Scavo*

Introduction

Program Description

MathWriter 2.0 (*MW*) is a "what you see is what you get" mathematical text processing program for the Macintosh. Much more than a mere equation editor, the latest version of *MathWriter* is a scientific word processor with scores of useful features making it an excellent writing tool for technical memos and reports, exams, problem sets, short articles, and papers. Automatic revision tracking and RTF support make *MW* particularly well-suited for collaborative writing efforts among multiple authors. It's probably not up to the task of writing a book or long technical manual however, for reasons which will hopefully be made clear below.

Hardware Required and Used

The program runs comfortably on an SE/30 or Mac II with at least 2MB of memory and a hard drive. Of these, the processor requirement is probably the most important since none of the 68000-based Macintoshes, including the Plus, SE, or Classic, do justice to this computation intensive program. And because *MathWriter* documents are memory-based,[1] the RAM requirement mentioned above is really a minimum that depends on the number and size of documents in actual use.

Before continuing, I should mention that virtually all of my testing was done on a stock SE with 2.5MB memory and a 20MB hard drive running *MultiFinder* 6.0.1 (and later, version 6.0.5). This less than optimal hardware configuration suffices for short documents, say less than 10 pages, with small to moderate amounts of technical text. Any serious work will most certainly require a Mac equipped with a 68030 processor and lots of memory.

Software Required and Used

I strongly recommend the installation of at least one complete font family which includes on-screen bold and italics.[2] Since mathematical text is heavily italicized, this will significantly enhance the wysiwyg on-screen appearance of your documents. Precisely which fonts you choose to work with is a function of your printer configuration and, of course, personal preference. For example, I use bold, italic, and Roman versions of Times for body text, and Helvetica for headings, headers, and footers with good results.

Installation

MathWriter requires the installation of both the Times and Symbol fonts,[3] and for those already familiar with Apple's Font/DA Mover this should be a routine operation. If your System file already has the Symbol font installed however, you will need to replace it with the Adobe version included on the distribution disks. (The latter apparently corrects a defect in Apple's version.) But after removing the Apple Symbol font and installing the new one, I discovered that the new version, even though it has the same name as the original, had somehow acquired a different Font ID number. Now as far as *MathWriter* is concerned, this is of little consequence since *MW* treats fonts by name rather than number, but my old Word documents were totally messed up as a result. To repair the situation, I had to go back and determine the old Font ID (even this was nontrivial!) and carefully edit my System file with ResEdit. As an experiment, I also tried to install the Adobe version without removing the existing Symbol font, but in this case I ended up with a pair of Symbol fonts, each with its own Font ID. Again I had to use ResEdit to rectify the situation.

If *MathWriter* is to be run under *MultiFinder*, the final step is to allocate an appropriately large chunk of memory—the larger, the better—in the application's Get Info dialog box. *MathWriter*'s memory allocation was factory set to 2500KB which I had to cut back to 1500KB given my particular hardware configuration. This is easy to do, but just as easy to forget.

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[1]In contrast, memory-based documents are optional in Microsoft Word. And *MathWriter* uses overlays, whereas in Word this is also an option.

[2]A program similar to Adobe Type Manager would also help.

[3]Also note that the Read Me file and some of the tutorial documents require the Zapf Dingbats and Bookman fonts which are not included on the distribution diskettes. Without these, the file contents will be distorted on screen.

User Interface

Menus

MathWriter's pull-down menus are a real pleasure to work with. They scroll smoothly and provide valuable feedback about the current state of the program. The Edit menu, for example, shows commands like Cut Picture Sidebar or Paste Text instead of the ordinary Cut and Paste. Also, numerous *hierarchical menus* significantly extend the range of commands accessible by mouse. Fonts, for example, are neatly tucked away in a lower level menu. Another use of hierarchical menus (i.e. default files) can be seen in the screen shot below (Figure 1).

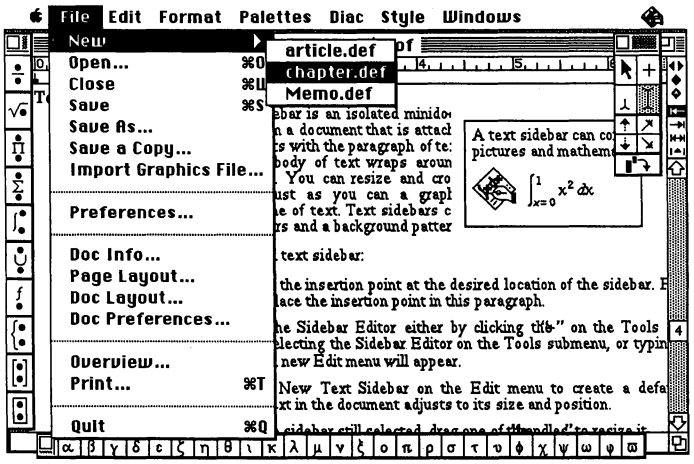

Figure 1

Floating Windows

Access to *MathWriter*'s various templates, palettes, tools, fonts, libraries, and on-line help is provided through so-called *floating windows*, any of which may be simultaneously opened and arbitrarily positioned. Since things get a little crowded on a Macintosh with a built-in 9″ screen however, only a few floating windows may be open at any one time (there are three floating windows open above, for example). Users with a large screen, say a full-page or 19″ monitor, are in for a real treat with this program.

Dialogs

MathWriter utilizes a wide assortment of dialog boxes, many with handy pop-up menus and slide controls. One window—the find/replace dialog—even has its own menu bar! The Page Layout window (a miniature version is shown on the left in figure 2), with its excellent visual feedback, is one of *MW*'s best designed windows. Some of the dialogs need work, however. With its iconic radio buttons and check boxes, the Doc Layout window (on the right in figure 2) for example, strikes me as rather odd. Moreover, accessing its functionality makes more sense as a button in Page Layout rather than a separate menu option.

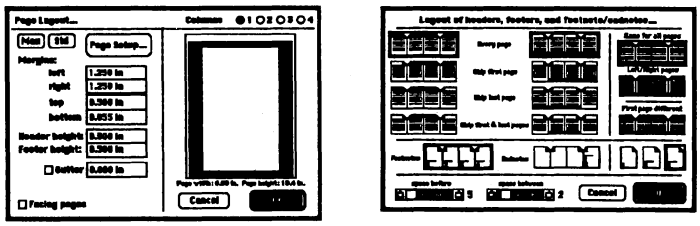

Figure 2

Cursors

An elaborate set of cursors (or pointers) provides visual feedback to the *MathWriter* user. Some of these cursors are delightfully high in entertainment value, like the searching eye of find/replace, or the marvelous animated cursor built into the RTF filter (see the bottom row in figure 3). Other cursors indicate the current tool (the left half of the first row) or the position of the pointer within the layout of the document (the third row).

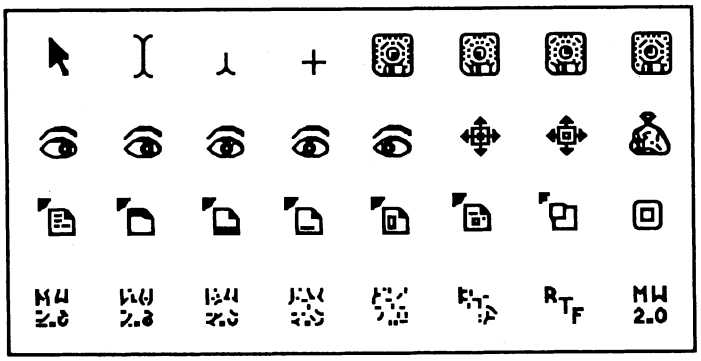

Figure 3

Features

As a *MathWriter* reviewer and beta tester, I've had ample opportunity to look at the software in detail. Along with features you'd expect in a high-end word processing program, *MW* also has

- a *library* (or glossary) facility that automatically inserts text, mathematical expressions, and graphic images into the document as you type;
- *sidebars*, a completely automatic "minipage" environment for both text and graphics; sidebars are especially useful for figures and other "boxed" items around which text must flow;
- a *Rich Text Format file filter* which helps ease the transition from Microsoft Word and other programs supporting RTF;
- a kind of electronic stationary known as *default files* which may contain boilerplate text, user-specified formats, and other default document characteristics;
- intelligent vertical *line spacing*;
- *memos*, the electronic equivalent of the ubiquitous Post-it™ note;

- a *generalized tab* feature that aligns text on an arbitrary character such as an equals sign;
- a handy, integrated *thesaurus* utility;
- multiple ways of accessing a wide variety of fonts, not the least of which is a font *table* that generalizes and simplifies Apple's Key Caps desk accessory;
- an easy-to-use menu of *diacritical marks*.

Other interesting features like revision tracking, line numbering, AutoScrap, and add-on modules were not evaluated by this reviewer. Below is an outline of the more significant of those tested.

Novel Features

One of *MathWriter*'s most impressive features is its ability to import files written in Microsoft's Rich Text Format,[4] itself something of a multi-platform, de facto standard in file interchange formats. An RTF file is a marked-up text file (vaguely reminiscent of LaTeX source) which can be exported by Word and other word processing programs so that it retains virtually all the formatting, formulas, and graphic information of the original document. Since it's nothing but text, an RTF file can be emailed, filtered, or otherwise treated like an ordinary text file.

The RTF filter faithfully translates fonts, borders, headers, footers, footnotes, bold and italicized text, and even dynamic page variables into their *MathWriter* equivalents. The filter even does a good job of translating complex Word formulas. It still has trouble with angle brackets, auto-sized parentheses, columns, and the limits of integrals, sums, and products, however. And of course it's not able to translate objects created with Word's Overwrite formula command, backward spacing, arbitrary bracketing characters, sections, and tables,[5] since *MathWriter* has little or no provision for these esoteric Word features. But all-in-all the RTF filter is a marvelous piece of software engineering, the only one I know of that even attempts to translate Word formulas. If and when a TeX filter becomes available, *MathWriter* will have the only RTF to TeX translator in existence!

Excellent Features

Subscripts and superscripts, staple fare for mathematical writers, are particularly easy to create with *MathWriter*. First, a simple keystroke or mouse click invokes the subscript (or superscript) tool. Then after typing the subscript, a single press of the enter key returns the cursor to the baseline. The size and placement of the subscript is automatic, previously set in the Metrics dialog as a global document characteristic. *MathWriter* can be configured, for example, to insert 9 point subscripts on 12 point text, 8 point subscripts on 10 point text, and so on. As a consequence, multiple levels of superscripts are extremely easy to do. *MW* also knows how to properly position the limits of integrals, sums, and products, but of course the user has the option of recording any special requirements that might exist.

Text, mathematical expressions, and graphic images used more than once should be stored in a library, another important *MW* feature similar in concept to Word's glossary. As an illustration, consider the Greek alphabet which *MathWriter* accesses in multiple ways. The font table (see figure 4 below) is one approach, but it takes up a lot of screen space which on my SE can't be spared. Alternatively, Greek letters could be clicked into place from a menu or a thin strip of a floating window, and for many, this will be the preferred way to go. For keyboard fanatics like myself, there's a handy toggle into and out of the Symbol font which contains the complete Greek alphabet. But even that is slightly less than optimal, since it takes three difficult keystrokes (toggle in, type the Greek letter, toggle out) to execute. So, using *MW*'s library feature, we logically attach the word "alpha" to the corresponding Greek letter.[6] While writing the text, each instance of "alpha" is immediately and automatically replaced with the corresponding library entry, in this case a Greek letter. No need to take your hands from the keyboard and fumble with the mouse—just continue typing while *MathWriter* performs the library substitution automatically.

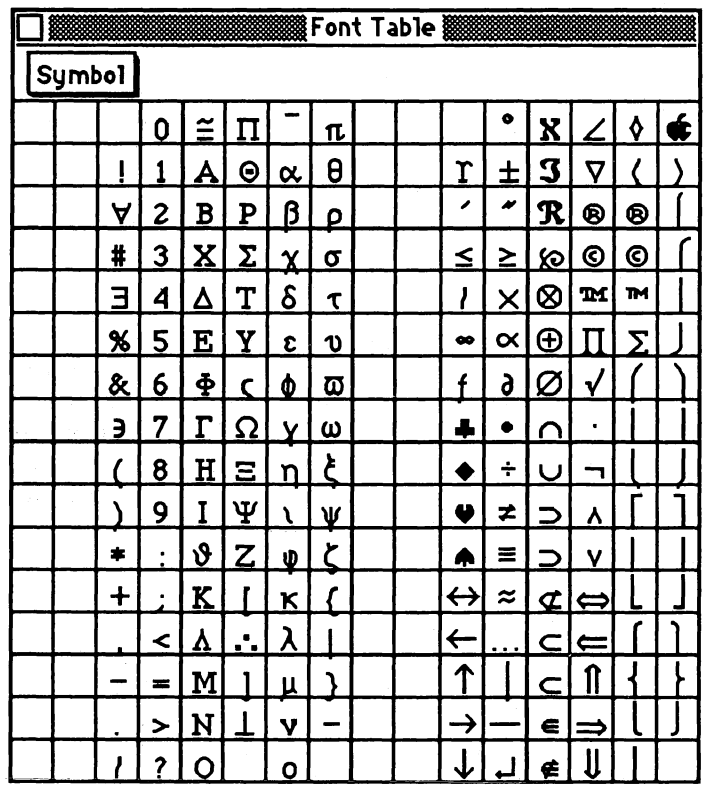

Figure 4

Also appreciated is *MathWriter*'s ability to automatically number footnotes and endnotes, as well as figures, defi-

[4]I'm told that an RTF export filter is presently in the works, and may be available by the time you read this.

[5]Since *MathWriter* isn't able to handle elaborate tables like those possible in Microsoft Word, these should be converted to text (Word has a command which will do this automatically) before running the document through the RTF filter.

[6]Actually, the qualified string "\alpha" would be more familiar to TeX users, and would allow "alpha" to be used literally in the document.

nitions, theorems, exercises, and practically anything else you can think of. Automatically updated cross-references are also provided. In fact, I never knew how easy numbering could be until I started using *MathWriter*. Simply give each user-defined variable a name, a format, and an optional label, and then insert an instance of the variable into the document where desired. *MathWriter* keeps track of insertions and deletions, accepts style changes at any time, and then automatically updates existing variables.

Inferior Features

I work with text files a lot, primarily email and electronically transmitted news articles. Unfortunately, text files are slow to open and save in *MathWriter*, and the redundant series of steps required to save a text file slows down the process even more. It would be better to have a button in the Save As dialog—called Text Options, say—for those rare situations in which the save parameters must be modified. Also, it would be extremely helpful if the text filter were more careful about maintaining vertical and horizontal spacing: tabs should be expanded into spaces, and the whitespace before and after paragraphs could be transformed into blank lines. A real fancy text translator would even convert simple mathematical expressions involving subscripts, superscripts, and fractions into text. *Maple* and other symbol manipulators, for example, do an excellent job of displaying equations using little more than standard ASCII characters.

Another weak point is *MathWriter*'s implementation of columns, mainly because it's not possible for a single document to have varying numbers of columns. Part of the problem is that *MW* has nothing like Word's concept of a section in its organizational hierarchy. Sections give users more control over certain document formatting characteristics like page numbering, columns, headers, and footers.

Finally, *MW*'s user-defined styles, one of the most important features of any WYSIWYG word processing program, are a big disappointment. For one thing, applying a user style supersedes any existing style, and consequently, styles can not be stacked one upon the other. More importantly, *MathWriter* is unable to attach ruler information or paragraph formatting to a style definition. This most unfortunate situation renders *MathWriter*'s style sheets virtually unusable. On the other hand, the fact that they're easily applied to characters is much appreciated. I discovered this feature quite by accident (even after reading the manual) after incorrectly assuming that styles applied to paragraphs, the fundamental unit of organization in most, if not all, word processing programs.

Documentation

Manual

The *MathWriter* package comes complete with a handy quick reference guide and approximately 300 pages of written documentation, a third of which is reference material organized by function according to menu. Another third gives a good introduction to technical writing from the vantage point of a *MW* user. Also included in the manual is a "Guided Tour" consisting of five interactive exercises, four of which exist as handy machine readable documents. The fifth exercise—"Mathematics"—contains practical examples of how to use the built-in expression editor, automatic numbering, and the library.

On-line Help

Backed by over 200 kilobytes of disk files, *MathWriter*'s on-line help facility is one of most extensive I've seen. Whereas the reference part of the manual is organized by function, however, the help screen topics are alphabetized. Neither is the help feature context-sensitive. Using Microsoft Word, for example, it's easy to obtain information about a particular feature simply by choosing that item from the menu using the ? cursor. *MathWriter*'s approach merely lets you browse a huge help file within a fixed-size floating window.

Summary

Developers

MathWriter is the brainchild of J. Robert Cooke and associates at Cooke Publications in Ithaca, New York. The code itself was implemented by E. Theodore Sobel. Bob and Ted are very responsive to user needs and dedicated to future releases and enhancements. They may be reached at

Cooke Publications, Ltd.
221 Langmuir Lab
Cornell Business and Technology Park
Ithaca, NY 14850

Versions

For users with modest technical typing needs, limited hardware, or reduced budgets, a subset of the full Professional Version of *MathWriter* 2.0 is available. Designed to run on **any** Macintosh, this Educational Version provides many of the basic technical writing tools discussed above, but certain key program features such as revision tracking, libraries, memos, sidebars, user styles, find/replace, hyphenation, auto-italics, and the thesaurus have been restricted or removed. Features retained in the Educational Version include variables (for automatic numbering), the font table, AutoScrap, default files, and graphics manipulation tools, along with basic word processing functions.

A free Demo Version of *MathWriter*, in which the save, cut-and-paste, and print features have been disabled or crippled, is also available. Additionally, the Demo Version lacks the spell-checking, thesaurus, and hyphenation utilities.

The Professional and Educational Versions of *MathWriter* 2.0 cost $395 and $99.95, respectively, and the Demo Version is free. Various educational site licensing options are also available. For information about these or any other aspect of the program, contact the software's distributor at

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Email: D2248@applelink.apple.com

Suggested Improvements

MathWriter will continue to grow and mature. It will certainly get faster, and with a macro programming language it will become more flexible. Some kind of TEX capability is essential to *MW*'s future success as a technical word processing program. The program also needs a table of contents generator, indexing, outlining, and bibliographic support for book writers, and it would be helpful if there were graphics tools for creating figures and diagrams. Last but not least, *MathWriter* sorely needs a more powerful stylesheet and table generation facility.

Conclusion

MathWriter promises to radically transform the laborious process of technical writing in much the same way that Wordstar liberated the writer of words over a dozen years ago. The program has certainly altered my perception of mathematical text processing, and there's every indication that *MathWriter* will become a driving force in the proliferation of wysiwyg technical word processors.

Inside the AMS

Strategic Planning

Background and Introduction

Since December of last year, the Society has engaged in a period of strategic planning to examine ways in which the AMS can better meet its responsibilities to its membership, to the broad mathematical sciences community, and to the general public. A number of *Notices* articles reported on this process to the AMS membership (see January 1991, page 17; March 1991, page 178; and May/June 1991, page 432).

In May of this year, the Executive Committee and Board of Trustees (ECBT) endorsed a report representing the deliberations of the Strategic Planning Task Force. The report interprets the Society's mission as encompassing some of the contemporary issues that have an impact on the lives of AMS members and that have been under discussion in the AMS for some time now. For the information of the AMS membership, this report is presented here in *Notices*.

The Task Force met for the first time during the Joint Mathematics Meetings in San Francisco in January, 1991. During the Meetings and afterward, interviews were conducted with key members of AMS constituencies and with AMS staff, and a portion of the membership was surveyed. The information gathered was formulated into a number of "strategic issues" facing the Society. These touched on existing AMS activities, such as publications and meetings, as well as on issues in which the AMS has been only peripherally involved, such as education and public awareness, and in which the Society's role has been unclear.

With this information in hand, the Task Force met in Providence in March and at a retreat in Santa Fe in April to build consensus on what actions the Society might take in addressing the strategic issues. After the Santa Fe retreat, the Task Force held an almost continuous meeting in electronic mail and by telephone while writing its report. The resulting document was put before the ECBT at its meeting in May in Washington, DC. The ECBT voted unanimously to endorse the report.

The ECBT's endorsement does not mean that the AMS has committed itself to a completely different approach to what it does. Rather, it means that the Society's mission has been interpreted in a way that allows the AMS to respond thoughtfully to current issues relating to mathematical research and scholarship. In fact, the Society has for some time been grappling with the issues raised in the strategic plan, but its efforts have been hampered and fragmented by a lack of clear focus and direction. Now, armed with a plan that incorporates concerns of the membership, reflects the thinking of leaders from the mathematical sciences community, and carries the approval of the ECBT, the AMS leadership and staff can begin to plan specific activities and programs to address these issues.

During the ECBT meeting, part of the discussion centered on some of the ideas the report presented for implementation of specific programs and projects. Although the Task Force had concerned itself primarily with the big picture, it was inevitable that such ideas would surface during their discussions. Many of these ideas have merit, but it would be impossible for the AMS to pursue them all, and no attempt has yet been made to evaluate and prioritize them. It became clear that these ideas were the "raw material" from which some workable action plans could be formulated and weighed against each other. Therefore the ECBT and the Task Force agreed that these ideas should be included as an appendix at the end of the report. Both groups felt this material would be helpful to the leadership and staff as they begin the task of building an operational plan based on the report.

From the beginning of the strategic planning process, the Society sought the ideas and concerns of its membership, by surveys and interviews and by assembling a Task Force that encompassed a wide range of views and experiences. The periodic reports in *Notices* provided news about the planning process and invited comments from the membership, and the Task Force received several responses. (One of them was submitted as a letter to the editor and appears in this issue of *Notices*, together with a response from the chair of the Task Force.) In presenting the strategic planning report in *Notices*, the Task Force is once again seeking the serious and thoughtful consideration of the community. It is impossible that the entire membership (or even the entire Task Force) will agree on all the details of this report, but the Task Force believes that the overarching themes and ideas will provide a sound basis on which the Society can plan its future.

Comments on the report may be communicated to the AMS Long Range Planning Committee through Timothy Goggins, Strategic Planning Task Force Manager, AMS, P.O. Box 6248, Providence, RI; electronic mail tjg@math.ams.com.

Allyn Jackson
Staff Writer

Report of the Strategic Planning Task Force

American Mathematical Society
May 1991

This report of the Strategic Planning Task Force surveys the challenges now facing the broad mathematical community and the needs and expectations of the constituencies of the American Mathematical Society. It presents a call to the Society to assume an active role in realizing these aspirations and meeting these challenges.

The report broadly interprets the AMS mission, providing a vision to clarify the Society's purpose and guide its organization over the next three to five years. The timely, specific goals the report sets forth will require the creativity and commitment of the membership and staff, as well as the adaptability of the management and government of the Society. Objectives are provided to elaborate and guide the achievement of these goals.

The goals and objectives specified in this report were discussed extensively at Task Force meetings. In the process, various strategies for achieving these goals developed and in some cases prompted further objectives. Strategies were not discussed in detail and were neither evaluated nor prioritized by the Task Force. It is strongly recommended that the Society move, through its staff, directly to this next step.

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I. The American Mathematical Society

The American Mathematical Society (AMS) is a nonprofit organization, founded over one hundred years ago to promote the interests of mathematical scholarship and research. Since that time, the Society has grown to a membership of nearly 28,000, with a staff of over 250 and an annual budget of over $17 million dollars. It has become a national and international resource for support of the mathematical sciences and for the exchange of information relating to the profession as well as the discipline of mathematics. AMS programs include:

Publications

- *Mathematical Reviews*—a continuously updated archive of the world's mathematical research literature with over 50,000 entries per year, contributed by almost 13,000 reviewers worldwide,
- *Proceedings*, *Transactions*, and numerous journals publishing current research articles, including the new *Journal of the AMS*—recognized in 1989 by the Association of American Publishers as the best new journal in Science, Technology and Medicine,
- translations from Russian, Japanese and Chinese,
- several book series, including the *Colloquium Monographs* and *Contemporary Mathematics*.

Meetings

- two annual national meetings in conjunction with the Mathematical Association of America (MAA) and other major professional groups,
- an annual three-week summer research institute in an area of contemporary research,
- a two-week seminar, sponsored jointly with the Society for Industrial and Applied Mathematics (SIAM), in an applied area of current research,
- the newly initiated expository quadrennial John Von Neumann Symposia on recent advances,
- a series of joint summer research conferences, sponsored jointly with the Institute for Mathematical Statistics, and SIAM.
- a symposium on mathematical questions in biology, held jointly with SIAM and the Society for Mathematical Biology,
- eight annual sectional meetings.

Information Services

- online databases, including a comprehensive listing of the world's mathematicians, and **MathSci**, a multicomponent service to electronically access the reviews, abstracts and other secondary information sources of the AMS,
- **e-MATH**, a node on the international computer network, for information exchange and the fostering of communication,
- a continuously updated base of professional and statistical information on the mathematical sciences gathered

through human resource and employment surveys and an annual employment register.

In this last decade of the twentieth century, mathematics, like all scientific disciplines, is in the process of extraordinary development in a changing environment. As a result, the demographics of the profession, the very directions and conduct of research and education in the science itself, and the resources available for its support are all in a state of transition.

The AMS is being called upon to become more versatile and flexible in its involvement in these changes and deepen its relations with other agencies and organizations. By providing the link between contemporary scientific inquiry and these changes, the AMS is in a unique position to sustain and support a dynamic profession effectively while maintaining a clear focus on the objectives of mathematical scholarship and research.

II. The Strategic Planning Task Force

Michael Artin, President of the AMS

Salah Baouendi, LRPC/2nd year member Executive Committee

Lenore Blum, Vice-President of the AMS

William Browder, Ex-President of the AMS

Robert M. Fossum, LRPC/Secretary of the AMS

Ramesh Gangolli, Chair, AMS Committee on Education

Frederick W. Gehring, LRPC/Chair of BT

Ronald L. Graham, LRPC/past Chair of BT

William H. Jaco, LRPC/Executive Director of the AMS

Donald L. Kreider, Treasurer of the MAA

Jill P. Mesirov, Member of AMS Committee on Computer Operations and Facilities, Past President of AWM, SIAM Board of Trustees

Franklin P. Peterson, LRPC/Treasurer of the AMS

Hugo Rossi, Chair, LRPC/3rd year member Executive Committee

Richard A. Tapia, Member of AMS Committee on Education, SIAM Board of Trustees, MAA Committee on Minority Participation

William P. Thurston, LRPC, Past Vice-President of AMS

At the beginning of the last decade, the AMS Board of Trustees created a standing committee—the Long Range Planning Committee (LRPC)—whose charge is to oversee the activities and functions of the Society from the point of view of its long range goals.

Every five years this committee is to conduct an intensive review of the Society's goals and propose strategies for attaining them. 1990 was to have been such a year. During that year, the LRPC confronted many emergent issues which demanded consideration. As the year progressed, it became clear to this committee that a thorough comprehension of the Society's mission, aspirations, and objectives, and the broad outline of strategy to attain them, should precede the study of particular issues and form the basis of their evaluation.

The Executive Committee of the Council and the Board of Trustees (ECBT), upon recommendation of the LRPC, decided to form an expanded committee (the Strategic Planning Task Force (SPTF)) which could separate itself from emergent issues for a time in order to engross itself fully in long range planning. A fifteen member task force was selected and charged with preparing a strategic plan for presentation to the ECBT at its May 1991 meeting. A team from the firm of KPMG Peat Marwick was hired to facilitate and assist the SPTF in its work.

The SPTF met in January in San Francisco, in March in Providence, and for a two-day retreat in April in Santa Fe. The charge of the Task Force was to:

(1) review the mission of the AMS, and consider its revision or reaffirmation, as appropriate,

(2) formulate three to eight specific goals for the Society for the next five years,

(3) develop specific objectives associated with these goals and strategies for attaining them; and to the extent possible

(4) articulate criteria for evaluating the success of thee strategies employed.

The strategic plan and the process by which it was developed follow a structure provided by the facilitators and developed by KPMG Peat Marwick.The process is described in Section IV.

Although the plan includes a reformulation of the statement of the mission of the Society, its primary purpose is to set sights on goals to be attained in the next three to five years. It is important to note that the strategies proposed in section VI are not yet developed as required in section II, point (3) of the charge, nor have we addressed point (4). While we believe that the objectives are viable and the strategies sound, they should be viewed as suggestions which are yet to be prioritized and evaluated as to cost, benefit, and feasibility so that the goals can be achieved efficiently, but in a thoughtful and sustaining way. We shall return to this in section VII on Next Steps.

III. Strategic Issues

One of the key components in the strategic planning process was the formulation of a set of "Strategic Issues." Synthesized from interviews, surveys, and other information, the Strategic Issues articulate some of the major challenges facing the mathematical community today and provide an impetus for change.

Strategic Issue #1: The Mission of the AMS

The mission statement included in the Certificate of Incorporation of the AMS of 1923 reads as follows:

The particular business and objects of the Society are the furtherance of the interests of mathematical scholarship and research.

Many AMS voluntary leaders, general members, and staff believe that the Society's mission statement needs to be reexamined and that the current mission statement does not serve to guide the organization in its role definition and decision-making.

Strategic Issue #2: AMS Publications, Meetings, and Membership

There is widespread agreement that publications, meetings, and membership are the three most important and visible AMS programs. These programs are considered to be central to the Society's mission. There is a general consensus that publications, meetings, and membership should continue to be core AMS programs in the future. There are, however, strategic as well as operational issues that need to be addressed regarding the future of these programs and their relationship to other current and potential AMS programs.

Strategic Issue #3: Other AMS Programs and Services

Beyond the meetings, publications, and membership programs, there is no shared vision regarding which additional AMS programs should be offered and how these programs—both individually and collectively—might address the many challenges facing mathematics and the mathematics profession.

Strategic Issue #4: External Challenges Facing the AMS and the Mathematics Community

The major external challenges facing AMS and the mathematics community over the next decade are widely recognized and acknowledged by the AMS voluntary leadership and others in the mathematical community. The appropriate role for AMS in responding to these issues is subject to debate. The major external issues include:

- the volatile job market for mathematicians,
- the renewal of the profession by ensuring sufficient and qualified enrollments in mathematics at the collegiate and graduate levels,
- mathematics education reform at all levels,
- national public policy development in support of the sciences generally and of mathematics specifically,
- creating, in the broader social context, a more positive image of mathematics and mathematicians.

Strategic Issue #5: Vitality of the Mathematics Profession

Many interviewees and the members of the Strategic Planning Task Force believe that the AMS should give priority to supporting the vitality of the mathematics profession and play a lead role in addressing access, recruitment and retention aspects of this issue.

Strategic Issue #6: Fragmentation of the Mathematics Community

Fragmentation of the mathematics community generally complicates the definition of the AMS' role in the resolution of issues confronting the profession. Additionally, the image of the AMS in the broader mathematics community is sometimes a barrier to productive working relationships.

Strategic Issue #7: Membership, Voluntary Leadership, and Governance

AMS does not effectively and efficiently use its available voluntary leadership nor does it have in place an effective strategy to extend opportunities to the broader membership to become voluntary leaders and enhance their participation and commitment to the AMS.

Strategic Issue #8: Internal Management of the AMS

The internal structure of the AMS management and operations needs to be reconsidered from the point of view of improving interactions, both internally and with the membership and voluntary leadership.

IV. The Strategic Planning Process

A. Definitions

The **mission** statement of an organization describes its permanent purpose in terms of its various constituencies, its aspirations for those constituencies, and the values to be exchanged with them. A **constituency** is any entity or group of individuals which interact with the organization. The **key** constituencies are those charged with the responsibility for leading and maintaining the society. **Select** constituencies are those from which the key are derived; all others are **mass**. These three groups of constituents form the life-blood of the organization and the basis of its strength.

The **resource audit** provides an inventory, based on a broad review, of the organization's internal and external environment and its existing and available resources, material as well as human.

The **vision** statement of a strategic plan interprets the organization's mission in terms of contemporary issues, providing the bridge between mission and the five year goals. **Goals** for the five year period are measurable and attainable and relate directly to the mission of the organization. **Objectives** are the tangibles associated to those goals, and **strategies** describe the routes to realizing the objectives.

B. Resource Audit

The purpose of the resource audit, besides that of providing information, was to involve a broad and representative group of individuals in the planning process at its initial stages. This audit reviewed the Society's programs and services, organizational structure, operations, environment, and revenue and included the following elements:

(1) Broad involvement of the AMS voluntary leadership and staff

- personal one hour interviews by a member of the facilitating team with 39 members of the AMS or representatives of external constituencies,
- a targeted questionnaire sent to another 120 representatives of the same constituencies as above which provided 61 responses,
- a questionnaire, developed for 1200 randomly selected members, which produced more than 500 responses,
- interviews by the facilitators with the directors and program managers in Providence and Ann Arbor, and reports from two staff retreats;

(2) Assessment of resources

- based on audited financial statements, By-Laws, and other materials provided by the Executive Director as well as on discussions with the SPTF;

(3) Understanding and stratification of the AMS constituencies

- see section IV.C below;

(4) Identification of major Strategic Issues

- Numerous specific contemporary issues were identified using the resource audit, interviews and returned questionnaires, and prior discussions of ECBT and LRPC. These were identified, summarized and synthesized by the facilitators into eight distinct "strategic issues." These are listed in section III.

Steps (3) and(4) were completed during the first two meetings of the SPTF and were based on a summary of the data obtained as described in section (1) above. This process led to a clarification of the AMS mission, a vision statement for the coming five-year period, and the development of goals, objectives, and strategies.

C. Stratification of Constituencies

Mass	Select	Key
INDIVIDUAL:		
Non-member mathematicians	Continuing members	Council
Previous members	Past council members	Board of Trustees
New members	Committee members	AMS staff
Graduate students	Invited speakers	Officers
Mathematics educators	Reviewers/referees	AMS editors
Other scientists	Prize winners	Members of key committees
Occasional customers	Regular customers	Major donors
Media specialists	Donors	
INSTITUTIONAL:		
Book distributors & book stores	Libraries	Research institutes
Publishers	Academic inst./ research depts.	Funding agencies
Congress	Employers of mathematicians	Employers of research mathematicians
High schools & 2-year colleges	NRC	Select foundations
Most foundations & corporations	Most mathematics organizations	MAA
Non-mathematical professional organizations		SIAM
		BMS

V. The Mission of the American Mathematical Society

The AMS, founded in 1888 to further the interests of mathematical research and scholarship, serves the national and international community through its publication, meetings, advocacy and other programs, which

* promote mathematical research, its communication and uses,

* encourage and promote the transmission of mathematical understanding and skills to ensure the continued vitality of the profession,

* support mathematical education at all levels,

* advance the status of the profession of mathematics, encouraging and facilitating full participation of all individuals,

* foster an awareness and appreciation of mathematics and its connections to other disciplines and everyday life.

VI. The Vision Statement

Over the past few decades, the discipline of mathematics and the mathematical profession have experienced many rapid changes which have far-reaching implications for the profession. These changes pose challenges to the mission of the AMS in terms of:

- efficient dissemination of an explosive volume of information to an increasingly heterogeneous audience,
- interdisciplinary links between mathematicians and users of mathematics,
- mathematics education in general, with special emphasis on the participation of underrepresented groups,
- recruitment, retention, employment, and professional advancement of mathematicians,
- public awareness of the role of mathematics and its importance in science and society.

The AMS must respond thoughtfully and effectively to these challenges in order to fulfill its mission. Over the next three years the Society will:

- articulate and advocate an agenda for the coming decade to provide the resources for the mathematical research enterprise, in terms of funds, time, and communications,
- position the publications program for growth and response to change.
- make mathematicians more aware of the importance of activities which contribute to mathematics education and

the contributions which can be made by the research community. Increase the involvement of mathematicians in these activities and facilitate the transfer of mathematical knowledge to other disciplines and to industry,

- enhance the participation of underrepresented groups in disciplines with a strong mathematical component. Promote the involvement of the diverse membership in the development and delivery of AMS programs and services,
- promote public awareness and advocate the advancement of mathematics through an understanding of the benefits of the study and application of mathematics,
- renew AMS organization, management, and governance to optimize use of its resources and its ability to identify and respond to current and emerging needs.

The actions undertaken to achieve these goals will contribute to the continued vitality of mathematics and the mathematical profession. Their realization will enhance the impact the AMS has on its membership and other constituencies. The next section amplifies these goals in the form of measurable objectives which can be attained in the next three to five years, together with potential strategies which emerged with strong support during our discussions.

VII. Goals and Objectives

I. Goal

Articulate and advocate an agenda for the coming decade to provide the resources for the mathematical research enterprise, in terms of funds, time and communication.

Objective 1
To achieve levels of academic and agency support which provide all entrants into the profession opportunities to develop their skills and talents and realize lifelong professional development.

Objective 2
To dampen the effects of wide fluctuations in the job market on mathematics and mathematicians.

II. Goal

Position the publications program for growth and response to change.

Objective 1
To structure the publication program to achieve the stated goal while maintaining a strong financial position.

Objective 2
To address a wide range of subject matter—research, applications, exposition—at all levels, and communicate with the broadest possible audience: mathematicians, scientists, the general public.

Objective 3
To improve communication and clarify the relationship between the staff and editorial committees.

Objective 4
To obtain an accurate benefit analysis of various options in electronic publishing and other new communications technologies in order to proceed with a viable program.

III. Goal

Make mathematicians more aware of the importance of activities which contribute to mathematics education, and those contributions which can be made by the research community. Increase the involvement of mathematicians in these activities and facilitate the transfer of mathematical knowledge to other disciplines and to industry.

Objective 1
To provide increased opportunities for professional interaction and exchange of information among research mathematicians, mathematics teachers, and others involved in mathematics education.

Objective 2
To create an ethos in which research mathematicians are encouraged to become and remain engaged in creative and effective undergraduate and graduate teaching.

Objective 3
Increase awareness of the contributions mathematicians can make in industrial research, and, in turn, to inform the mathematics community of the opportunities and expectations in industrial research.

Objective 4
To make graduate students aware of the educational and pedagogical issues they are likely to face as teachers of undergraduate and graduate mathematics.

IV. Goal

Enhance the participation of underrepresented groups in disciplines with a strong mathematical component. Promote the involvement of the diverse membership in the development and delivery of AMS programs and services.

Objective 1
To increase opportunities for informal interaction and communication in the membership and to develop mechanism which enable broad and effective membership participation.

Objective 2
To establish, in collaboration with MAA and MSEB, mechanisms for communicating information about programs that improve the performance and the representation of women and underrepresented minorities in undergraduate and graduate mathematical sciences education.

Objective 3
To explore ways to improve the rate at which women and underrepresented minorities advance from undergraduate studies to graduate studies, and from graduate studies to successful research careers.

Objective 4
To create vehicles for nurturing research activity of newly established women and underrepresented minority mathematicians.

Objective 5
To develop a coordinated plan of annual, summer, and sectional meetings addressing broad and timely scientific, educational, interdisciplinary, and professional issues.

V. Goal

Promote public awareness and advocate the advancement of mathematics through an understanding of the benefits of the study and application of mathematics.

Objective 1
To establish a "Washington presence" for the Society which interfaces effectively with policy-makers, funding agencies, and offices of other mathematical organizations and advocates adequate and appropriate funding for scholarship and research.

Objective 2
To work towards appropriate science media coverage for mathematics, and to develop mutually fruitful interactions between mathematicians and the media.

Objective 3
To establish a Board-approved development plan to assist AMS in pursuing goals and programs consistent with its mission.

VI. Goal

Renew AMS organization, management, and governance to optimize use of its resources and its ability to identify and respond to current and emerging needs.

Objective 1
To create an organizational structure for AMS, comprising both management and governance, with clear lines of reporting and communication.

Objective 2
To adopt a plan for a management and staff structure that continuously evaluates and improves AMS products and services and enables the Society to fulfill its mission and goals.

Objective 3
To develop an effective, efficient governance which is comprehensive, responsive, responsible and has clear and open lines of communication with management and staff.

VIII. Strategies

This is where the report of the SPTF ends. While the preceding sections comprise those items on which we reached consensus during our meetings, what follows is more speculative and tentative.

The SPTF discussions inevitably brought to the surface many ideas for specific strategies for pursuing the goals and objectives the Task Force identified. We felt that communicating the full range and flavor of our discussions necessitated some description of these ideas. However, it is important to bear in mind that this section does not represent an agenda which the SPTF expects the Society to pursue in every detail. Rather, it contains "raw material" from which some workable strategies may be culled, refined, prioritized, and evaluated in terms of cost and effectiveness. The last section will recommend a process for approaching this task.

In this section, each strategy is preceded by the number of the corresponding Objective from Section IV.

I. Goal

Articulate and advocate an agenda for the coming decade to provide the resources for the mathematical research enterprise, in terms of funds, time and communication.

Objective 1
To achieve levels of academic and agency support which provide all entrants into the profession opportunities to develop their skills and talents and realize lifelong professional development.
Strategies:

A. Impress upon research institutions and universities the significance of "small" science in the entire research enterprise by means of the Chair's symposia and through the influence of the many mathematicians in academic administration.

B. Communicate the value and impact of innovative and exploratory research by means of the Washington Office, the Public Information Office and Congressional liaisons.

Objective 2
To dampen the effects of wide fluctuations in the job market on mathematics and mathematicians.
Strategies:

A. On the basis of available and new data, the AMS can, in collaboration with other organizations, make an informed prediction of the long range employment dynamics for the profession. Then other strategies can be advocated as appropriate, for example: increased levels of research support for new faculty (in addition to full research postdoctorates) can be useful in retention as well as modulation of the job market.

B. Through its advocacy and publicity, the AMS can help create an atmosphere which facilitates the mathematical endeavor. For example, encouraging universities to offer jobs to new faculty with a several year commitment, and an explicit provision for research and scholarship.

II. Goal

Position the publications program for growth and response to change.

Objective 1

To structure the publication program to achieve the stated goal while maintaining a strong financial position.

Strategies:

A. Examine the current production system very carefully and adapt it to meet the changing needs of authors and customers. Take advantage of new technologies and management techniques to produce timely and cost-effective publications. Costs must be separated and various options compared, for example, in-house vs. outside costs of print, composition, etc.

B. Expansion of journals should be structured so that publications pay for themselves. There should be no more new translation journals.

C. Enhance the Society's publication program through a coordinated acquisitions effort in both traditional and electronic media, for example:

- expand book publication, but not too quickly.
- develop an comprehensive marketing and distribution system so that the AMS can compete effectively with commercial publishers. There should be no internal subsidy; the goal is to increase revenues, not to redistribute them.

D. Acquisition editors must recruit new authors aggressively for expository writing, and the AMS must establish values to make this successful.

E. Obtain an effective benefit analysis for various options in electronic publishing and other new technologies of communication in order to proceed with a viable program.

Objective 2

To address a wide range of subject matter—research, applications, exposition at all levels, and communicate with the broadest possible audience: mathematicians, scientists, the general public.

Strategies:

A. Examine the possibility of establishing an expository journal aimed at a wide range of people - graduate students and all scientists. These articles should be understandable to all who want to learn. Using existing journals for this purpose is not a solution.

B. The *Bulletin* provides the mathematical community with timely reports on current publications, in the form of survey articles, research announcements and reviews of books. Editors should solicit more survey articles so that all major areas of current research are periodically covered.

C. See 1C. and 1D.

Objective 3

To improve communication and clarify the relationship between the staff and editorial committees.

Strategies:

A. Bring chief editors and chair of EBC to Providence to understand the entire publication operation, and to meet and discuss issues with staff. This should be done on a regular basis. Assign appropriate staff to editorial boards to act as liaison between editors and production. Include all editorial boards.

B. Streamline the acquisitions process. A very small editorial board should be empowered to sign off on manuscripts for books quickly. Quality is very important but one must be able to move and make decisions with a minimum of red tape.

C. Find a means for evaluating and replacing editors who are not effective.

Objective 4

Obtain an accurate benefit analysis of various options in electronic publishing and other new communications technologies in order to proceed with a viable program.

Strategy:

Do the analysis detailed in Objective 2, Strategy 1 for electronic publishing.

III. Goal

Make mathematicians more aware of the importance of activities which contribute to mathematics education, and those contributions which can be made by the research community. Increase the involvement of mathematicians in these activities and facilitate the transfer of mathematical knowledge to other disciplines and to industry.

Objective: 1

To provide increased opportunities for professional interaction and exchange of information among research mathematicians, mathematics teachers, and others involved in mathematics education.

Strategies:

A. Publicize the extensive activities of other organizations, such as MAA, NCTM, MSEB in mathematics education and programs already under way and encourage support of, and participation in, these activities and programs.

B. Develop an AMS Speakers' Bureau with widespread participation and regional components that will coordinate and organize events in which there can be meaningful mathematical interaction between high school students, teachers and research mathematicians.

C. Include School teachers and others involved in mathematics education in programs and social events at AMS meetings.

D. Pursue strategies A, B and C in synchrony with other organizations; for example joint sponsorship at AMS-MAA meetings, in order to amplify (rather than borrow) AMS, SIAM, WAM and AWM Speaker's Bureaus, replicating models of "High School Days", "Expanding Your Horizons", etc.

Objective 2

To create an ethos in which research mathematicians are encouraged to become and remain engaged in creative and effective undergraduate and graduate teaching.

Strategies:

A. Underscore the importance of such activity by devoting time to the discussion of issues in undergraduate education at national meetings, by encouraging symposia and conferences devoted to such issues, and by publicizing the participation of research mathematicians in such activity.

B. In collaboration with other professional organizations, prepare and disseminate packages which help repeat the success of programs that:

- retain minority students in mathematics (at all levels),
- nurture creative uses of computation in mathematical exploration,
- foster undergraduate research,
- convert specific courses from lecture-based to experiment motivated learning, etc.

C. Study the feasibility of starting a new journal, possibly in collaboration with the MAA and SIAM, dealing with issues in mathematics education.

Objective 3
Increase awareness of the contributions mathematicians can make in industrial research, and, in turn, to inform the mathematics community of the opportunities and expectations in industrial research.
Strategies:

A. Prepare a brochure describing examples of fruitful contributions to interdisciplinary research by mathematicians. Establish a mechanism which enables it to reach scientific research managers in industry on a continuing basis.

B. Collaborate with other professional organizations in disseminating information about successful industrial internship programs for mathematics students at all levels. Advocate the increased use of such programs nationally.

C. Encourage links between industry, other disciplines and research mathematicians by scheduling events at which these diverse types of participants can exchange ideas at meetings and symposia.

Objective 4
To make graduate students aware of the educational and pedagogical issues they are likely to face as teachers of undergraduate and graduate mathematics.
Strategies:

A. Advocate attention to this aspect of a graduate student's training. Disseminate information about the experience of different graduate departments concerning discussion of these practical professional issues in their programs.

B. Provide opportunities for the exchanging of experiences with endeavors of this type at meeting (e.g. a gathering of graduate directors and graduate students from various research universities.)

IV. Goal

Enhance the participation of underrepresented groups in disciplines with a strong mathematical component. Promote the involvement of the diverse membership in the development and delivery of AMS programs and services.

Objective 1
To increase opportunities for informal interaction and communication in the membership and to develop mechanisms which enable broad and effective membership participation.
Strategies:

A. Enhance the educational quality of meetings by encouraging student participation and by developing programs directed toward students.

B. Strengthening the sectional structure of the AMS. This will increase the number of members in program development, and give more AMS programs a regional flavor.

Objective 2
To establish, in collaboration with MAA and MSEB, mechanisms for communicating information about programs that improve the performance and the representation of women and underrepresented minorities in undergraduate and graduate mathematical sciences education.
Strategies:

A. Devise mechanisms such as instructional kits (including texts as well as step-by step manuals), and develop special workshops which convey the elements of successful programs.

B. Create a Committee on Minority Participation in Mathematics to cooperate with other organizations in advocating support programs for minority students and awareness programs for educators.

Objective 3
To explore ways to improve the rate at which women and underrepresented minorities advance from undergraduate studies to graduate studies, and from graduate studies to successful research careers.
Strategy:

Disseminate data and information on successful programs and ways for improving them in collaboration with other organizations. Provide workshops on overcoming gender and other cultural biases.

Objective 4
To create vehicles for nurturing research activity of newly established women and underrepresented minority mathematicians.
Strategy:

Establish a program, in the spirit of the NSF Postdoctoral Program, where successful applicants in their first few years as an instructor can intern with a leading mathematical scientist in the research area of interest.

V. Goal

Promote public awareness and advocate the advancement of mathematics through an understanding of the benefits of the study and application of mathematics.

Objective 1:
To establish a "Washington presence" for the Society which interfaces effectively with policy-makers, funding agencies, and offices of other mathematical organizations and advocates adequate and appropriate funding for scholarship and research.
Strategies:

A. Found an AMS office in Washington for advocacy and contact.

B. Develop a list of contacts/acquaintances between mathematicians and legislatures, and reinforce these with contacts at the staff level with the AMS Washington office.

C. Reconsider participation in the congressional fellow program.

D. Create a resource pool of people and material which can readily provide information, analyses of data, views of the mathematical community, interpretations of research, trends, events, for Congress, funding agencies, and other organizations.

Objective 2
To work towards appropriate science media coverage for mathematics, and to develop mutually fruitful interactions between mathematicians and the media.
Strategies:

A. Support the Washington public information program.

B. Develop a resource pool, for the Public Information Office, of skilled communicators with the media.

C. Create training programs for mathematicians, and for media people in expressing mathematical ideas and results to the general public. These may have diverse forms such as:

- workshops for mathematicians and the media,
- presentations at AMS meetings,
- internships for prospective science writers.

D. Work with MAA and SIAM (i.e., through JPBM) in carrying out Strategies A, B, and C.

Objective 3
To establish a Board-approved development plan to assist AMS in pursuing goals and programs consistent with its mission.
Strategy:
A. Identify and develop volunteer leadership to act as a catalyst to fundraising plans.

VI. Goal

Renew AMS organization, management, and governance to optimize use of its resources and its ability to identify and respond to current and emerging needs.

Objective 1
To create an organizational structure for AMS, comprising both management and governance, with clear lines of reporting and communication.
Strategies:
A. Define specific roles and responsibilities for all elected and appointed officials of the Society.
B. Establish staff liaisons/support for appropriate committees and volunteer activities.
C. Support staff as they carry out Society policy.
D. Carry out Strategies A, B and C so that new or revised management and governance structures evolve together and can be effectively interlaced.

Objective 2
To adopt a plan for a management and staff structure that continuously evaluates and improves AMS products and services and enables the Society to fulfill its mission and goals.
Strategy:
A. Perform a management study, with the assistance of an external team, to propose such a plan.

Objective 3
To develop an effective, efficient governance which is comprehensive, responsive, responsible and has clear and open lines of communication with management and staff.
Strategies:
A. Develop a format for efficient and effective decision making within and between the Council, Executive Committee and the Board of Trustees.
B. Develop a more efficient and effective committee structure.
C. Create a process, at the local level, for identifying and recruiting new volunteers. This process should involve existing regional structures (e.g., associate secretaries and program committees).
D. Develop and execute a training program for newly elected/appointed officers.

IX. Next Steps

The Task Force views this report as defining directions for AMS over the next five or so years consistent with the Society's mission statement. We recognize that pursuing these directions is a substantial undertaking which must proceed in an evolutionary way, coupled with full and open discussion. Acceptance of this report by the Board of Trustees and Executive Committee of the Council (ECBT) is the beginning of this process. Considering the issues currently facing AMS, we urge that the ECBT move at once to form an operational plan leading to implementation of the recommendations of this report.

It is essential that the Board of Trustees work closely with the Executive Staff in further developing this plan. We therefore recommend that the ECBT, upon acceptance of this report:

1. authorize its publication so as to stimulate discussion among the membership,
2. place it on the information calendar of the August meeting of the Council of the AMS for elucidation and discussion,
3. transmit it to the Senior Executive Staff and Managers and through them to all the Staff, as a document, initiated and endorsed by the Board, representing the renewed purpose of the Society and the strategic directions it will take in the next three to five years,
4. charge the AMS management and staff to implement a feasible, effective plan of operation. This operating plan should include an analysis of the viability of objectives and their strategies, based on resources, and should provide timelines. It is to be presented to the ECBT at its November, 1991 meeting, at which time action items can be derived and transmitted as appropriate for prioritization and implementation,
5. charge the Long Range Planning Committee (presumably at the November Board meeting) to take up the question of monitoring and assessing progress toward attaining these goals, and then,
6. in collaboration with the AMS Executive Staff, start the implementation of the operational plan by referring specifics to staff, committees, and the Council, as appropriate.

This report puts AMS in a position to reorganize its approach to emerging issues in the near future, as well as over the long term. It provides an opportunity to initiate a continuous improvement program based on a concept of teamwork, to break down functional barriers, and to encourage cooperation across department and divisional lines. Above all, it is a framework for action over the next five years that should be considered, not as a set of stone tablets, but as a flexible, working outline for progress.

Reduced Subscription Rate on New Journal

As a service to its members, the Society has made an arrangement with the publishers of the new journal *Experimental Mathematics* for a reduced subscription rate. Details were recently sent to all members with their dues notification. Dedicated to the publication of experimental

work in mathematical research which is intended to develop mathematical theory and insight, *Experimental Mathematics* will also attempt to help in the development of standards for the reporting of experimental results in mathematics such as those which already exist for other experimental sciences. Interested members who may have misplaced the special order card may contact the AMS Membership Manager, Carol-Ann Blackwood, at 800-321-4AMS (from within the U.S. and Canada) or via email at amsmem@math.ams.com.

e-MATH Initiatives

The e-MATH development effort is now being directed towards implementing applications that demonstrate the usefulness of electronic communication in scholarly research and publishing. Work is proceeding on the following initiatives:

- a selection that opens an e-MATH connection to "Archie", the searcheable database of nearly 650 software archive sites developed and maintained by the School of Computer Science at McGill University.
- the electronic distribution of the *Bulletin of the American Mathematical Society*, in TEX and Postscript format, beginning with the 1992 issue year.
- a look-up application for authors appearing in the publications *Mathematical Reviews* and *Current Mathematical Publications* that returns the *MR* review number and the *CMP* volume and issue for recent items or index-only citations.
- the installation of two conferencing systems, UNIX NEWS and CONFER, that would allow for moderated and unmoderated conferences; and a register for local, regional, and national meetings of professional interest to mathematicians.
- a selection that opens an e-MATH connection to Yale's IMP (Instant Math Preprints), a database of preprint abstracts that point to the location of an anonymous FTP site from which the preprint paper can be retrieved.
- a prototype electronic journal in the mathematical sciences based on a centralized document database and bi-directional LATEX/SGML processing.

Policy issues raised by some of these initiatives (e.g., IMP, electronic journal) are being reviewed by an e-MATH oversight committee established at the AMS ECBT (Executive Committee and Board of Trustees Meeting) in mid-May. A demonstration version of a number of the new capabilities is anticipated for the Joint Summer Meeting in Orono, Maine.

For further information, or for assistance accessing and using e-MATH services, send email to:

support@e-math.ams.com.

Washington Outlook

This month's column is written by Lisa A. Thompson, who is the Assistant for Governmental Affairs of the Joint Policy Board for Mathematics (JPBM).

Research and the New Policy Environment

Several features distinguish Congressional activity in mathematics and science issues during the first session of the 102nd Congress, not the least of which is the severity of the spending caps imposed by last year's budget agreement. The Budget Enforcement Act, adopted last October after months of stalemate, set annual caps on three categories of discretionary spending: defense, international, and domestic. If a cap is breached, across-the-board cuts are imposed within that category. Changes in taxes and entitlements cannot be used to raise the cap.

Federal domestic discretionary spending in Fiscal Year 1992, for which a budget is now being formulated, was capped at roughly the level budgeted for the current year, FY 1991, in real terms (i.e. adjusted for inflation). Therefore, budget increases for particular programs are allowed only at the expense of other programs.

In light of the real and perceived needs domestic federal programs must address—housing, health, environment, and education to name a few—it becomes difficult to convince the average member of Congress of the necessity of increases for academic research. Given the vigorous growth of basic research budgets in the recent past—about 70 percent during the past decade—pleas for special consideration of science are being met with incredulity. Citations of the number and discomfort of unfunded scientists are easily dismissed by Members of Congress who can point to widespread discomfort among many of their constituencies.

Rep. George Brown (D-CA), Chairman of the Committee on Science, Space, and Technology and science's best friend on Capitol Hill, noted in a speech at the annual meeting of the American Association for the Advancement of Science that Congress no longer views generous federal funding of research as the sacred right of the U.S. scientific community. Revelations about academia's misuse of federal indirect-cost payments and the response of the scientific community to what turned out to be fraudulent science in the Baltimore case have exacerbated this diminishing of Congressional goodwill toward science.

A more encouraging development is the renewed vigor and assertiveness with which the House Science, Space, and Technology Committee is addressing science policy issues. Congressman Brown, in his first year as Chairman, is positioning his committee as a leader in areas under the committee's jurisdiction, including technology, space, and the integrity of science and scientific institutions. Some aspects of these areas also fall within the purview of other committees, and until Brown took over, the science committee exerted relatively little influence in the chamber.

The committee has been and will continue looking broadly at federal research policy, guided by a document recently prepared by the Office of Technology Assessment, Federal Funding of Research: Decisions for a Decade. The document, which is expected to receive serious attention on the Hill, is the first attempt to rigorously characterize the issues involved in setting priorities for research. The report points out that there will always be more opportunities than can be funded by the government, and thus rational policies based on explicit priorities in the context of national goals are necessary.

Pro-science politicians—notably Brown and Presidential Assistant for Science and Technology Allan Bromley—have been telling the research community that it must make an effort to engage Congress on science issues. Furthermore, the scientific community is being admonished to demonstrate that its efforts contribute to the national interest, and in fact, to play a role in formulating science policies that reflect the interests of the nation. In his AAAS speech, Brown urged the scientific community to support technology development efforts, which are the natural outgrowth of scientific progress.

The Executive Branch, too, is engaged in a new mode of activity: the multiagency, FCCSET-coordinated research programs in areas of national interest. (FCCSET, pronounced fixit, is the Federal Coordinating Council for Science, Engineering, and Technology, chaired by Bromley.) FCCSET's interagency committees have examined federal efforts in global change research and in high performance computing and communications. A coordinated budget proposal, describing the roles and levels of funding of the agencies

involved, was prepared for each program, and the appropriate committees continue to coordinate activities in support of each program.

The initiatives typically have a great deal of support on the Hill, and support is critical for programs scattered throughout the executive departments and agencies (and thus the responsibility of more than one Congressional committee). Because spending increases are distributed among several agencies, Congressional appropriations committees are able to fund the programs relatively easily.

Legislation, authorizing the High Performance Computing and Communications (HPCC) program, breezed through House and Senate committees, despite controversy in the Senate over whether the National Science Foundation (NSF) or the Department of Energy (DOE), and thus which committee, would be responsible for establishing the proposed high-speed communications network that is the centerpiece of the program.

The HPCC program, in particular, includes an important role for the mathematical sciences. NSF's Division of Mathematical Sciences will provide $1.6 million in support of the program. The DOE's Office of Energy Research plans to devote $4 million to develop and support the discipline of computational science.

Planning for the ongoing HPCC program is a dynamic process, so there is opportunity for the mathematical sciences community to contribute to its development. Associate OSTP Director Eugene Wong, noting the necessity of the community's involvement in the initiative, invited the Board on Mathematical Sciences to do just that.

New initiatives on materials science and biotechnology are scheduled to be introduced during the start of the next budget process, as federal support for research continues to move toward a thematic approach and away from a disciplinary approach.

While these initiatives provide expanded opportunities for researchers, it is important to keep in mind that the subject areas reflect the priorities of the nation's elected representatives. The mathematical sciences community must involve itself in these initiatives for this reason. The community has recognized its duty to encourage adequate support for mathematics. It now needs to acknowledge its responsibility to ensure that mathematics is sufficiently contributing to the needs of the nation.

The era of severe federal budget constraints is not over. Congress and the Administration will face even tougher fiscal choices next year, not only among scientific endeavors but between science and the broader realm of federal activities as well. It is frustrating to see the support engendered by expensive, high-profile programs, like the Space Station, funded at what appears to be the expense of science. But that does not relieve us of the necessity to demonstrate that a vibrant mathematical sciences enterprise is an essential element of scientific and technical progress and economic growth.

News and Announcements

National Academy of Sciences Elections

At its 128th meeting in April 1991, the National Academy of Sciences announced the election of sixty new members and fifteen foreign associates in recognition of their distinguished and continuing achievements in original research. Election to membership in the Academy is considered one of the nation's highest honors in science. This election brings the current membership to 1626, plus 277 foreign associates.

The Academy is a private organization of scientists and engineers dedicated to the furtherance of science and its use for the general welfare. It was established in 1863 by a congressional act of incorporation, signed by Abraham Lincoln, that calls upon the Academy to act as an official adviser to the federal government in any matter of science and technology.

The following mathematical scientists were elected to the Academy: LUIS A. CAFFARELLI, Institute for Advanced Study; ALEXANDRE J. CHORIN, University of California at Berkeley; and RICHARD M. SCHOEN, Stanford University.

J.-L. Lions Wins Japan Prize

JACQUES-LOUIS LIONS has received the Japan Prize for his work in applied mathematics. The prize of fifty million Japanese yen (approximately $363,350) was presented at a ceremony at the National Theatre in Tokyo on April 25, 1991, that was attended by the Emperor and Empress of Japan and 1000 guests.

During the ceremony, Lions was lauded for "his pioneering and creative research works in the field of the analysis and control of distributed systems, and for his leading contributions to found and promote applied analysis, which is an important part of modern applied mathematics .... As a consequence of his efforts, applied analysis now flourishes worldwide to meet the needs in ... engineering and applied sciences."

Lions gained a reputation early in his career for contributions to the understanding of evolution equations, nonhomogenous boundary value problems, and interpolation spaces. Among Lions' most notable achievements are analysis of linear and nonlinear partial differential equations of mathematical physics; systematic improvement of numerical methods such as the difference method, the finite element method, and the penalty method; introduction of variational inequalities; establishment of the asymptotic method for the homogenization problem; and establishment and development of the control theory of distributed systems governed by partial differential equations. Lions has made many contributions to specific application areas, such as computational aerodynamics, the petroleum industry, and energy research, and some of his recent work has applications to global environmental problems.

Lions was born in 1928 in Grasse, France. After earning academic degrees in 1947 and 1950 from the Ecole Normale Supérieure in Paris, he spent five years at the University of Nancy. He was a professor at the University of Paris from 1963 to 1973, at the Ecole Polytechnique in Paris from 1966 to 1986, and at the Collège de France since 1973. In 1988, he was named Honorary Professor at the Ecole Polytechnique and at the University of Paris. His longtime association with INRIA (National Institute for Research in Information and Automation) began when he became director of research in 1968 and continued with his tenure as president from 1980 to 1984. Currently, he serves as chairman of Analysis and Systems Control at the Collège de France, president of France's National Center for Space Studies, and president of the Scientific Committee of Electricité de France. In addition, he will serve as president of the International Mathematical Union (1991-1994).

Lions has received several prizes from the French Academy of Sciences, including the Grand Prix Cognac Jay, with L. Schwartz and B. Malgrange, in 1970. He was an invited lecturer at the International Congress of Mathematicians (1958, 1970, 1974) and at the International Mathematical Union in Moscow (1972), and he presented the John von Neumann Lecture of the Society for Industrial and Applied Mathematics (1986). He has received a number of honorary doctorates and is a member of several scholarly societies worldwide.

The other Japan Prize recipient this year is John Julian Wild of the Medico-Technological Research Institute in Minneapolis, who was honored for contributions to imaging techniques in medicine. The Japan Prize, begun in 1985 and awarded annually, is intended to recognize individuals who have served the cause of peace and prosperity for mankind through original and outstanding achievements in science and technology.

Bergman Prize Awarded to Bell and Ligocka

Steve Bell of Purdue University and Ewa Ligocka of the Polish Academy of Sciences have been named as the second awardees of the Stefan Bergman Trust. The trust, established in 1988, recognizes mathematical accomplishments in the areas of research in which Stefan Bergman worked. The two awardees will share the prize fund of $20,000 per year for two years.

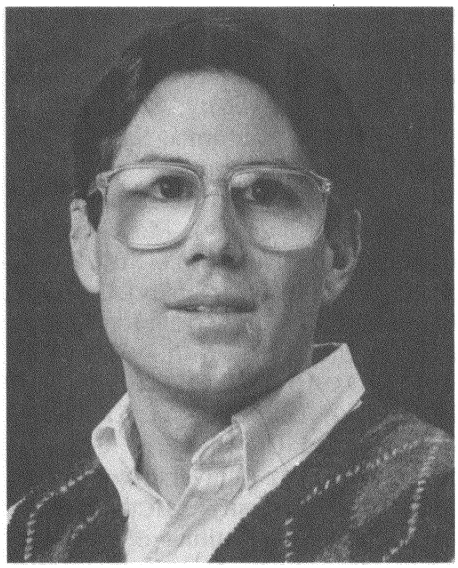
Stefan Bergman is best known for his research in several complex variables and the Bergman projection and the Bergman kernel function which bear his name. A native of Poland, he taught at Stanford University for many years and died in 1977 at the age of 78. He was an AMS member for 35 years. When his wife died, the terms of her will stipulated that funds should go toward a special prize in her husband's honor.

The AMS was asked by Wells Fargo Bank of California, the managers of the Bergman Trust, to assemble a committee to select recipients of the prize. In addition, the Society assisted Wells Fargo in interpreting the terms of the will to assure sufficient breadth in the mathematical areas in which the prize may be given. Awards will be made every two years in the following areas: 1) The theory of the kernel function and its applications in real and complex analysis; 2) Function-theoretic methods in the theory of partial differential equations of elliptic type with attention to Bergman's operator method.

The committee awarding the prize to Bell and Ligocka consisted of Frederick J. Gehring, J. J. Kohn (chair), and Halsey Royden. The citation for the prize reads: "With their joint paper, 'A simplification and extension of Fefferman's theorem on biholomorphic mappings' (*Inventiones Math.*, **57**, 283-289 (1980)), Bell and Ligocka opened a new and fertile area of research. In the theory of one complex variable, the Bergman kernel has been used to study conformal mappings since the 1930s. On strongly pseudo convex domains, Fefferman developed a detailed analysis of the Bergman kernel and using this together with some very intricate differential equation techniques proved that a biholomorphic mapping between two such domains extends smoothly to the boundary. The result of Bell and Ligocka is that the same conclusion holds whenever the domains satisfy condition R. A domain satisfies condition R whenever the Bergman projection for the domain takes smooth functions with compact support to smooth functions. This result leads to far reaching generalizations to classes of domains which are not strongly pseudo convex and to proper holomorphic mappings. Since the publication of the seminal paper discsussed above, both Bell and Ligocka have made important contributions to the study of the Bergman kernel and of holomorphic mappings."

What follows is a biographical sketch of Steve Bell. *Notices* has been unable to obtain biographical information about Ewa Ligocka, but will publish her biographical sketch as soon as the information is available.

Steve Bell was born in Ypsilanti, Michigan in 1954. He received his B.S. in 1976 from the University of Michigan and his Ph.D. in 1980 from the Massachusetts Institute of Technology. His thesis, under the direction of Norberto Kerzman, was entitled "Applications of the Bergman projector in the theory of functions of several complex variables."



Steve Bell

Bell was a research associate and lecturer at MIT before moving to Princeton University, where he held positions as visiting fellow (1980-1981), instructor (1981-1982), assistant professor (1982-1984), and visiting associate professor (1984-1985). In 1984-1985, he also held a position as associate professor at Purdue University. At Purdue, he was promoted to associate professor in 1985 and to his current position as professor in 1988. Bell also held a visiting associate professorship at the Université de Bordeaux (May 1987).

His awards and honors include Distinguished Achievement in Applied Mathematics, University of Michigan (1975); Distinguished Scholar Award, University of Michigan (1976); a National Science Foundation Postdoctoral Fellowship (1980); a Sloan Fellowship (1984); and an AMS Centennial Research Fellowship (1988). He has been an invited speaker at many national and international conferences, including the AMS meeting in Indianapolis (April 1986), where he presented a one-hour invited address, and the AMS Summer Research Institute on several complex variables (July 1989). He has also presented numerous colloquium and invited lectures at various universities.

Bell's more than forty-five publications have focused on complex variables and partial differential equations.

NSF Announces Mathematical Sciences Postdoctoral Research Fellowships

The Division of Mathematical Sciences of the National Science Foundation (NSF) has offered Mathematical Sciences Postdoctoral Research Fellowships to 31 recent recipients of doctoral degrees in the mathematical sciences.

"It is critical that there be a continuing influx of young mathematical scientists possessing the advanced training and talent needed to contribute to the future vitality of the scientific effort of the nation," said Judith Sunley, NSF division director for mathematical sciences.

As researchers in the mathematical sciences expand their interactions with other disciplines, and as the interplay increases between the various areas of mathematics itself, opportunities for

postdoctoral research and training become increasingly important.

The Fellowship Program helps to provide these opportunities and serves to focus attention on this much-needed cross-disciplinary fertilization throughout the broad mathematical sciences community.

Awards are made to U.S. citizens or nationals based on their demonstrated ability and on the significance of the career improvement the fellowship would potentially provide. The program is designed to allow recipients to choose research environments at host institutions that will have maximal impact on their future scientific development.

A panel of mathematical scientists, chosen by the American Mathematical Society, the Institute of Mathematical Statistics, and the Society for Industrial and Applied Mathematics, evaluated 130 applications. Final selections were made by the NSF.

The stipend of $66,000 provides support for two nine-month academic years and three two-month summers. Each awardee may choose between two options for receiving the academic year support: as full-time support for any eighteen academic year months in a three-year period, in intervals not shorter than three consecutive months (the Research Fellowship Option), or as a combination of full-time and half-time support over a period of three academic years, usually one academic year full-time and two academic years half-time (the Research Instructorship Option).

The 1991 recipients are listed below (institutions in parentheses are the current institutions, those outside the parentheses are those at which the fellowship will be held.) Two of the awards were jointly supported by the Division of Computer and Computation Research at NSF.

ADEBISI AGBOOLA (Columbia University), Mathematical Sciences Research Institute and University of California, Berkeley; JANET BECKER, (University of New South Wales), University of Washington; ANDREA BERTOZZI (Princeton University), University of Chicago; ANTONIA BLUHER (University of California, Los Angeles), University of California, Los Angeles; AVRIM BLUM (Massachusetts Institute of Technology), Carnegie Mellon University; DAVID BUTLER (University of California, Los Angeles), University of Michigan; CHARLES CONLEY (University of California, Los Angeles), Institute for Advanced Study; TODD DRUMM (Brandeis University), Mathematical Sciences Research Institute; NIKAN FIROOZYE (Institute for Mathematics and Its Applications), Institute for Mathematics and Its Applications; CHRISTOPHE GOLÉ (ETH), Stanford University and State University of New York at Stony Brook; IVO HERZOG (University of California, Irvine), Brandeis University; PAUL KIRK (California Institute of Technology), Indiana University; GREGORY KUPERBERG (University of California, Berkeley), University of California, Berkeley; ROBERT KUSNER (University of Massachusetts), Rice University; MICHAEL LACEY (Indiana University), Indiana University; MICHAEL LASKOWSKI (University of Maryland), University of Illinois at Chicago; GAIL LETZTER (Wayne State University), Massachusetts Institute of Technology; JAMES LEWIS (California Institute of Technology), Mathematical Sciences Research Institute; MARK LOW (University of California, Berkeley), Stanford University; WILLIAM MCGOVERN (University of Washington), University of Washington; KEITH PROMISLOW (Indiana University), Pennsylvania State University; ARUN RAM (University of California, San Diego), Massachusetts Institute of Technology; WILLIAM RICHTER (Massachusetts Institute of Technology), Massachusetts Institute of Technology; DANIEL ROCKMORE (Columbia University), Columbia University; HAL SADOFSKY (Johns Hopkins University), Northwestern University; DAVID SEETAPUN (Cambridge University), University of California, Berkeley and University of Chicago; EDWARD SHPIZ (University of Michigan), Tufts University; MICHAEL SIEGEL (California Institute of Technology), Ohio State University; SETH STAFFORD (Cornell University), Northwestern University; DAVID ZUCKERMAN (University of California, Berkeley), Massachusetts Institute of Technology; and KEVIN ZUMBRUN (State University of New York at Stony Brook), Princeton University and State University of New York at Stony Brook.

Information about the NSF Mathematical Sciences Postdoctoral Research Fellowship Program for 1992 appears in the Funding Information for the Mathematical Sciences section of this issue of *Notices*.

Sloan Awardees Announced

Eighty-nine outstanding young individuals engaged in research in physics, chemistry, mathematics, neuroscience, and economics will receive Sloan Research Fellowships from the Alfred P. Sloan Foundation.

More than 500 nominations for the 1991 awards were reviewed by a committee of distinguished scientists. The awardees were selected on the basis of their exceptional promise to contribute to the advancement of knowledge. Candidates for the fellowships are nominated by department chairs and other senior scholars familiar with the nominees' talents.

The Sloan Fellowships were established in 1955 as a means of encouraging research by young scholars at a time in their careers when other support is difficult to obtain. The grants of $30,000 each for a two-year period are administered by the fellows' institutions. Once chosen, the fellows are free to pursue whatever lines of inquiry interest them and to use the funds in a wide variety of ways to further their research aims. To date, the Sloan Foundation has spent nearly $58 million for support of over 2600 researchers.

This year's group of awardees includes twenty in the mathematical sciences: HUAI-DONG CAO, Columbia University; GUI-QIANG CHEN, University of Chicago; EZRA GETZLER, Massachusetts Institute of Technology; AIMO HINKKANEN, University of Illinois, Urbana-Champaign; SHELDON KAMIENNY, University of Arizona; MIKHAIL LYUBICH, State University of New York at Stony Brook; OLIVIER MATHIEU, Rutgers University; RAFE MAZZEO, Stanford University; GEOF-

FREY MESS, University of California at Los Angeles; KIERAN G. O'GRADY, Columbia University; CARLOS T. SIMPSON, Princeton University; BERND STURMFELS, Cornell University; EVA TARDOS, Cornell University; JEREMY T. TEITELBAUM, University of Illinois at Chicago; ABIGAIL THOMPSON, University of California at Davis; GANG TIAN, State University of New York at Stony Brook; MICHAEL WOLF, Rice University; ZHOUPING XIN, New York University; HORNG-TZER YAU, New York University; and MACIEJ ZWORSKI, Harvard University.

NSF Graduate Fellowships Announced

The National Science Foundation (NSF) has announced the names of 950 students who have been offered fellowships for graduate study in the natural and social sciences, mathematics, and engineering.

The NSF Graduate Fellowships provide a stipend of $14,000 per year for three years of full-time graduate study, together with an annual cost-of-education allowance in lieu of all tuition and fees at U.S. institutions. The fellowships may also be used over a five-year period to permit students to incorporate teaching or research assistantships into their education. The fellows may attend any appropriate non-profit U.S. or foreign institution of higher education.

Applications were submitted by 7346 students in the nationwide competition. The applications were evaluated by panelists assembled by the National Research Council and were awarded by the NSF on the basis of merit. Awards were made in all fifty states, the District of Columbia, and Puerto Rico. Nearly four hundred went to women.

The awards include fifty-four in the mathematical sciences and forty-five in computer science. The recipients in the mathematical sciences are listed below, together with their baccalaureate institutions (in parentheses) and the institutions where they will pursue their graduate studies.

DONALD ALLERS (Pomona College), University of Washington; JAY AUSTIN (California Polytech State University), Cornell University; JENNIFER BEINEKE (Purdue University), University of California, Los Angeles; NICHOLAS BENNETT (University of the South), Princeton University; DANIEL BERNSTEIN (New York University), University of California, Berkeley; MARIANNE BITLER (Pennsylvania State University), University of Minnesota; TIMOTHY CHOW (Princeton University), University of California, Berkeley; DAVID COHEN (Yale University), Brown University; ANDREAS COPPI (Massachusetts Institute of Technology), University of Chicago; WILLIAM CROSS (California Institute of Technology), University of Chicago; BRIAN CURTIN (Ripon College), University of Illinois, Urbana-Champaign; GEORGE DONOVAN (University of Denver), Stanford University; TOBIN DRISCOLL (Pennsylvania State University), Brown University; JONATHAN DUSHOFF (University of Pennsylvania), Cornell University; CAROL FAN (Pomona College), Cornell University; JONATHAN FARLEY (Harvard University), University of Oxford; BRUCE FISCHER (Stanford University), Harvard University; KEVIN FORD (California State University, Chico), University of Illinois, Urbana-Champaign; BRENDA GENET (Calvin College), University of Texas, Austin; ROBERT GHRIST (University of Toledo), Cornell University; DEBORAH GOLDMAN (Massachusetts Institute of Technology), Harvard University; TODD GRAVES (Michigan State University), Stanford University; CHARLES HEILIG (University of Florida), University of Wisconsin, Madison; MATTHEW HUDELSON (University of Washington), University of Washington; TEMPIE HULBERT (Indiana University), University of Michigan; HELEN KIM (Texas A&M University), University of Illinois, Urbana-Champaign; ZEPH LANDAU (Harvard University), University of California, Berkeley; BRENDON LASELL (California Institute of Technology), University of Chicago; JOHN LOFTIN (Stanford University), Harvard University; MICHAEL MALTENFORT (Cornell University), University of Chicago; MARTIN MOHLENKAMP (University of Notre Dame), Brown University; MIRIAM MYJAK (Seattle University), University of California, Berkeley; MICHAEL NAKAMAYE (Gonzaga University), Yale University; JÈANNE NIELSEN (Duke University), Harvard University; RAHUL PANDHARIPANDE (Princeton University), Harvard University; DAVID PERRY (University of Wisconsin, Madison), University of Wisconsin, Madison; MARK PRINDIVILLE (University of Pennsylvania), Stanford University; ERIC RAINS (Case Western Reserve University), Harvard University; ADIL SANAULLA (Trinity College), University of Chicago; ADRIAN SCOTT (Rensselaer Polytechnic Instititute), Rensselaer Polytechnic Institute; SCOTT SMEDIRA (Carnegie Mellon University), Cornell University; CHRISTINA SORMANI (New York University), New York University; STEVE SPEER (Arizona State University), University of Arizona; NATHANIEL THURSTON (Reed College), Princeton University; THOMAS TUCKER (Harvard University), Princeton University; ILEANA VASU (Stanford University), Yale University; MARTIN WATTENBERG (Brown University), Harvard University; SUSAN WHITMIRE (Georgia Institute of Technology), Stanford University; University; KIM WHITTLESEY (Princeton University), University of California, Berkeley; ELIZABETH WILMER (Radcliffe College), Princeton University; DAVID WILSON (Massachusetts Institute of Technology), Massachusetts Institute of Technology; JEROME WOLBERT (University of Michigan), University of Cambridge; CHRISTOPHER WOODWARD (Harvard University), Massachusetts Institute of Technology; ITAI ZUKERMAN (Columbia University), University of California, Berkeley.

Mathematical Society of Japan Awards

The Mathematical Society of Japan (MSJ) has announced the recipients of a number of prizes.

The Spring Prize of the MSJ for 1991 was awarded to MORIHIKO SAITO of the Research Institute for Mathematical Sciences, Kyoto University, for his outstanding contribution to the theory of Hodge modules.

The Geometry Prizes of the MSJ for 1991 were awarded to MASARU TAKEUCHI of Osaka University for his outstanding work in symmetric spaces, and to TAKASHI TSUBOI of the University of Tokyo for his outstanding contribution to C^1 foliated structures.

The Inoue Prize for Science was awarded to SHIGEYUKI MORITA of the Tokyo Institute of Technology for his outstanding contribution to the theory of moduli spaces of Riemann surfaces from the topological viewpoint. This prize is awarded annually by the Inoue Foundation for Science to five individuals for outstanding scientific research.

Rollo Davidson Trust

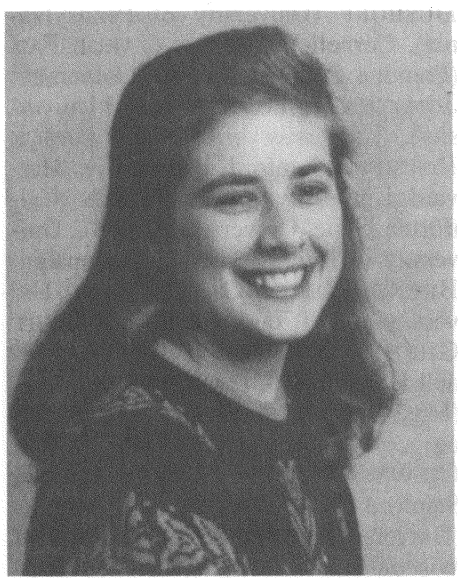
The trustees of the Rollo Davidson Trust have announced the recipient of the 1991 Rollo Davidson Prize. The prize was awarded to ALAIN-SOL SZNITMAN of Eidgenössische Technische Hochschule, Zurich, Switzerland, for his work on the development of chaos in stochastic systems.

AWM Announces Schafer Prize Winner

JÈANNE NIELSEN, a senior at Duke University, was awarded the second annual Alice T. Schafer Mathematics Prize, sponsored by the Association for Women in Mathematics (AWM). Named after Alice T. Schafer, former president and founding member of AWM, the $1000 prize is presented each year to an undergraduate woman in recognition of excellence in mathematics.

ZVEZDELINA STANKOVA, a junior at Bryn Mawr College, was named Runner-Up. The eight Honorable Mentions are: SARAH MARIE BELCASTRO, Haverford College; DEBRA BOUTIN, Smith College; CHERYL GROOD, University of Michigan; KAREN KING, Spelman College; SPERANTA MARCU, Santa Clara University; EDITH MOOERS, University of Washington; JESSICA POLITO, Harvard University; and DIANA THOMAS, University of Montana. In addition, two nominees were given special recognition by the prize committee for outstanding achievements in mathematics early in their careers: YICK CHAN, Barnard College; and MILLIE NISS, Columbia University. There were ninety nominations for the prize, more than twice the number received last year.

Neilsen was described as a "highly original, enthusiastic, and talented young mathematician," and one of the best undergraduate mathematics majors her nominators had seen anywhere. She began to show promise as a research mathematician the summer after her sophomore year, obtaining results in finite group theory which have since been submitted for publication. More recently, she has done impressive work in algebraic and differential geometry. In his letter nominating her for the prize, Robert Bryant of Duke University wrote, "Her mathematical maturity and insight are astonishing." Neilsen received an Honorable Mention in this year's Putnam Competition, finishing thirtieth out of 2347 contestants.



Jèanne Nielsen

Runner-up Stankova is on a full scholarship at Bryn Mawr College, having won a competition in Bulgaria to identify gifted students for study in the U.S. As a high school student, she was on the Bulgarian team for the International Mathematical Olympiad, capturing silver medals in 1987 and 1988. She finished 101st in this year's Putnam Competition. As a senior next year, she will take graduate courses at the University of Pennsylvania. Rhonda Hughes of Bryn Mawr called Stankova "one of the brightest young people I have ever known."

The criteria for selection for the Schafer Prize include, but are not limited to: the quality of the nominee's performance in mathematics courses and special programs, an exhibition of real interest in mathematics, the ability to do independent work, and performance in mathematical competitions, if any. This year's selection committee consisted of Bhama Srinivasan (chair) of the University of Illinois at Chicago, Alice T. Schafer of Marymount University, and Jill P. Mesirov of Thinking Machines Corporation.

The prize is funded by an endowment, with the initial contribution coming from the AWM, the AMS, and the Mathematical Association of America, in addition to many individual contributors.

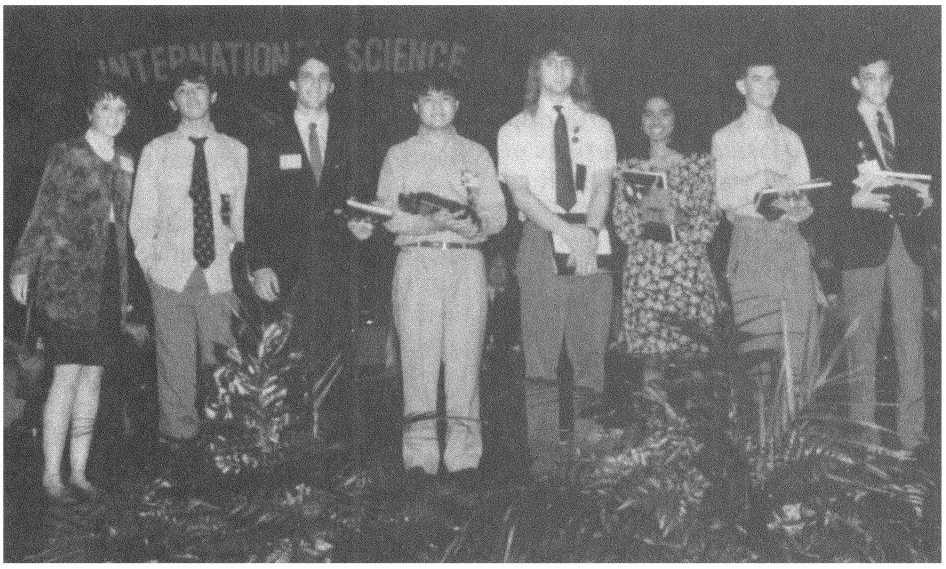
The AWM was established in 1971 to serve and encourage women to study and pursue active careers in the mathematical sciences. The headquarters office functions as a resource center, providing information and career materials upon request. For more information, contact the executive director, Patricia N. Cross, Association for Women in Mathematics, Box 178, Wellesley College, Wellesley, MA 02181.

AMS Awards Prizes at International Science & Engineering Fair

The American Mathematical Society presented Karl Menger Memorial awards to seven high school students at the 42nd International Science and Engineering Fair (May 5-11, 1991). This is the fourth year that the Society has participated in the Fair's Special Awards Program.

Each of the eight hundred invited projects at the Orlando fair had already won regional prizes in their states, territories, and other countries. Many other awards from the International Science and Engineering Fair (ISEF) and from professional and government organizations went to projects which our judging team regarded highly, although no entry in mathematics or applied mathematics received any of the four grand ISEF awards.

The AMS judges screened all of the entries in categories other than mathematics to find those which we considered to be creative applications of mathematics. Seventeen students in six other science categories were selected for interviews in addition to the forty entrants in mathematics. Our judges were impressed by the general competence and enthusiasm of the students and hope in their interviews to have encouraged further study of mathematics even though the number of our awards was limited. Our time talking with these talented high school students, all of them truly winners, served as a refreshing counterpoint to newspaper headlines screaming about the low scores on mathematics tests of U. S. school children.



Left to right: Bettye Anne Case, Monwhea Jeng, Hans Christian Gromoll, Jesse L. Tseng, Jeb E. Willenbring, Rageshree Ramachandran, Matthew A. Neimark, Andrew Dittmer. (Photo by FocusOne.)

The monetary awards and certificates were accompanied by a booklet about Karl Menger, AMS t-shirts, and the book *Mathematical Impressions* by Anatoliĭ Fomenko. The first prize ($1000) went to MONWHEA JENG, 16, St. Louis Country Day School, Ladue, MO, for "Multi-Dimensional Platonic Solids". Second prizes ($500) went to HANS CHRISTIAN GROMOLL, 18, Ward Melville High School, Setauket, NY, for "On Minimal Steiner Trees" and to JESSE L. TSENG, 15, Little Rock Central High School, Little Rock, AR, for "Tiling Triangles with Triamonds". The four third prizes ($250) went to ANDREW DITTMER, 16, Thomas Jefferson High School for Science and Technology, Alexandria, VA, for "Analysis of a New Method of Summation of Divergent Series"; MATTHEW A. NEIMARK, 18, Montgomery Blair High School, Silver Spring, MD, for "Graphs Composed of the Two Middle Levels of (2n+1)-Cubes"; RAGESHREE RAMACHANDRAN, 16, Rio Americano High School, Sacramento, CA, for "A Chaotic Model for the El Niño–Southern Oscillation"; and JEB E. WILLENBRING, 18, Mandan High School, Mandan, ND, for "Error Introduced by Assuming a Nonlinear System Follows Harmonic Motion".

It is interesting to note from the biographical information provided by ISEF that the AMS winners are from seven states; six attend public high schools. All were born in the U. S. except one, five within a few miles of their present homes; graduate study in a science is typical among their parents.

Each of the seven AMS winners received category awards from ISEF and most won other Special Awards; Dittmer received six other awards. Ramachandran won two fair awards and she was also a tenth-place winner in the Westinghouse Science Talent Search. All AMS final winners were in the mathematics category except Ramachandran (Earth and Space Sciences). However, the final pool of ten projects from which the seven AMS winners were chosen also included three classified in other areas: Anne M. Dudzik (Microbiology), Eric Spotted Elk (Computer Science), and Jeremy Stevenson (Physics). These ten students each won multiple awards and among them twenty-nine awards.

Ten professors from a wide range of mathematical specialties served as AMS judges; former judges Andy Magid from the University of Oklahoma and Dave Minda from the University of Cincinnati joined colleagues from Florida universities: Bettye Anne Case (Chair), Louis Howard, Mark Hughes, and Jack Quine from Florida State University, Fred Hoffman from Florida Atlantic University, Leonard Lipkin from the University of North Florida, Li Shen from the University of Florida and Roselyn Williams from Florida Agricultural and Mechanical University.

The Society's participation in the International Science and Engineering Fair is supported, in part, by income from the Karl Menger Fund, which was established by the family of the late Karl Menger. Individuals interested in supporting the Society's participation in this program may send their contributions to Karl Menger Fund, American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571.

Bettye Anne Case
Florida State University

NSF Makes Education Awards to States

Ten states have been selected as the first to receive funds from the National Science Foundation (NSF) for system wide reform of their mathematics and science programs from the kindergarten level through the undergraduate level. The awards are intended to bring together governors, state and local education leaders, businesses, parents, and other community leaders to develop well-coordinated programs for change.

The awards, the first in NSF's Statewide Systemic Initiative program, total $75 million for up to five years. The states have promised to match the NSF contribution with a total of nearly $100 million in public and private funds. Thirty states spent more than a year preparing proposals to compete in the program, which is intended to act as a catalyst for comprehensive changes in science and mathematics education nationwide.

Most of the programs target elementary and secondary schools. However, the NSF hopes these programs will also have an impact at the college level, fostering changes in teacher training and realignment of the college curriculum to mesh with the new skills students will gain in school as a result of the reforms.

These awards are made as part of a cooperative agreement between the NSF and each state, allowing the Foundation to provide substantial technical and management advice in the development and implementation of the projects. NSF funding for each award will be phased out over the duration of the award, but the resulting reforms are to be supported through long-term commitments from state and other sources.

The states receiving the awards are: Connecticut ($8 million), Delaware ($5 million), Florida ($8 million), Louisiana ($10 million), Montana ($10 million), Nebraska ($4.5 million), North Carolina ($8 million), Ohio ($10 million), Rhode Island ($9.5 million), and South Dakota ($7.5 million).

New Army Center in Nonlinear Analysis

The Army Research Office (ARO) has awarded a $3 million, five-year contract to Carnegie-Mellon University (CMU) to establish the Center for Nonlinear Analysis, a center of excellence in mathematics. CMU will also contribute $1 million toward the Center. Hampton University, a historically black college in Hampton, Virginia, is a subcontractor and will maintain a center on its campus as well.

The Center's principal investigators are Morton Gurtin (founding director), David Kinderlehrer, and Luc Tartar, and Steven Shreve is the Center's associate director; all are in the mathematics department at CMU. James Turner, head of Hampton's mathematics department, will direct research at that institution.

A key element in the work of the Center will be the use of analysis and computation to solve problems in materials science, a focus of research at CMU for more than forty years. Among other topics, the researchers will study problems relating to how the microstructures of metals change under impact or under the application of a magnetic field. The Center activities will also allow Hampton to develop a strong graduate program in computational fluid dynamics.

The Center is the fourth ARO mathematics center in the U.S. One of the others is the Mathematical Sciences Institute (MSI) at Cornell University (see *Notices*, May/June 1991, page 443, for a description of the recent reorganization of MSI); one is a consortium center involving Brown and Harvard Universities and the Massachusetts Institute of Technology; and one is the Army High Performance Computing Research Center at the University of Minnesota (see *Notices*, December 1989, page 1369).

An inaugural conference will be held September 24-27, 1991. For more information about the conference, see *Notices*, May/June 1991, page 473.

IBM Support for MSEB

The International Business Machines (IBM) Corporation has announced that it will provide loaned computers, software, training, and service support to the Mathematical Sciences Education Board of the National Research Council. The goal is to establish a nationwide network, to be in operation by October of this year, which will link leaders in mathematics education reform. The IBM support is valued at $2.8 million.

The network, the Mathematical Sciences Education Leadership Network (MSELnet), will enhance communication among 165 leaders in nine national organizations which are cooperating to implement national mathematics education reforms in each state. The organizations have a combined membership of about 90,000 individuals. MSELnet will allow timely sharing of ideas among decisionmakers at the national, state, and local levels.

1991 Mathematical Sciences Department Chairs Colloquium

The 1991 Mathematical Sciences Department Chairs Colloquium sponsored by the Board on Mathematical Sciences, National Research Council, will be held on October 18-19, 1991 in Arlington, Virginia. The theme of the 1991 colloquium is "Encouraging Talent into the Mathematical Sciences Pipeline." The program is designed to provide information and materials chairs may use in the design of recruiting and nurturing programs for their departments.

Conferees will be provided with handouts containing information concerning the various aspects and levels of the mathematical sciences pipeline. On Friday, October 18, 1991, a panel presentation and floor discussion on these issues will be held. The following morning, workshops on what department chairs may do to encourage talented students to enter and remain in the mathematical sciences will be held. There will be separate workshops for research universities and liberal arts and/or teaching institutions. The information presented the preceding day will serve as the basis for the workshops.

New department chairs are encouraged to attend the session planned for their benefit. Topics to be discussed include resource allocation and faculty evaluation.

The keynote speaker for the colloquium is Mary Good, Chair of the National Science Board. The program also includes sessions providing information on encouraging members of underrepresented groups in the mathematical sciences, the Ph.D. job market, and the pipeline in statistics. In addition, there will be two panels of representatives of federal agencies that fund mathematical sciences projects: one panel will discuss programs concerned with research oriented programs and the other will discuss education/pipeline/infrastructure programs.

The registration fee is $160.00 and includes all colloquium sessions, materials, and related meals and social

activities. For further information, contact the Board on Mathematical Sciences at 202-334-2421. The mailing address is Board on Mathematical Sciences, National Research Council, 2101 Constitution Avenue, NW, Room NAS 312, Washington, DC 20418.

News from the Institute for Mathematics and its Applications

University of Minnesota

During the past year, Ford Motor Company, Hitachi, Kao Corporation, and Siemens have joined the Institute for Mathematics and its Applications (IMA) as Participating Corporations (PCs). This brings the number of PCs to thirteen. In addition, four companies are participating in the IMA Postdoctorate in Industrial Mathematics Program, supporting five IMA postdocs at the level of 50%.

Kent State University, the University of Kentucky, the University of Manitoba, the University of Maryland, and the Pennsylvania State University have become IMA Participating Institutions (PIs) this past year. The number of PIs has now reached twenty-four.

The 1991-1992 academic year program at the IMA is Applied Linear Algebra. The coordinators for this program are R.A. Brualdi, G. Cybenko, A. George, G. Golub, M.B. Luskin, and P. Van Dooren. The advisory committee is A. Bjorck, T. Kailath, V. Klee, J. McKenna, and R. Ward.

The fall quarter will concentrate on Discrete Matrix Analysis with emphasis on the mathematical analysis of sparse matrices and combinatorial structure. The program will begin September 4-10 with a Tutuorial, led by the coordinators. These lectures will touch on most of the issues for the first quarter and some of those (Matrix Computations with special emphasis on iterative methods) for the second quarter. The Tutorial will be followed immediately by the SIAM Conference on Applied Linear Algebra (September 11-14), held at the Radisson Hotel Metrodome and the University of Minnesota.

During October 14-18, the IMA will offer the workshop Sparse Matrix Computations: Graph Theory Issues and Algorithms organized by A. George, J. Gilbert, and J. Liu. On November 11-15, the workshop Combinatorial and Graph-Theoretic Problems in Linear Algebra will be held, organized by R. Brualdi, S. Friedlander, and V. Klee.

The winter quarter Applied Linear Algebra program will concentrate on Matrix Computations with special emphasis on iterative methods for solving systems of linear equations and computing the eigenvalues of sparse, possibly structured matrices.

During January 13-17, there will be a workshop on Linear Algebra, Markov Chains, and Queueing Models organized by J. McKenna, R.J. Plemmons and G.W. Stewart. Markov chains and queueing models are playing an increasing role in the understanding of complex systems such as computer, communication, and transportation systems. Three areas are important in the construction and numerical solution of these problems: linear algebra, Markov chains, and queueing network models. The object of this workshop is to bring together experts from these three areas to share their different points of view of the subject.

Details concerning the rest of the Applied Linear Algebra program will appear in future issues of *Notices*.

As part of the IMA Industrial Mathematics Program, on October 7-11, 1991 the Institute will host the workshop Transfer of Mathematics to Industry in the U.S. and France, co-sponsored by the Institut National de Recherche en Informatique et en Automatique (INRIA). Both Institutes have considerable, but differing, experience in relating academic mathematics to industrial application. The workshop will bring together some of the key people from industry and from universities in France and the United States who are playing roles in building bridges between the two communities. There will be ten speakers from French industry and from INRIA; ten speakers from U.S. industry, government agencies, and universities; overview talks by A. Bensoussan (Pres. of INRIA) and A. Friedman (Dir. of IMA); as well as round table discussions.

For more information about IMA programs: IMA, University of Minnesota, 514 Vincent Hall, 206 Church St., SE, Minneapolis, MN 55455-0436; 612-624-6066; Fax: 612-626-7370; or ima_staff@ima.umn.edu.

News from the Mathematical Sciences Institute

Cornell University

The three ARO Centers of Excellence in the Mathematical Sciences administered by the Mathematical Sciences Institute (MSI) invite participation in workshops and periods of concentrated activity that inaugurate the Institute's new, five-year contract.

Early summer saw MSI support for workshops in Biomathematics (April 26), Fluid Mechanics (June 5–15), Hybrid Systems (June 10–12), Conditional Inference (June 2–15), and Patch Dynamics (June 23–July 19).

In July, MSI will support three events. The Center for Stochastic Analysis will host a period of concentrated activity on Interacting Particle Systems at Cornell. A two-day conference, organized by Center Director R. Durrett, will summarize findings on July 15 and 16. The Center for Symbolic Methods in Algorithmic Mathematics will sponsor a workshop on Combinatorics and Discrete Geometry at Cornell from July 17–20. This meeting is organized by N.L. White from the Univ. of Florida, Gainesville. In addition, Institute Director A. Nerode, together with W. Marek from the Univ. of Kentucky and V.S. Subrahmanian from the Univ. of Maryland, will lead the First International Workshop on Logic Programming and Non-Monotonic Reasoning. This workshop will be held in Washington, DC from July 22–24.

During August, S. Busenberg of Harvey Mudd/Claremont College is the organizer of a two-day workshop on Modern Computational Methods in Industrial Mathematics to be held at the Claremont Colleges. The workshop is co-sponsored by MSI through the Center for Symbolic Methods in Algorithmic Mathematics. Sixty participants are expected from the universities and from industry.

In the fall, the MSI/Stony Brook Center for the Mathematics of Nonlinear Systems will begin a period of concentrated activity in the area of Nonlinear Hyperbolic Waves. L. Henderson from Australia will be a senior visitor. Two workshops sponsored by MSI will be part of this activity: One on Hyperbolic Waves and one on Bifurcation and the Geometry of Riemann Problems.

The fall will also see special studies on the interactions of probability and partial differential equations at the Center for Stochastic Analysis. The Center will be interested in hydrodynamic limits of interacting particle systems, measure-valued diffusion, and stochastic p.d.e.'s. S.R.S. Varadhan from the Courant Institute will organize a workshop on Hydrodynamic Limits and D. Griffeath from the Univ. of Wisconsin, Madison, will organize a workshop on Cellular Automata. A period of concentrated activity on stochastic p.d.e.'s is being planned for the summer of 1992 by C. Mueller of the Univ. of Rochester.

Listings of MSI Technical Reports are now available through the UNIX File Transfer Protocol (FTP) on the MSI computer system. MSI's email address is msi@msiadmin.cit.cornell.edu or 128.253.216.2. There is currently a single directory containing report titles filed by year from TECH86 through TECH91.

As a final note, a collection of abstracts from the workshop on Mathematics of Computation in Partial Differential Equations, held at Cornell last January in honor of J.H. Bramble, is now available by writing to the Mathematical Sciences Institute, Suite 321, 409 College Ave., Ithaca, NY 14850.

News from the Mathematical Sciences Research Institute

Berkeley, California

William Thurston of Princeton University has accepted the Directorship of the Mathematical Sciences Research Institute (MSRI) for a period of five years beginning in the fall of 1992. The current director, Irving Kaplansky, will have completed eight years in the position, after replacing the original director, S.-S. Chern. Thurston has expressed an interest in expanding the role of MSRI to include activities related to mathematics education and public outreach, and to increase interaction among different branches of mathematics as well as between mathematics and other fields. He brings experience in these areas, having served as a judge in the Westinghouse Science Talent Search, as editor-in-chief of *Quantum*, and on the Mathematical Sciences Education Board of the National Research Council. Among the many citations and awards that Thurston has received are the Veblen Prize of the AMS in 1976, the Alan T. Waterman award from NSF in 1979, and the Fields Medal in 1982.

During Thurston's first year at MSRI, 1992-1993, three programs will be featured: A full-year program in algebraic geometry, a half-year program on symbolic dynamics in the fall, and a half-year program on transcendence and Diophantine problems in the spring. Although these areas are emphasized, applications in all fields will be welcome. Mid-career awards of Research Professorships are for applicants who received their Ph.D. in 1986 or earlier. Applications must be submitted by the **end of September 1991**. There is a later deadline for postdoctoral fellowships and senior memberships: **November 30, 1991**.

Two programs have been scheduled for 1993-1994: A full-year program on differential geometry and a half-year program in the spring on coherent structures for integrable and near-integrable PDE's.

The first workshop during the coming academic year, on Quantitative Methods in AIDS, will be held September 30 - October 4, 1991.

The period July 6 - August 14, 1992 will be devoted to a summer program in Mathematical Biology.

Howes Heads DoE Mathematics Program

Frederick A. Howes has joined the Scientific Computing Staff of the Department of Energy (DoE) to take a permanent position managing DoE's Applied Mathematics Program. He took the new position after finishing a two-year tour of duty in the Division of Mathematical Sciences at the National Science Foundation, where he served as program director for Applied Mathematics and for Classical Analysis. Howes succeeds Donald Austin, who is now executive director of the Army's High Performance Computing Research Center at the University of Minnesota.

In his new position, Howes will initiate and support research in areas of interest to the DoE—primarily applied mathematics research to model physical and biological phenomena using analytical techniques and numerical simulations. The two subprograms under Howes' jurisdiction are being redefined somewhat. The Analytical and Numerical Methods subprogram will support energy-related research in mathematical modeling and analysis and in numerical simulations. The Information Analysis Techniques subprogram, which in the past supported work in mathematical physics, geometric computation, and databases, will now focus more on numeric, symbolic, and geometric computation, and on visualization. Mathematical physics will be moved into the Analytical and Numerical Methods subprogram.

Although current budget figures were uncertain at the time of this writing, Howes estimates that the Applied Mathematics Program will spend about $13 million this year, with about 55% going to DoE laboratories and about 45% to researchers at universities. The program may receive new funds through the federal High Performance Computing and Communications Initiative, which begins in 1992.

"I would hope in my new job to foster and support improved collaborations between university researchers and the DoE labs," Howes remarks. "I feel [they] would find increased collaboration mutually beneficial, especially as more and more of the research at the labs turns to problems involving climate change, biotechnology, and materials research."

Howes received his Ph.D. in mathematics from the University of Southern California in 1974. He held postdoctoral positions at the Courant Institute

of Mathematical Sciences (1975) and at the University of Wisconsin at Madison (1976). He was an assistant professor at the University of Minnesota from 1977 to 1979, when he moved to the University of California at Davis. He became a full professor at Davis in 1984. Since 1985, he has been a consultant to the Computational Physics Program at Lawrence Livermore National Laboratory. His current research interests lie in the asymptotic-numerical solution of problems in fluid dynamics.

Howes can be reached at: Office of Energy Research, Scientific Computing Staff, ER-7, Department of Energy, Washington, DC 20585; telephone 301-353-5800.

Call for Nominations for Waterman Award

The National Science Foundation (NSF) seeks nominations for the seventeenth annual Alan T. Waterman Award. This prestigious award recognizes an outstanding young researcher in any field of science, mathematics, or engineering, and is intended to stimulate further high-quality research.

The award consists of a medal and up to $500,000 for up to three years of research or advanced study. The award was established by Congress in 1975 to mark the twenty-fifth anniversary of the NSF and to honor Alan T. Waterman, the first director of the Foundation.

Candidates for the award must be U.S. citizens or permanent residents and must be thirty-five years old or younger, or not more than five years beyond the receipt of the Ph.D., by December 31, 1991. Candidates should have sufficient personal accomplishments, outstanding capability, and exceptional promise for significant future achievement. Previous Waterman awardees in the mathematical sciences include Charles Fefferman and William P. Thurston of Princeton University, Harvey Friedman of the Ohio State University, and Edward Witten of the Institute for Advanced Study.

Nominations for the award may be submitted by individuals, professional societies, industrial companies, or other appropriate organizations within the scientific and educational communities. Nominations must be received by **December 31, 1991**. The award will be announced and presented in May 1992. Additional information may be obtained by contacting Susan E. Fannoney, Executive Secretary for the Alan T. Waterman Award Committee, National Science Board, Room 545, National Science Foundation, 1800 G Street, NW, Washington, DC 20550; telephone 202-357-7512.

Report on Mathematics Education Programs

The U.S. Department of Education has released a report entitled "Mathematics Education Programs that Work: A Collection of Proven Exemplary Educational Programs and Practices in the National Diffusion Network." The National Diffusion Network (NDN) is a nationwide system established to assist educational institutions. The report provides information about NDN-approved mathematics programs available for implementation in classrooms. A list of all NDN facilities is also included.

The 34-page report, stock number 065-000-00443-7, is available for $2.25 from: Department 36-JW, Superintendent of Documents, Washington, DC 20402-9325. VISA or Mastercard telephone orders are accepted: 202-783-3238.

Report on Mandatory Retirement

Tenured faculty at institutions of higher learning should not be required to retire when they reach age seventy, concluded a National Research Council (NRC) committee in a report released in May 1991.

A 1986 act of Congress that prohibits mandatory retirement for most workers contains an exemption permitting mandatory retirement for tenured faculty members at colleges and universities until 1994. Congress asked the NRC to examine whether there are special circumstances that justify this exemption and to analyze the consequences of removing it. In its report, the NRC committee recommended that the exemption be allowed to expire in 1994.

Examining demographic and retirement data from more than 3200 institutions, the committee concluded that most tenured faculty currently choose to retire before age seventy and would continue to do so. However, they concluded that "at some leading research universities, a high proportion of faculty would choose to work past age seventy if mandatory retirement is eliminated." At such institutions, there may be adverse effects from low faculty turnover, but such incentives as attractive early retirement benefits can lessen undesirable effects, the report notes.

The committee urged that retirement incentive programs be expanded and pension policies be revised so that the overall policies "create neither disincentives to retirement nor inadvertent incentives to postpone retirement."

The report, "Ending Mandatory Retirement for Tenured Faculty: The Consequences for Higher Education," is available for $20 (prepaid) plus shipping from the National Academy Press, 2101 Constitution Avenue, NW, Washington, DC 20418; telephone 202-334-3313 or 1-800-624-6242.

Funding Information for the Mathematical Sciences

AMS Centennial Fellowships Invitation for Applications, 1992-1993 Deadline December 1, 1991

These fellowships are intended to provide enhanced research opportunities to mathematicians who are several years past the Ph.D., who have a strong research record, but who have not had extensive postdoctoral research support in the past. Applicants should have received the Ph.D. degree between January 1, 1980, and December 31, 1985, and should not have had the equivalent of more than two years of full-time postdoctoral support.

The stipend for fellowships awarded for 1992-1993 has been set by the Trustees of the Society at $40,000 for nine months. In addition, there will be an expense allowance of $1,300. Applicants must be citizens or permanent residents of a country in North America. The fellowship may be combined with other stipends and/or part-time teaching; this option can be used to extend the award to cover a period of up to two years. For further information about the acceptability of such arrangements, individuals should contact the Secretary of 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 three fellowships a year for the past four years.

The deadline for receipt of applications is **December 1, 1991**. Awards will be announced in February 1992, or earlier if possible.

For application forms, write to the 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.)

Mathematical Sciences Postdoctoral Research Fellowships

The National Science Foundation's (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 citizens, nationals, or lawfully admitted permanent resident aliens of the United States as of January 1, 1992; 2. will have earned, by the beginning of their fellowship tenure, a doctoral degree in one of the mathematical sciences; 3. will have held the doctorate for no more than five years as of January 1, 1992; and 4. will not previously have held any other NSF postdoctoral fellowship. Typically, between 25 and 30 fellowships have been awarded. It is expected that in FY 1992, 30 to 40 awards will be made. 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 Office of Special Projects, Room 339, Division of Mathematical Sciences, National Science Foundation, 1800 G Street, NW, Washington, DC 20550; telephone 202-357-3453; or the American Mathematical Society at telephone 401-455-4000.

The deadline for applications is **October 15, 1991.** ***Please note that this deadline is one month earlier than in prior years.***

For Your Information

BMS Issues Reports

In recent years, science has increasingly been viewed as just another "special interest group" asking for limitless increases in funding to satisfy its own needs, regardless of the larger social and political context. Some recent news stories—such as the Baltimore data-doctoring case, the Stanford overhead charge scandal, Leon Lederman's idealistic plea to return to the "Golden Age" of science by doubling federal support—have fueled this perception. More than ever before, any science asking for new funds must demonstrate how it will contribute to something beyond its own ends.

Taken in this light, two recent reports of the Board on Mathematical Sciences (BMS) of the National Research Council (NRC) may have some chance of making a difference. The first, "Mathematical Sciences, Technology, and Economic Competitiveness," is a major overview of the role of mathematics in technology and industry. The second, "Applications of the Mathematical Sciences to Materials Science," is a shorter, more focused report that discusses mathematical problems arising in a wide array of materials science research areas.

Technology Transfer in Mathematics

Mathematicians often complain that although their field has made fundamental contributions to some of the major technological developments of our time, the credit often goes to another science or to engineering. The purpose of the report "Mathematical Sciences, Technology, and Economic Competitiveness" is to reveal these hidden stories and to draw connections between mathematics and the economic strength of the nation. Using the term "economic competitiveness" in the title is a frank admission of a hope for political appeal, but on the whole the report sets aside cheerleading to present an array of interesting nuggets about what kinds of mathematical problems arise in industry.

The report's editor, James G. Glimm of the State University of New York at Stony Brook, counts the economy, national security, and health as the three major areas in which "mathematics has an impact in political terms." In choosing the first area, he hopes to include business, industry, and the government, as well as the mathematical sciences community, in the audience for the report. His report may be the first to look at the mathematical sciences purely through the lens of its contributions to the industrial and economic strength of the nation.

One of the most interesting sections of the report surveys the status of five U.S. industries in the world market—aircraft, semiconductors and computers, petroleum, automobiles, and telecommunications. Providing evidence for the importance of research and technological advances for the strength of these industries, the report points out how mathematics arises in each of them. What is intriguing about this chapter is that the information about mathematics is organized around industry, not around the particular mathematical areas that are relevant.

For example, the report notes that labor, management, and the government were often blamed for the downturn in the automobile industry in the 1980s, but makes a persuasive case for the importance of technological advances in improving the competitive strength of American automobile companies. The report points out how mathematics—through modeling, numerical methods, and operations research—has provided the foundation for many of these advances. In the area of oil recovery, the report notes that oil fields typically retain two-thirds of the oil after conventional production methods have been used, making the need for efficient alternative oil recovery methods—including accurate assessments of their feasibility and cost—a crucial part of the industry. These methods depend on characterization of the reservoir geology and predicting fluid flow patterns through the geology, both major areas in which mathematics has made contributions.

To point out that mathematics is important not just in research and development, the next chapter looks at various phases of the product cycle—planning, simulation and design, production, quality control, and so on—and how mathematics has contributed to each. Case studies are drawn from various industries to illustrate how mathematics has affected specific product cycle functions. The next chapter is organized more around mathematical areas, providing examples of contributions to technology. One part tells the story of how the foundations of statistical quality control methods were developed in the U.S. and the United Kingdom in the 1920s and were brought to Japan in the 1950s. The Japanese quickly translated the theory into new design methodologies which had a profound impact on raising the

quality of Japanese products. It was only in the 1980s that these methods were brought into use in the U.S.

Even if one is persuaded of the importance of such contributions, the question remains: Can industry and technology run on the mathematics it has? The report says no, and recommends the establishment in colleges and universities of programs in industrial mathematics, to be funded by industry and government. The report also approvingly describes a number of existing programs of this type, such as the Institute for Mathematics and its Applications at the University of Minnesota, the industrial mathematics conferences held at Rensselaer Polytechnic Institute, and the Center for Quality and Productivity Improvement at the University of Wisconsin, among others.

Surprisingly, the report's main recommendations do not ask for more funds (though funding is addressed in the secondary recommendations), but rather call for change in the rewards system to provide more adequate recognition for achievements that support industrial mathematics. When the community convinces itself of the importance of the contributions, the report seems to be saying, it will be in a better position to ask for more funds.

But how easily will such attitudes change? Some may see the report as implying that the only good mathematics is useful mathematics. Glimm disagrees, saying it's a question of balance. "I don't see a high degree of conflict between the traditional views and those in the report," he says. "There's room for both." The mathematical sciences already has breadth and diversity, he points out, and the report simply calls for building on that aspect of the discipline. "There's the perception that the mathematical community had to choose between theory and applications, and it chose theory," he explains. "But I don't think that's correct. We can develop the theory, but still be outward-looking."

"We all know about the beauty of mathematics, but mathematics is also useful—we want both messages out there," he continues. "And this report is a fairly definitive message of the utility of mathematics that doesn't undercut its beauty." In fact, Glimm maintains that the message that mathematics meets its responsibilities to other sciences and to the nation is a powerful argument for supporting all of mathematics.

Given the plethora of reports coming out of the mathematical sciences community in recent years, will this report simply get lost in the crowd? On that score, Glimm is optimistic. "This report is much better tied into larger political currents than other reports," he says. And following such currents is crucial. "The mathematical community doesn't set the political agenda. We either ride the wave or wallow in the trough."

Mathematics and Materials Science

The BMS report, "Applications of the Mathematical Sciences to Materials Science," which appeared in February of this year, is shorter, more focused, and more technical than the Glimm report. David Sanchez, assistant director for Mathematical and Physical Sciences of the National Science Foundation, requested the report in October of last year. An earlier NRC report on materials science persuaded him that cross-agency initiatives in materials research, synthesis, and processing were waiting in the wings. "I thought there was some interesting mathematics there, but nowhere in these documents did mathematics explicitly appear," Sanchez notes. He therefore asked BMS to put together a panel to produce a quick overview of this topic. The panel, chaired by Avner Friedman, director of the Institute for Mathematics and its Applications and a member of BMS, consisted of two mathematicians and eight materials scientists knowledgeable about the interface of these two areas. The panel's preponderance of materials scientists gave the report greater impact at the NSF.

Though the report suffers from some unevenness—different sections appear to have been written by different authors—it is overall an interesting and readable account. The first section is organized around particular classes or applications of materials, such as electronic and semiconductor materials, nonlinear optical materials, ceramics, glasses, etc. One of the most interesting sections deals with the mathematics of polymers. The fact that polymers are made up of long-chain molecules that intertwine pose enormous mathematical problems. Understanding the relationship between the bulk polymer properties and the shapes and interactions of the individual molecules is a major mathematical hurdle, the report says. Mathematics has already played a significant role in unraveling some of these problems, and the tools used are surprisingly diverse—random walks, lattice models, renormalization group methods, among others. Another particularly interesting section of the report looks at biomolecular materials, and, more specifically, the mathematical questions arising in protein folding, neural networks, and engineered materials that mimic characteristics of materials produced by some living creatures—the so-called biomimetic materials.

In discussing the more general mathematical problems common to many materials, the report makes a case for the need for a mathematical framework to cope with the three-dimensional complexity of the microstructure of crystals. Microstructure problems are "generally not problems of pure geometry," the report notes. "Particularly attractive are mathematical theories that do not assume the geometry of microstructure at the outset and are therefore able to predict new microstructures that are optimal in a specific sense." The report also points to such methodologies as neural networks, cellular automata, and fractal analysis as holding promise for the creation and understanding of novel materials.

The report closes with a look at some of the modeling and computational issues arising in materials research and a list of some mathematical areas likely to prove important in the future. At only twenty-six pages, the report covers a lot of ground and sticks purely to scientific issues—there are no calls for new funds, no institutes or workshops proposed. "I think it's a nice report because it highlights various materials and talks about the mathematical problems involved," says

Sanchez. "It's brief, you can hand it to people, and they'll read it." To provide more detail, the panel is now beginning work on a more expansive and technical follow-up report.

As for the impact of the report, Sanchez points to the fiscal 1993 budget, which is under development now and which includes plans for cross-agency funding of materials science research. According to Sanchez, the NSF fiscal 1992 budget does include $10-12 million for materials research, but that money is going into materials science, chemistry, and engineering at NSF, not into the Division of Mathematical Sciences (DMS). Although DMS may be able to initiate some split-funding for mathematics-materials science research, it will probably have to wait until 1993 for a bigger piece of the action.

Allyn Jackson
Staff Writer

The report "Mathematical Sciences, Technology, and Economic Competitiveness" is available for $25 from the National Academy Press, 2101 Constitution Avenue, NW, Washington, DC 20418; telephone 1-800-624-6242 or 202-334-3313. "Applications of the Mathematical Sciences to Materials Science" is available free from the Board on Mathematical Sciences, National Research Council, at the same street address given above; telephone 202-334-2421.

Educational Activities of the Mathematical Association of America

Lida K. Barrett and Marcia P. Sward

Lida K. Barrett served as President of the Mathematical Association of America (MAA) from 1988-1990 and is currently Professor of Mathematics and Dean of the College of Arts & Sciences at Mississippi State University. Marcia P. Sward is Executive Director of the MAA.

At the December 1990 meeting of the AMS Committee on Science Policy, we were asked to make a presentation about the MAA's educational activities to assist the committee in its deliberations about the educational role of the AMS. Many members of the committee, some of whom have been long-time MAA members, expressed surprise at the range and variety of MAA educational activities. AMS Executive Director William H. Jaco invited us to submit to *Notices* an overview of these activities.

The MAA was founded in 1915 "to promote the interests of mathematics, especially at the collegiate level." During its 75 years, it has remained true to this charge and has developed many programs, projects, and publications devoted to collegiate mathematics education. The goals of the MAA, as articulated in the 1986 Long Range Plan are:

To promote excellence in teaching mathematics:

- Stimulate curriculum development;
- Encourage innovative instructional practices;
- Provide opportunities for professional development;
- Support quality exposition of mathematics;
- Encourage excellence in preparation of mathematics teachers.

To cultivate mathematical talent:

- Promote mathematical opportunities for women and minorities;
- Identify and encourage mathematically talented students;
- Demonstrate how mathematics is useful and necessary;
- Increase awareness of mathematics-based careers.

To enhance public awareness of mathematics:

- Stimulate awareness of mathematics and its applications;
- Encourage sound public policy concerning mathematics;
- Publicize the importance of mathematics.

These goals will be updated by a newly appointed Long Range Planning Subcommittee of the Executive and Finance Committees.

The membership of the MAA, now numbering 33,000, consists of college and university faculty, mathematicians, students, high school teachers, individuals from business, industry, and government, and hobbyists. The primary focus of MAA is collegiate mathematics, but MAA's activities and publications serve a broader audience. While the MAA has limited involvement in the frontiers of mathematics research, research mathematicians have always played a large role in the activities of the Association. There is considerable overlap among the memberships of MAA, AMS (total membership 28,000), and SIAM (total membership 8000). Among those belonging to two of these organizations are 9000 who are members of AMS and MAA, and 700 who are members of MAA and SIAM. Nearly 1400 people belong to all three organizations.

The MAA has 29 geographically-defined Sections, each of which has its own officers and holds its own meetings once or twice a year. Every member of the MAA is automatically a member of a Section. Every Section elects a Governor to serve on the national Board of Governors, the MAA's governing body, along with nationally-elected officers, editors, and various representatives.

The Sections are one of the major strengths of the MAA, providing many members with the opportunity for active involvement in the organization and its programs. Sections form part of the network administering mathematics competitions, cooperate with regional NCTM organizations, distribute materials, generate discussion and input to the national leadership, and run workshops and short courses. Many Sections host student activities at their meetings, and recognize and motivate student research papers.

The MAA has banded together with the AMS and SIAM in two significant areas of common interest: public information and governmental relations. Through the Joint Policy Board for Mathematics, the three organizations sponsor *UME Trends*, Mathematics Awareness Week, and the Office of Governmental and Public Affairs.

The MAA is also deeply involved in the affairs of the greater mathematical, educational, and scientific communities through the Conference Board of the Mathematical Sciences, the Mathematical Sciences Education Board of the

National Research Council, and the Council of Scientific Society Presidents.

As the MAA enters its 76th year, we believe that the hardest challenges and the greatest opportunities are yet to come. The MAA must continue to grow in its sense of purpose, and its capacity to meet the needs of its own membership and of the larger mathematical community. And this must be done by forging stronger bonds with the AMS and other mathematical organizations, clarifying and strengthening our common agendas, and by reaching out more broadly and more effectively to the American public about the value of mathematical thinking.

Committees

MAA committees are currently being grouped into six areas: Administration, Awards, Competitions, Education, Human Resources, Meetings, and Publications. There are 140 committees, subcommittees, and boards, with a total of 570 individual members. Some key MAA committees are:

Committee on the Undergraduate Program (CUPM)
Lynn A. Steen, Chair
Virtually all of the work of CUPM takes place through its subcommittees: Service Courses, Calculus Reform and the First Two Years (CRAFTY), Undergraduate Major, Symbolic Computing Systems, Undergraduate Research, Quantitative Literacy, Assessment of Undergraduate Majors, and Basic Library List. Four documents were published in fall 1990 and winter 1991: *Priming the Calculus Pump*, *Models for Undergraduate Research in Mathematics*, *Challenges for College Mathematics* (a joint MAA-AAC Task Force report), and the *Undergraduate Major in the Mathematical Sciences.*

CUPM recommendations have had a major impact on the collegiate mathematics curriculum. Its 1965 recommendations helped focus the undergraduate major in mathematics on preparing more students properly for graduate study in mathematics; they proposed the sophomore linear algebra course that is now standard. Its 1981 recommendations sought to direct the major toward a broadened mathematical sciences major preparing students for a wide spectrum of industrial careers as well as graduate study in mathematics and cognate disciplines. Recent reports are giving increasing attention to teaching rather than the content of collegiate mathematics courses.

Committee on the Mathematical Education of Teachers (COMET)
James R. C. Leitzel, Chair
COMET is working cooperatively with the National Council of Teachers of Mathematics (NCTM) and the Mathematical Sciences Education Board (MSEB) on companion reports on the mathematical education of teachers and their professional evaluation. A set of reports, one from each organization, were released in March 1991 and provide information from the mathematical community to help inform the work of the National Board for Professional Teaching Standards in establishing a voluntary certification process for teachers. (See the May/June 1991 *Notices*, page 443, for more information about these reports.)

Committee on Testing (COT)
John Harvey, Chair
COT administers the MAA Placement Test Program, Teaching Mathematics with Calculators: A National Workshop, Prognostic Testing Network Project, and Development of Software for Computer-Based Placement Tests, all described below.

Committee on the Participation of Women
Patricia Kenshaft, Chair
This committee seeks to increase the participation of women in the MAA and generally in mathematics. Its report, *Winning Women into Mathematics*, was released in April 1991 and is receiving nationwide attention.

Committee on Minority Participation in Mathematics (CMPM)
Sylvia Bozeman and Manuel Berriozabal, Co-chairs
CMPM designed the MAA's new program Strengthening Underrepresented Minority Mathematics Achievement (SUMMA), described below. It is concerned with the mathematical education of Blacks, Hispanics, and Native Americans at all educational levels.

Science Policy Committee
John Thorpe, Chair
The Science Policy Committee provides advice and recommendations to the MAA leadership on issues that affect the relationship between the MAA and government agencies and between the MAA and other mathematical and scientific societies. It also seeks to bring public policy issues to the attention of the mathematics community through panels and speakers at national meetings.

There are over a dozen joint committees including the AMS-MAA Data Committee, AMS-MAA Committee on Employment and Educational Policy, and AMS-MAA-SIAM Committee on Employment Opportunities.

A complete listing of MAA committees is available from MAA Headquarters in Washington, DC and is printed in the Mathematical Sciences Professional Directory published by the AMS.

Publications

The MAA publishes three journals. The *American Mathematical Monthly* is published ten times a year and has a circulation of 21,000. It contains expositiory and historical articles, short notes on mathematical topics, book reviews, and problems.

The *College Mathematics Journal*, published five times a year with a circulation of 13,000, features popular interviews with renowned mathematicians, easy-to-read expository articles, columns on student research projects, classroom capsules, and media highlights and book reviews.

Appearing five times a year with a circulation of 17,000, the *Mathematics Magazine* is designed to enrich undergraduate study and features expository articles, innovative proofs, poems, and other features of interest to the collegiate mathematical community.

Currently, the MAA has 110 books in print in seven series: *The New Mathematical Library, Dolciani Mathematical Expositions, Carus Mathematical Monographs, Studies in Mathematics, The Raymond W. Brink Series, MAA Notes,* and *MAA Spectrum.* In addition, the MAA publishes a number of newsletters. Perhaps the best known of these is *Focus*, the prime vehicle for communicating news and events to the MAA membership. *CrossSections* features news of the MAA Sections, and most of the twenty-nine Sections have their own newsletters. A newsletter for student chapters is under development. With the AMS and SIAM, the MAA sponsors *UME Trends*, which carries news and reports on undergraduate mathematics education.

The MAA also publishes career materials. "Careers in the Mathematical Sciences" is a brochure that features profiles of six mathematical scientists at work. More than 10,000 copies have been disseminated since it was released in August 1990. "Mathematical Scientists at Work," which appeared earlier this year, presents fourteen individuals describing their mathematical work in their own words. The MAA periodically sends out to MAA Student Chapters "Mathematician of the Month" flyers, which highlight an individual whose work extensively uses mathematics. In addition, the National Security Agency has provided support for a videotape focusing on mathematical careers.

Programs

Student Chapters

The MAA established Student Chapters in 1988. There are now 300 chapters on college and university campuses with more than 3,500 members. With financial assistance from the Exxon Education Foundation, four symposia for students in the Sections have been held, a newsletter initiated, and special events for students organized at the Columbus and San Francisco meetings. Many Sections sponsor student contributed paper sessions and other special student events at their sectional meetings in the fall and spring.

Women and Mathematics (WAM)

The year 1990 marks the 15th anniversary of WAM. This program seeks to encourage female students in grades 6 through 12 to explore mathematical and scientific topics and develop their talents in these areas. The WAM program provides contact with role models, career and academic counseling, workshops, corporate tours, and mentors as well as presentations for classrooms and for student, parent, or teacher associations. The members of WAM are all women pursuing careers that require an extensive background in mathematics.

Each year, WAM reaches over 25,000 students and 5,000 adults in over 400 presentations. WAM is currently active in 13 regions in the United States; nearly 500 women serve as mentors and WAM is financially supported by the MAA and by grants from IBM, John Hancock, and George I. Alden Trust.

Precollege Competitions

The American Mathematics Competitions is managed by the MAA, and cosponsored by the MAA, Society of Actuaries, Mu Alpha Theta, National Council of Teachers of Mathematics, Casualty Actuarial Society, American Statistical Association, American Mathematical Association of Two-Year Colleges and American Mathematical Society. There are five examinations:

The American Junior High School Mathematics Examination (AJHSME), the American High School Mathematics Examination (AHSME), the American Invitational Mathematics Examination (AIME), the USA Mathematical Olympiad (USAMO), and the International Mathematical Olympiad (IMO). The IMO is the most difficult and prestigious mathematics competition at the high school level. The American team, gleaned from high scorers of the AHSME, AIME, and USAMO, undergoes a training session before the competition. The U.S. team usually places among the top three nations and placed first in 1977, 1981, and 1986.

Putnam Competition

The Putnam Competition for undergraduate students is supported by the William Lowell Putnam Prize Fund for the Promotion of Scholarship. Students in the United States and Canada are eligible to participate and win honors for themselves and for their institutions. Prizes are awarded to the ten highest ranking individuals, to the mathematics departments of the top five teams, and to members of those teams. A graduate fellowship at Harvard University is awarded to one of the top five students.

Strengthening Underrepresented Minority Mathematics Achievement (SUMMA)

This is a new program of the MAA. Operating with grants from the Exxon Education Foundation, the Carnegie Corporation of New York, and the MAA, SUMMA is now planning activities for the next decade. SUMMA will challenge and involve the collegiate mathematics community in making fundamental changes in attitude and practice, particularly in regard to minority students. It encompasses five interrelated programs: Intervention Projects for Middle and Secondary School Students; Mainstreaming Projects for College and University Students; School and College Mentorship Program, Development Assistance Program, and Program to Attract Minorities into Teaching. Funding is being sought from federal agencies and private foundations.

Program of Visiting Lecturers

The MAA annually publishes a booklet listing mathematicians who are willing to visit college and university campuses to present lectures. Host institutions make arrange-

ments directly with the MAA lecturer and pay expenses and honoraria.

Consultants Bureau
The Consultants Bureau provides colleges with a consulting service to aid them in developing or modifying their mathematics programs. The MAA publishes a booklet listing the consultants, their mathematics areas of expertise, and areas in which they are willing to give advice.

Placement Test Program
This program is designed to assist colleges and universities with the development of on-campus programs for assessing the mathematical skills of entering students. It is run on an annual subscription basis, providing up-to-date tests and placement testing information to its subscribers each year. There were 450 subscribers in 1990.

Projects

American Mathematics Project (AMP)
AMP was initiated in 1987, with funding from the National Science Foundation (NSF), as an effort to replicate at many sites the highly successful Bay Area Mathematics Project directed by Leon Henkin. In its first phase, AMP concentrated on helping 20 MTP's (Mathematics Teacher Projects) get started. These projects involve school, college, and university faculty, as well as leaders in their communities. In its second three-year phase, AMP proposes to serve as a coordinating agent for mathematics teacher network projects across the country.

Teaching Mathematics with Calculators: A National Workshop
This joint project with the NCTM is being conducted in two Texas school districts. It will produce a series of videotapes and corresponding print materials for teachers on the use of calculator technology in the classroom. It is funded jointly by the NSF and Texas Instruments Incorporated.

Curriculum Action Project
The primary objective of this project, funded by the NSF, is to develop and disseminate an "intellectual agenda" for undergraduate mathematics that can guide NSF, MAA, and the broader mathematical community. A secondary objective is to initiate a broad-based dialogue about this agenda both within the mathematical community and with the many external constituencies whose own efforts are loosely linked to collegiate mathematics. This work will be conducted in cooperation with the MSEB.

Preparing the College Mathematics Teachers of the Future
Funded by the U.S. Department of Education, this project will work with five or six doctoral mathematics programs to develop pilot programs designed to enrich the standard graduate program with carefully-planned seminars on topics relevant to the teaching of college mathematics, and other strategies for assuring mathematics breadth. The steering committee for this project is the joint AMS-MAA-SIAM Committee on Preparation for College Teaching.

Prognostic Testing Network Project
This NSF-funded project is working toward the establishment of a network of programs that assess high school juniors who use college level placement tests and as a result, reduce the use of remedial college mathematics enrollments.

Development of Software for Computer-Based Placement Tests
The Committee on Testing is developing software to produce multiple choice placement tests. The test will be disseminated to all subscribers to the Placement Test Program. Funding is being provided by the U.S. Department of Education.

Development of Standards for Teachers of Mathematics
The Committee on Mathematical Education of Teachers (COMET), in a coordinated project with the National Council of Teachers of Mathematics and the Mathematical Sciences Education Board, is developing standards for the mathematical preparation of teachers. A set of reports, one from each organization, was released in March of this year.

Rapid Dissemination of New Calculus Projects
Calculus Reform and the First Two Years (CRAFTY) has published a Notes volume, "Priming the Calculus Pump: Innovations and Resources" highlighting ten calculus projects which describe the developments in calculus reform. The NSF has provided support for the project.

A Basic Library Collection to Support Undergraduate Programs in the Mathematical Sciences
The NSF and Exxon are providing support to prepare and disseminate a volume containing up-to-date recommendations for library collections in the mathematical sciences.

Symbolic Computation Systems in Undergraduate Mathematics
This project, supported by a grant from the Sloan Foundation, involves activities related to the use of symbolic computation in undergraduate mathematics. Components of the project are: 1) development of instructional materials, 2) resources to help instructors get started using computer systems, 3) panels and speakers at sectional and national meetings of mathematics organizations, 4) a leadership conference with other disciplines, and 5) a directory of active users and a list of consultants to assist mathematics departments.

1991 AMS Elections

Biographical information on candidates in the 1991 AMS Election will appear in the **September 1991** issue of *Notices.*

Council Nominations

President-Elect

One president-elect will be elected by the Society in a contested election in the fall of 1991. The candidate elected will serve for one year as president-elect, two years as president, and one year as ex-president. The term of office will begin February 1, 1992. The Council has nominated two candidates for the position, namely:

Ronald L. Graham
Stephen Smale

Vice President, Members-at-Large, Trustee

One vice-president, five members-at-large of the Council, and one trustee will be elected by the Society in a contested election in the fall of 1991.

The vice-president will serve for a term of three years effective February 1, 1992. The Council has nominated three candidates for the position, namely:

Avner Friedman
Robert Osserman
Linda Keen

The five members-at-large will serve for a term of three years. The Council nominated nine candidates, namely:

Ruth M. Charney
Carl C. Cowen, Jr.
Jacob E. Goodman
Alfred W. Hales
Rebecca A. Herb
Joshua A. Leslie
Elliott H. Lieb
De Witt L. Sumners
Gunther A. Uhlmann

The trustee will serve for a term of five years. The Council nominated two candidates, namely:

Maria M. Klawe
Charles C. Sims

President's Candidates

Nominating Committee for 1991 and 1992

Three members of the Nominating Committee are to be elected in the fall of 1991. Continuing members are: Michael Aschbacher, Jerry L. Kazdan, Barbara Lee Keyfitz, Ray Kunze, Walter David Neumann, Robert F. Williams. One candidate has been nominated by petition, namely:

Carol S. Wood

President Michael Artin has named five additional candidates:

Daniel M. Burns, Jr.
Hermann Flaschka
John B. Friedlander
Joseph Lipman
Birgit Speh

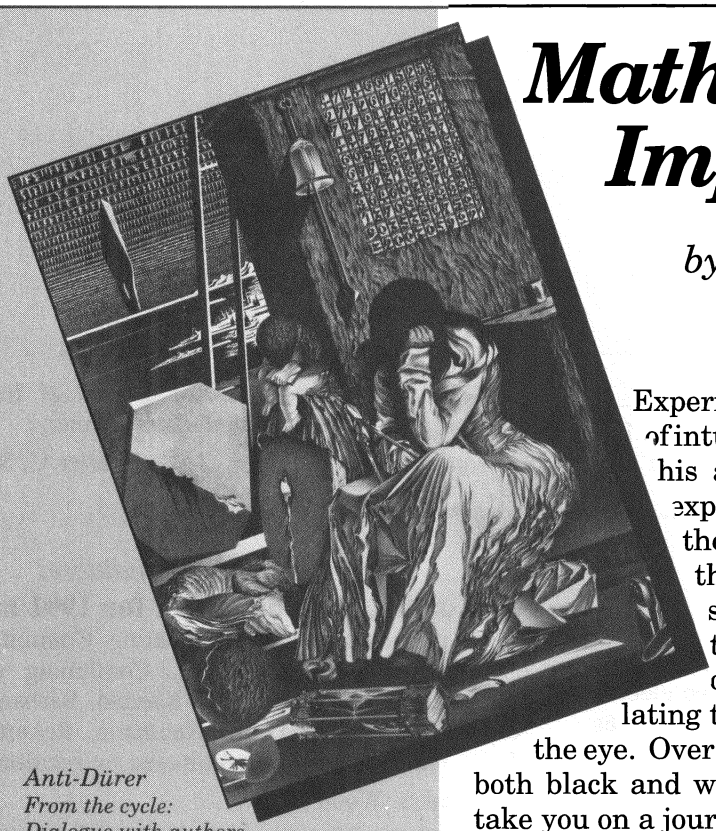
Editorial Boards Committee

Two members of the Editorial Boards Committee are to be elected in the fall of 1991. Continuing members are: Linda Keen, Richard James Milgram, Barry Simon, Nolan R. Wallach. President Michael Artin has named four candidates for the other two places:

Eugene Fabes
John Fornaess
Bhama Srinivasan
Robert J. Zimmer

Robert M. Fossum
Secretary
Urbana, Illinois

JOURNEY TO A STRANGE NEW WORLD



Anti-Dürer
From the cycle:
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(Geometric fantasy on the theme of concepts in general mathematics and random number generators)
India ink and pencil on paper,
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Orono Mathfest
August 8–10, 1991

Preliminary Program

The preliminary program for the Orono Mathfest follows. Participants who preregistered by June 6 and who so elected will have their badge and the final program mailed to them before the meetings. All other registrants will receive the final program at the meetings. Participants who have not yet registered should read the information in the April and May/June issues of *Notices* and *Focus* for further details. The additional information below is to assist those who will register at the meetings and those preregistrants who elected not to receive their badge and final program by mail.

Program Updates

AMS Committee on Science Policy Panel Discussion

The Committee on Science Policy will sponsor a panel discussion on *Report of the Strategic Planning Task Force: Its potential for the coming decade* on Thursday, August 8, from 2:00 p.m. to 3:00 p.m. The panel will discuss the report of the Task Force (recently unanimously endorsed by the Executive Committee and Board of Trustees) and how its conclusions can impact the community. Panelists include **Richard A. Askey**, University of Wisconsin, Madison; **Lenore Blum**, International Computer Science Institute; **Harvey B. Keynes**, University of Minnesota, Minneapolis; and **Michael C. Reed**, Duke University. The moderator is **Hugo Rossi**, University of Utah. All those attending the Orono Mathfest are encouraged to attend.

MAA Report on the Undergraduate Major Panel Discussion

A panel discussion on *The major in the mathematical sciences–Looking forward*, will take place from 1:00 p.m. to 2:30 p.m. on Friday. This panel is sponsored by the CUPM subcommittee on the Undergraduate Major and will be organized by the committee chair, **Bettye Anne Case**. Panelists include **Richard A. Alo**, University of Houston, Downtown; **Jerry L. Bona**, Pennsylvania State University; **J. Kevin Colligan**, National Security Agency; **William A. Marion**, Valparaiso University; **Samuel M. Rankin, III**, Worcester Polytechnic Institute; and **Alan C. Tucker**, SUNY at Stony Brook.

AWM-MAA Panel Discussion

Panelists for the AWM-MAA Panel Discussion on *Careers that count: Opportunites in the mathematical sciences* on Thursday, August 8, at 3:00 p.m. include **Jacquie Callahan**, Jet Propulsion Laboratory; **Sharon Chapman**, Amherst Junior High School; **Ruth Gonzalez**, Exxon; and **Allyn Jackson**, AMS Staff Writer. **Jenny Baglivo**, Boston College, will serve as moderator.

JPBM/OGPA Session

The **Joint Policy Board for Mathematics** and the **Office of Governmental and Public Affairs** is sponsoring a forum on *The academic employment situation for mathematicians.* This forum will take place on Friday, August 9, from 7:15 p.m. to 8:15 p.m. instead of the time previously announced and there not be a reception following session. The program will consist of two fifteen-minute presentations. The first by **Donald E. McClure**, Brown University and chair of the AMS-MAA Data Committee. He will give as up-to-date a picture of the employment situation for new mathematicians as can be had from data already in our hands. The second presenter will be the as yet unnamed chair of the AMS Task Force on Employment. He or she will report on the approach to the study of the employment problem under development by the Task Force at the time of the Orono meeting. These presentations will be followed by a period for audience comments, questions, and suggestions.

CBMS Session

On Friday, August 9, at 6:00 p.m. a preliminary report of the 1990 CBMS Suvey of Undergraduate Programs in the Mathematical Science and Computer Science will be presented by **Donald Rung**, survey director, and **Donald Loftsgaarden**, survey statistician. Figures will be given on enrollments, baccalaureate degree granted, faculty characteristics, calculus innovations, features of the mathematics major program, math library holdings, and other items. Similar information on two-year colleges will be presented.

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 obtain discounts at the AMS and MAA Book Sales and to cash a check with the Mathfest cashier. If a preregistrant should arrive too late in the day to pick up his/her badge, he/she may show the acknowledgement received from the Mathematics Meetings Service Bureau as proof of registration.

Registration fees: Registration fees may be paid at the meetings in cash, by personal or travelers' check, or by Visa or MasterCard credit card. Canadian checks must be marked for payment in U.S. funds. Although other credit cards are being accepted by hotels for housing payments, only Visa or MasterCard can be accepted for registration. Letters verifying attendance at the meetings can be obtained from the Mathfest cashier or at the Registration Assistance section of the registration desk.

Joint Mathematics Meetings

Member of AMS, Canadian Mathematical Society, MAA, $\pi\mu\epsilon$	\$111
Emeritus Member of AMS, MAA	\$ 33
Nonmember	\$172
Student/Unemployed	\$ 33

AMS Short Course

Student/Unemployed	\$ 30
Member/Nonmember	\$ 70
Emeritus Member of AMS, MAA	\$ 30

MAA Minicourses
(if openings available)

Minicourses #1-9	\$ 36

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 meetings and pay the nonmember fee will receive mailings from AMS and MAA, after the meetings are over, containing information about a special membership offer.

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.

Registration Dates, Times, and Locations

AMS Short Course
Outside Room 137, Bennett Hall

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

Joint Mathematics Meetings
[and MAA Minicourses (until filled)]
Lown Room, Memorial Union

Wednesday, August 7	3:00 p.m. to	6:00 p.m.
Thursday-Friday, August 8-9	8:00 a.m. to	4:00 p.m.
Saturday, August 10	8:00 a.m. to	1:00 p.m.

Accommodations

Participants who did not reserve a room during preregistration but who would like to obtain a dormitory room should go to the Reception Desk in Wells Commons for room assignments. **The number of rooms available is limited and based on availability only.** Those participants being assigned a room on-site by the university will be required to fill out a housing form and to sign a form to be given to the Mathfest Housing Coordinator, to whom payment should be given at the Registration Assistance Section of the Mathfest registration desk.

Those who want to reserve a room at the hotels/motels listed on page 332 of the April issue of *Notices* should call the hotel/motel directly. At this time, convention rates cannot be guaranteed.

Questions about on-site room assignments should be directed to the Housing Coordinator at 401-455-4145 or by electronic mail: meet@math.ams.com.

Preliminary Program of the Sessions

If available, abstracts of papers presented by AMS-MAA lecturers, AMS History of Mathematics lecturer, AMS Progress in Mathematics lecturers, MAA Hedrick lecturer, MAA-Mu Alpha Theta lecturer, and speakers in other MAA sessions will be found in a colored insert in the program given to registrants. Abstracts of papers presented in AMS Special Sessions and AMS Sessions for Contributed Papers will be found in the August issue of *Abstracts of papers presented to the American Mathematical Society*, which will also be provided to registrants at the meeting, upon request. Abstracts for other talks are not available.

To maintain the schedule, beginning and ending times of presentations will be strictly enforced. For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting. Where a presenter is visiting another institution, the permanent affiliation is given first, followed by the name of the institution being visited.

Tuesday, August 6

AMS Short Course

2:00 p.m.–5:30 p.m.

2:00 p.m. (1) *The unreasonable effectiveness of number theory in physics, communication, and music.*
Manfred R. Schroeder, University of Göttingen, Germany

3:45 p.m. (2) *Number theory and statistical mechanics.*
George E. Andrews, Pennsylvania State University, University Park

5:00 p.m. General Discussion

Wednesday, August 7

MAA Board of Governors

8:00 a.m.–4:00 p.m.

AMS Short Course

9:00 a.m.–5:30 p.m.

9:00 a.m. (3) *Number theory and dynamical systems.*
Jeffrey C. Lagarias, AT&T Bell Laboratories, Murray Hill, New Jersey

10:45 a.m. (4) *The mathematics of random number generators.*
George Marsaglia, Florida State University

2:00 p.m. (5) *Cyclotomy and cyclic codes.*
Vera S. Pless, University of Illinois, Chicago

3:45 p.m. (6) *Number theory in computer graphics.*
M. Douglas McIlroy, AT&T Bell Laboratories, Murray Hill, New Jersey

5:00 p.m. General Discussion

AMS Council

2:00 p.m.–6:30 p.m.

MAA Section Officers

4:00 p.m.–6:00 p.m.

Thursday, August 8

AMS-MAA Invited Address

8:30 a.m.–9:20 a.m.

(7) *On the maximum principle.*
Louis Nirenberg, Courant Institute of Mathematical Sciences, New York University

MAA Earle Raymond Hedrick Lectures: Lecture I

9:35 a.m.–10:25 a.m.

(8) *The sensual (quadratic) form. Can you see the values of* $3x^2 + 6xy - 5y^2$?
John Horton Conway, Princeton University

AMS Progress in Mathematics Lecture

10:40 a.m.–12:10 p.m.

(9) *Algorithms in algebraic number theory.* Preliminary report.
H. W. Lenstra, Jr., University of California, Berkeley
(867-11-100)

AMS Business Meeting

12:25 p.m.–12:55 p.m.

National Science Foundation Informal Discussion Group

1:00 p.m.–2:00 p.m.

Thursday, August 8 (cont'd)

MAA-Mu Alpha Theta Lecture

1:40 p.m.–2:30 p.m.

(10) *Calculus in an age of technology.*
Paul A. Foerster, Alamos Heights High School, San Antonio, Texas

AMS Special Session on Commutative Noetherian Rings with Applications in Algebraic Geometry, I

1:40 p.m.–5:30 p.m.

1:40 p.m. (11) *Tangent modules of symmetric algebras.* Preliminary report.
Aron Simis, Universidade Federal da Bahia, Brazil, **Bernd Ulrich**, Michigan State University, and **Wolmer V. Vasconcelos***, Rutgers University, New Brunswick (867-13-22)

2:10 p.m. (12) *The ideal theory of graphs.* Preliminary report.
Aron Simis, Universidade Federal da Bahia, Brazil, **Wolmer V. Vasconcelos**, Rutgers University, New Brunswick, and **Rafael H. Villarreal***, Institute Politecnico National, Mexico (867-13-26)

2:40 p.m. (13) *Grade four almost complete intersections and linkage.* Preliminary report.
Susan M. Palmer, Southwest Missouri State University (867-13-31)

3:10 p.m. (14) *On quasihomogeneity of isolated singularities.*
Alex Martsinkovsky, Northeastern University (867-13-24)

3:40 p.m. (15) *Regular differential forms and relative duality.* Preliminary report.
Reinhold Hübl, University of Regensburg, Germany (867-14-40)

4:10 p.m. (16) *On the descent of the approximation property.*
Dana Weston, University of Missouri, Columbia (867-13-49)

4:40 p.m. (17) *Weak d-sequences generate ideals of quadratic type.*
K. N. Raghavan, Purdue University, West Lafayette (867-13-97)

5:10 p.m. (18) *Betti numbers of modules of finite length.* Preliminary report.
Matthew Miller, University of South Carolina, Columbia (867-13-56)

AMS Special Session on Continuum Theory and Dynamical Systems, I

1:40 p.m.–5:30 p.m.

1:40 p.m. (19) *Full attracting sets of annulus maps which are inverse limits of circles.*
Sarah Holte, University of Missouri, Rolla (867-58-73)

2:10 p.m. (20) *On certain inverse limits as non-hyperbolic attractors.*
Witold Szczechla, University of Maryland, Baltimore County (867-58-161)

2:40 p.m. (21) *Inverse limits on* $[0,1]$ *with logistic bonding maps.* Preliminary report.
Marcy Barge, Montana State University, and **W. T. Ingram***, University of Missouri, Rolla (867-54-87)

3:10 p.m. (22) *Dynamical properties of the shift maps on the inverse limit spaces.*
Shihai Li, University of Florida (867-55-80)

3:40 p.m. (23) *Prime and dynamics associated with the Hénon map.*
Marcy Barge, Montana State University (867-58-91)

4:10 p.m. (24) *Dimension, differentiability and dynamics-a survey of recent results.* Preliminary report.
Jenny Harrison, Mathematical Sciences Research Institute, Berkeley (867-58-188)

4:40 p.m. (25) *Distortion in Denjoy dynamics on the* 2*-torus.* Preliminary report.
Alec Norton, University of Texas, Austin (867-58-78)

5:10 p.m. (26) *Denjoy diffeomorphisms of the torus.* Preliminary report.
Vladimir N. Akis, California State University, Los Angeles (867-57-108) (Sponsored by John C. Mayer)

AMS Special Session on Analytic Number Theory, I

1:40 p.m.–5:00 p.m.

1:40 p.m. (27) *Cyclotomic polynomials with large coefficients.*
Helmut Maier, University of Georgia (867-11-129)

2:10 p.m. (28) *Mean-value theorem for character sums.*
John Friedlander, University of Toronto (867-11-88)

2:40 p.m. (29) *Approximations to fractional powers of* $\zeta(s)$ *by Dirichlet polynomials.* Preliminary report.
Brian Conrey, Oklahoma State University, Stillwater (867-11-186)

3:10 p.m. (30) *An exponential sum over primes.*
Daniel A. Goldston, San Jose State University (867-11-171)

3:40 p.m. (31) *On the sum* $\Sigma I_{0<\gamma\leq T}|\zeta'(p)|^{2}$.
Steven M. Gonek, University of Rochester (867-11-162) (Sponsored by William M. Snyder)

4:10 p.m. (32) *Non-vanishing theorems for* L*-functions.*
V. Kumar Murty, University of Toronto (867-11-187)

4:40 p.m. (33) *Lower and upper bounds for the number of representations of an integer as a sum of* $5, 6, 7,$ *or* 8 *squares.*
Paul T. Bateman, University of Illinois, Urbana-Champaign (867-11-154)

AMS Special Session on Geometric Inequalities for Polytopes, I

1:40 p.m.–5:30 p.m.

1:40 p.m. (34) *Aesthetics and geometric inequalities.*
Daniel Pedoe, University of Minnesota, Minneapolis (867-51-144) (Sponsored by Stanley Rabinowitz)

2:10 p.m. (35) *A new look at some old inequalities.*
Roland H. Eddy, Memorial University of Newfoundland (867-51-53) (Sponsored by Stanley Rabinowitz)

2:40 p.m. (36) *Generalizations of Ptolemy's inequality.*
Murray S. Klamkin, University of Alberta (867-52-69)

3:10 p.m. (37) *Betweeness relations among centers and lines in the plane of a triangle.*
Clark Kimberling, University of Evansville (867-51-43)

3:40 p.m. (38) *Inequalities of a triangle involving products of angles.* Preliminary report.
Peter Yff, Ball State University (867-51-145)

4:10 p.m. (39) *Some inequalities for inradii associated with a simplex.*
Stanley Rabinowitz, MathPro Press , Westford, Massachusetts (867-51-176)

4:40 p.m. (40) *A trigono-geometric relationship.* Preliminary report.
Leon Bankoff, Los Angeles, California (867-51-175)

5:10 p.m. Informal Discussion

AMS Special Session on Variational Methods, Differential Analysis and Symmetry, I

1:40 p.m.–5:00 p.m.

1:40 p.m. (41) *Kostant's convexity theorem in infinite dimension.* Preliminary report.
Chuu-Lian Terng, Northeastern University (867-53-77)

2:10 p.m. (42) *A new Cayley-Hamilton theorem.*
Robert S. Williams*, **Matthew Stafford**, University of Texas, Austin, and **Steve Kennedy**, University of Delaware (867-58-149)

2:40 p.m. (43) *Regularizing the second fundamental form for Yang-Mills orbits.* Preliminary report.
Yohiaki Maeda, Keio University, Japan, **Philippe Tondeur**, University of Illinois, Urbana-Champaign, and **Steven Rosenberg***, Boston University (867-58-54)

3:10 p.m. (44) *An example of the Poisson action of a Lie group.*
Karen Uhlenbeck, University of Texas, Austin (867-53-151)

3:40 p.m. (45) *Quantum symmetry, knot invariants, and topology.* Preliminary report.
Louis Crane, Yale University (867-55-132)

4:10 p.m. (46) *Singularities of solution to some variational problems.*
Libin Mou, University of Minnesota, Minneapolis (867-49-137)

4:40 p.m. (47) *On the positive solutions of semilinear equations* $\Delta u + \lambda u - hu^p = 0$ *on the compact manifolds.*
Tiancheng Ouyang, University of Toledo (867-35-61) (Sponsored by Chuu-Lian Terng)

AMS Special Session on Function Algebras and Function Spaces, I

1:40 p.m.–6:30 p.m.

1:40 p.m. (48) *Sequences in the maximal ideal space of* H^∞.
Sheldon Axler*, Michigan State University, and **Pamela Gorkin**, Bucknell University (867-30-42)

2:10 p.m. (49) *Bourgain algebras on the unit disk.* Preliminary report.
Joseph A. Cima*, University of North Carolina, Chapel Hill, **Karel Stroethoff** and **Keith Yale**, University of Montana (867-30-04)

2:40 p.m. (50) *Polynomial extreme points of the unit ball of* $H^\infty(B)$.
John McDonald, Arizona State University (867-46-41)

3:10 p.m. (51) *Multiplicative structure of de Branges spaces.*
Benjamin A. Lotto* and **Donald Sarason**, University of California, Berkeley (867-30-21)

3:40 p.m. (52) *Möbius-invariant subspaces of the Bloch space and their relation to BMOA.*
Pratibha Ghatage*, Cleveland State University, and **Dechao Zheng**, State University of New York, Stony Brook (867-30-156)

4:10 p.m. (53) *Closed ideals of weak Bezout type in* H^∞.
Raymond Mortini, University of Karlsruhe, Germany (867-30-120)

4:40 p.m. (54) *Bourgain algebras of the disk, polydisk and ball algebras.* Preliminary report.
Keiji Izuchi, Kanagawa University, Japan (867-46-59)

5:10 p.m. (55) *Compact weighted composition operators on the* L^p*-spaces.* Preliminary report.
Hiroyuki Takagi, Waseda University, Japan (867-46-62)

5:40 p.m. (56) *Isometries of abstract Bloch spaces.* Preliminary report.
Krzysztof Jarosz, Southern Illinois University, Edwardsville (867-46-164)

6:10 p.m. (57) *Functions that operate on a Banach function algebra.* Preliminary report.
Osamu Hatori, Tokyo Medical College, Japan (867-46-83)

AMS General Session, I

1:40 p.m.–6:40 p.m.

1:40 p.m. (58) *Decision problems in linear algebra and in language theory.*
Melven Krom*, University of California, Davis, and **Myren Krom**, California State University, Sacramento (867-03-85)

1:55 p.m. (59) *Binary matroids with every circuit basis fundamental.* Preliminary report.
Lawrence Wargo, Louisiana State University, Baton Rouge (867-05-140)

2:10 p.m. (60) *The number of* D*-classes in the semigroup of binary relations on* 5 *elements.* Preliminary report.
George Markowsky, University of Maine, Orono (867-08-19)

2:25 p.m. (61) *Integral bases for quartic number fields that have a quadratic subfield.*
James G. Huard*, Carleton University, **Blair K. Spearman**, Carleton University and Okanagan College, and **Kenneth S. Williams**, Carleton University (867-11-153)

2:40 p.m. (62) *Variations of the* L^3 *base reduction algorithm in two dimensions yield continued fractions!* Preliminary report.
Alice A. Deanin, Villanova University (867-11-45)

2:55 p.m. (63) *A Fibonacci congruence.*
Donald F. Bailey, Trinity University (867-11-75)

3:10 p.m. (64) *On Galois embedding problem for p-extensions in characteristic p.*
T. Kambayashi, Tokyo Denki University, Japan (867-12-105)

3:25 p.m. (65) *Product schemes with group action and secant sheaves on quotients.*
Mark Huibregtse, Skidmore College (867-14-179)

3:40 p.m. (66) *Quadratic forms and Ternery algebras.*
Xiaorong Shen, Iowa State College, Ames (867-15-134)

Thursday, August 8 (cont'd)

3:55 p.m. (67) *Chain addition cycles.* Preliminary report.
Jody Lockhart and **William Wardlaw***, United States Naval Academy (867-15-139)

4:10 p.m. (68) *The divisor and summatory functions of integer matrices.*
Gautami Bhowmik, Jesus & Mary College, India (867-15-190) (Sponsored by Ashok K. Agarwal)

4:25 p.m. (69) *Certain cotriples on Cat.*
Paul G. Glenn, Catholic University of America (867-18-131)

4:40 p.m. (70) *A generalization of Hamiltonian groups.*
Joseph Buckley*, Western Michigan University, **John C. Lennox** and **James Wiegold**, University of Wales, United Kingdom (867-20-133)

4:55 p.m. (71) *The endocenter and representation theory.* Preliminary report.
Jon Phillips, Iowa State College, Ames (867-20-172)

5:10 p.m. (72) *Verma bases for irreducible A_n modules and for their kernels.*
A. J. Coleman, Queen's University, and **R. W. Deckhart***, Kansas State University (867-22-158)

5:25 p.m. (73) *Convergence without epsilons.*
Darwin E. Peek, Trinity University (867-26-117)

5:40 p.m. (74) *Characteristic functions of certain Carleman classes.*
Jamil A. Siddiqi, Université Laval (867-26-191)

6:00 p.m. (75) *H^p-classes on spaces of negative curvature.*
Adam Koranyi, Herbert H. Lehman College, City University of New York (867-31-110)

6:15 p.m. (76) *Postulational formulation of the Maxwell equations.*
Arjan Sobhraj Mirchandaney, Defiance College, **Domina Eberle Spencer***, University of Connecticut, Storrs, **Shama Y. Uma**, Bridgewater State College, and **Philip J. Mann**, University of Connecticut, Storrs (867-31-167)

6:30 p.m. (77) *Different and trace.*
Joseph Lewittes, Herbert H. Lehman College, City University of New York (867-12-14)

MAA Session on Using Student Projects in the First Two Years of the Curriculum, I

1:40 p.m.–5:45 p.m.

1:40 p.m. Introduction

1:45 p.m. (78) *Using student projects in an elementary math modeling course (graphs and networks) for liberal arts students.*
Helen Christensen, Loyola College in Maryland

2:05 p.m. (79) *Strip patterns: A project in ethnomathematics.*
Marcia Ascher, Ithaca College

2:25 p.m. (80) *Using student reading projects in linear algebra.*
Christine R. Leverenz, Georgetown College

2:45 p.m. (81) *Calculus, differential equations, and linear algebra projects at the University of Arizona.*
David O. Lomen* and **David Lovelock**, University of Arizona

3:05 p.m. (82) *A projects-based calculus.* I.
Eric E. Robinson, Ithaca College

3:25 p.m. (83) *Student research projects in calculus: A department-wide program.*
David J. Pengelley, New Mexico State University, Las Cruces

3:40 p.m. Break

3:50 p.m. (84) *Conjecture and experimentation in a calculus laboratory.*
Lawrence C. Moore and **David A. Smith***, Duke University

4:10 p.m. (85) *Using student projects in calculus.*
Mic Jackson, Earlham College

4:30 p.m. (86) *Student projects: An historical perspective to calculus.*
Ronald N. Bell, Midland Valley High School, Langley, South Carolina

4:50 p.m. (87) *Who are these mathematicians?*
Kay Gura, Ramapo College of New Jersey

5:10 p.m. (88) *The chromatic triangles project.*
Dorothy Buerk, Ithaca College

5:30 p.m. (89) *Art research project for a geometry course.*
Catherine A. Gorini, Maharishi International University

Pi Mu Epsilon Contributed Paper Session

1:40 p.m.–6:40 p.m.

MAA Minicourse #1: Part A

1:45 p.m.–3:45 p.m.

Julia sets and the Mandelbrot set. **Robert L. Devaney**, Boston University

MAA Minicourse #2: Part A

1:45 p.m.–3:45 p.m.

Integrating calculus and physics for freshmen. **Joan R. Hundhausen** and **F. Richard Yeatts**, Colorado School of Mines

MAA Minicourse #3: Part A

1:45 p.m.–3:45 p.m.

Making mathematics more concrete. **Agnes Azzolino**, Mathematical Concepts

AMS Committee on Science Policy Panel Discussion

2:00 p.m.–3:00 p.m.

Report of the Strategic Planning Task Force: Its potential for the coming decade.

AWM-MAA Panel Discussion

3:00 p.m.–4:00 p.m.

Careers that count: Opportunities in the mathematical sciences.

MAA Minicourse #4: Part A

4:00 p.m.–6:00 p.m.

Teaching mathematical modeling. **Frank Giordano**, U.S. Military Academy, and **Maurice Weir**, Naval Postgraduate School

MAA Minicourse #5: Part A

4:00 p.m.–6:00 p.m.

Conceptualizing, organizing, and seeking funding for teacher education projects. **Joan Ferrini-Mundy**, University of New Hampshire, and **Carole Lacampagne**, National Science Foundation

MAA Minicourse #6: Part A

4:00 p.m.–6:00 p.m.

Symmetry analysis of repeated patterns. **Donald Crowe**, University of Wisconsin, Madison

MAA Minicourse #7: Part A

4:00 p.m.–6:00 p.m.

Great theorems from mathematical analysis: 1689-1881. **William Dunham**, Hanover College

AWM Membership Meeting

4:00 p.m.–4:30 p.m.

MAA Committee on Computers in Mathematics Education & CUPM Subcommittee on Symbolic Computer Systems Panel Discussion

4:15 p.m.–6:15 p.m.

Uses of computers in NSF calculus projects.

Friday, August 9

AMS-MAA Invited Address

8:30 a.m.–9:20 a.m.

(90) *Mathematics under hardship conditions in the Third World.*
Neal I. Koblitz, University of Washington

MAA Earle Raymond Hedrick Lecture: Lecture II

9:35 a.m.–10:25 a.m.

(91) *The sensual (quadratic) form. Can you hear the shape of a lattice?*
John Horton Conway, Princeton University

AMS History of Mathematics Lecture

10:40 a.m.–11:30 a.m.

(92) *The interaction between mathematics and physics with emphasis on the nineteenth century.*
G. W. Mackey, Harvard University

PME Council

noon–1:00 p.m.

AMS Special Session on Problems in Number Theory, I

1:00 p.m.–5:50 p.m.

1:00 p.m. (93) *Some number-theoretic divisibility problems.*
R. L. Graham, AT&T Bell Laboratories, Murray Hill, New Jersey (867-11-67)

1:30 p.m. (94) *Estimates of the least prime factor of a binomial coefficient.*
Carole B. Lacampagne, National Science Foundation and Northern Illinois University (867-11-192)

2:00 p.m. (95) *Reverse digit constructions of perfect, magic and doubly magid cubes.* Preliminary report.
Joseph Arkin, **David C. Arney***, **Frank R. Giordano**, **Rickey A. Kolb** and **Paul Smith**, United States Military Academy (867-11-01)

2:30 p.m. (96) *A note on the sequence* $\{F_{5n}/(5F_n)\}$. Preliminary report.
Marco Bucci, **Adina Di Porto** and **Piero Filipponi***, Fondazione Ugo Bordani, Italy (867-11-08)

Friday, August 9 (cont'd)

3:00 p.m. (97) *A classification scheme for Stolarsky interpersions.*
Clark Kimberling, University of Evansville (867-11-44)

3:30 p.m. (98) *Stirling relationships.* Preliminary report.
Joseph Arkin, **David C. Arney**, **Frank R. Giordano** and **Rickey A. Kolb***, United States Military Academy (867-11-10)

4:00 p.m. (99) *On p-class groups of cyclic extensions of prime degree p of number fields.*
Frank Gerth, III, University of Texas, Austin (867-11-06)

4:30 p.m. (100) *Some stray footnotes in the spirit of recreational mathematics.*
Herta T. Freitag, Roanoke, Virginia (867-11-70)

5:00 p.m. (101) *Algorithmic manipulation of Fibonacci identities.*
Stanley Rabinowitz, MathPro Press, Westford, Massachusetts (867-11-178)

5:30 p.m. (102) *Various Diophantine equations in various stages of solution.*
Richard K. Guy, University of Calgary (867-11-17)

AMS Special Session on Commutative Noetherian Rings with Applications in Algebraic Geometry, II

1:00 p.m.–5:20 p.m.

1:00 p.m. (103) *Old and new results on Buchsbaum rings.*
Wolfgang Vogel, Martin-Luther-Univesity, Germany (867-13-07) (Sponsored by Andrew R. Kustin)

1:30 p.m. (104) *Quotients of toric varieties.*
M. M. Kapranov, **B. Sturmfels*** and **A. V. Zelevinsky**, Cornell University (867-14-16)

2:00 p.m. (105) *Projective lines over one-dimensional semilocal domains.*
William Heinzer, Purdue University, West Lafayette, **David Lantz**, Colgate University, and **Sylvia Wiegand***, University of Nebraska, Lincoln (867-13-55)

2:30 p.m. (106) *Remarks on hyperplane sections of a Veronese variety.* Preliminary report.
Wei-Eihn Kuan, Michigan State University (867-13-30)

3:00 p.m. (107) *Local geometry of smooth curves on singular surfaces.*
David B. Jaffe, University of Nebraska, Lincoln (867-14-18)

3:30 p.m. (108) *Purity, flatness, and filtered rings.* Preliminary report.
Joseph P. Brennan, North Dakota State University (867-13-182)

4:00 p.m. (109) *Subalgebras of polynomial rings.*
Sarah Glaz, University of Connecticut, Storrs (867-13-39)

4:30 p.m. (110) *Results about homogeneous coordinate rings of rational surfaces in projective space.*
A. V. Geramita, Queen's University, **A. Gimigliano**, University of Genova, Italy, and **B. Harbourne***, University of Nebraska, Lincoln (867-14-52)

5:00 p.m. (111) *Equational constraints and module-finite extension of domains.* Preliminary report.
Ian M. Aberbach, Purdue University, West Lafayette (867-13-48)

AMS Special Session on Continuum Theory and Dynamical Systems, II

1:00 p.m.–5:20 p.m.

1:00 p.m. (112) *Pleating coordinates for the Riley slice of Schottky space.*
Linda Keen*, Herbert H. Lehman College, City University of New York, and **Caroline Series**, Warwick University, England (867-30-79)

1:30 p.m. (113) *Indecomposable continua and Julia sets.* Preliminary report.
James T. Rogers, Jr., Tulane University (867-58-122)

2:00 p.m. (114) *Topology and the complex exponential.*
Robert L. Devaney, Boston University (867-30-180)

2:30 p.m. (115) *Pseudocircles in dynamical systems.*
Judy Kennedy*, University of Delaware, and **James A. Yorke**, University of Maryland, College Park (867-54-86)

3:00 p.m. (116) *Minimal sets of dynamical systems.*
Krystyna Kuperberg, Auburn University (867-58-121)

3:30 p.m. (117) *Dynamics of annulus homeomorphisms.* Preliminary report.
Philip Boyland, State University of New York, Stony Brook (867-58-159)

4:00 p.m. (118) *Accessible rotation number of attractors in crisis.*
Kathleen T. Alligood, George Mason University (867-58-160)

4:30 p.m. (119) *Rotation numbers on cofrontiers.* Preliminary report.
Mark Turpin, Boston University (867-58-106)

5:00 p.m. (120) *Denjoy meets rotation on an indecomposable cofrontier.*
John C. Mayer* and **Lex G. Oversteegen**, University of Alabama, Birmingham (867-54-81)

AMS Special Session on Geometric Inequalities for Polytopes, II

1:00 p.m.–3:50 p.m.

1:00 p.m. (121) *Extremal polyhedra inscribed in spheres.* Preliminary report.
Kenneth B. Stolarsky, University of Illinois, Urbana-Champaign (867-52-66)

1:30 p.m. (122) *Existent and non-existent spherical simplexes.*
Boris V. Dekster, Mount Allison University (867-51-35)

2:00 p.m. (123) *Cross-sectional inequalities for cubes.* Preliminary report. **Eric L. Grinberg**, Temple University (867-51-177)

2:30 p.m. (124) *Geometric inequalities and random products.* **John M. Dye**, California State University, Northridge, and **Simeon Reich***, University of Southern California (867-52-65)

3:00 p.m. (125) *Polar duals of rotors.* **Mostafa Ghandehari**, Naval Postgraduate School (867-52-25)

3:30 p.m. Informal Discussion

AMS Special Session on Function Algebras and Function Spaces, II

1:00 p.m.–5:50 p.m.

1:00 p.m. (126) *A characterisation of pick bodies in C^n.* Preliminary report. **Brian Cole**, **Keith Lewis** and **John Wermer***, Brown University (867-46-12)

1:30 p.m. (127) *Maximum modulus algebras with analytic varieties.* **Donna Kumagai***, Pennsylvania State University, Reading, and **Zbigniew Slodkowski**, University of Illinois, Chicago (867-46-89)

2:00 p.m. (128) *Using infinitely many complex variables to attack a problem in one complex variable.* Preliminary report. **Alexander J. Izzo**, University of Michigan, Ann Arbor (867-46-94)

2:30 p.m. (129) *Some remarks on uniform approximation.* **P. M. Gauthier**, University of Montreal (867-32-152)

3:00 p.m. (130) *Approximation on a disk.* Preliminary report. **Peter J. De Paepe**, University of Amsterdam, The Netherlands (867-32-50)

3:30 p.m. (131) *Algebras of Γ-analytic functions in the big-plane.* Preliminary report. **Toma Tonev**, University of Toledo (867-46-119)

4:00 p.m. (132) *Cauchy transforms of measures and weighted shift operators on the disc algebra.* **R. A. Hibschweiler*** and **E. A. Nordgren**, University of New Hampshire (867-30-60)

4:30 p.m. (133) *Properties diametrically opposite to those which characterize $C(X)$.* Preliminary report. **Chris White**, Castleton State College (867-46-130) (Sponsored by I. K. Yale)

5:00 p.m. (134) *The cyclic behavior of translation operators on Hilbert spaces of entire functions.* **Kit C. Chan** and **Joel H. Shapiro***, Michigan State University (867-47-82)

5:30 p.m. (135) *Banach algebras, decomposable multipliers, and applications to harmonic analysis.* **Michael M. Neumann**, Mississippi State University (867-47-90)

MAA Minicourse #4: Part B

1:00 p.m.–3:00 p.m.

Teaching mathematical modeling. **Frank Giordano**, U.S. Military Academy, and **Maurice Weir**, Naval Postgraduate School

MAA Minicourse #8: Part A

1:00 p.m.–3:00 p.m.

Knot theory for undergraduates. **Stefanos Gialamas**, Columbia College

MAA Minicourse #9: Part A

1:00 p.m.–3:00 p.m.

Unifying themes for discrete mathematics. **Ralph Grimaldi**, Rose-Hulman Institute of Technology

AMS General Session, II

1:00 p.m.–5:55 p.m.

1:00 p.m. (136) *Classical formulations of the Maxwell equations.* **Arjan S. Mirchandaney**, Defiance College, **Domina E. Spencer**, University of Connecticut, Storrs, **Shama Y. Uma***, Bridgewater State College, and **Philip J. Mann**, University of Connecticut, Storrs (867-31-168)

1:15 p.m. (137) *Gaussian formulations of the Maxwell equations.* **Arjan S. Mirchandaney**, Defiance College, **Domina E. Spencer**, University of Connecticut, Storrs, **Shama Y. Uma**, Bridgewater State College, and **Philip J. Mann***, University of Connecticut, Storrs (867-31-169)

1:30 p.m. (138) *A vector method of solving potential equations with Neumann boundary conditions.* **Gerard Coutu***, Hartford Graduate Center, **Domina Eberle Spencer** and **Wallace W. Bowley**, University of Connecticut, Storrs (867-31-170)

1:45 p.m. (139) *The limits for Jacobi function of the second kind.* **Mihr J. Shah**, Kent State University (867-33-33)

2:00 p.m. (140) *Dirichlet averages and B-splines.* **B. C. Carlson**, Iowa State University (867-33-103)

2:15 p.m. (141) *Behavior of the integral curves of differential systems near a singular point.* Preliminary report. **Zhivko S. Athanassov**, Bulgarian Academy of Sciences, Bulgaria (867-34-112)

2:30 p.m. (142) *Weighted composition operators, semigroups, linear skew-product flows, spectral theory and the multiplicative ergodic theorem.* **Yuri D. Latushkin**, Mathematical Sciences Research Institute, Berkeley (867-34-174)

Friday, August 9 (cont'd)

2:45 p.m. (143) *The perturbed Toda lattice.*
Russell L. Herman, University of North Carolina, Wilmington (867-35-147)

3:00 p.m. (144) *Complex sequences whose "moments" all vanish.*
W. M. Priestley, University of the South (867-40-138)

3:15 p.m. (145) *Smooth interpolating curves and surfaces generated by iterated function systems.*
Peter R. Massopust, Vanderbilt University (867-41-28)

3:30 p.m. (146) *Martingale transforms and Hardy spaces.*
J.-A. Chao*, Cleveland State University, and **R.-L. Long**, Academia Sinica, Peoples Republic of China (867-41-111)

3:45 p.m. (147) *Amenable left Banach $L^1(G)$-modules and subspaces of $L^\infty(G)$.*
A. G. Myasnikov, Moscow Civil Engineering Insitute, USSR (867-43-02)

4:00 p.m. (148) *Theorems on Stieltjes type integral transforms and their applications.*
Osman Yurekli, Ithaca College (867-44-141)

4:15 p.m. (149) *Some multi-dimensional Laplace transforms involving radical form.*
M. Vinayagamoorthy, Arkansas College (867-44-116)

4:30 p.m. (150) *The analytic Poincaré inequality and trace class operators.*
Valentin Andreev, Lamar University (867-46-183)

4:45 p.m. (151) *Trylonizations revisited.*
Rodney T. Hood, Franklin College (867-51-189)

5:00 p.m. (152) *On the estimate of the first eigenvalue of the Laplacian on a compact Riemannian manifold.* Preliminary report.
Dong Pyo Chi, Seoul National University, Korea (867-53-05)

5:15 p.m. (153) *A note on $w\Delta$ spaces.* Preliminary report.
G. R. Hiremath, Talladega College (867-54-51)

5:30 p.m. (154) *Whitney duality theorems for simplicial manifolds.*
Ockle E. Johnson, Saint Olaf College (867-57-155)

5:45 p.m. (155) *The stabilization of a linearized self-excited wave equation by an energy absorbing boundary.*
G. R. Sarhangi* and **H. K. Wang**, Wichita State University (867-93-195)

MAA Session on Relating Mathematics to the Real World: Applications of Mathematics for Classroom Use

1:00 p.m.–4:55 p.m.

1:00 p.m. (156) *Applications of algebra to environomental issues.*
Christopher Schaufele* and **Nancy Zumoff**, Kennesaw State College

1:30 p.m. (157) *Life in the fast lane, a problem from the Indy 500.*
John H. Rickert, Rose-Hulman Institute of Technology

2:00 p.m. (158) *Lifetime of geothermal injection wells.*
John Beebee, University of Alaska, Anchorage

2:30 p.m. (159) *Iceberg drift prediction model.*
Ted Lindstrom and **Ernest Manfred***, United States Coast Guard Academy

3:00 p.m. (160) *Indepth applications for a differential equations course.*
Leslie Hogben, Iowa State College, Ames

3:30 p.m. (161) *A differential-difference equation modeling human circulatory systems.*
Herbert R. Bailey, Rose-Hulman Institute of Technology

4:00 p.m. (162) *Relating mathematics to the real world: Applications of mathematics for classroom use.*
Robert D. Larsson, Schenectady, New York

4:30 p.m. Summary and General Discussion

MAA Session on Using Student Projects in the First Two Years of the Curriculum, II

1:00 p.m.–2:40 p.m.

1:00 p.m. Introduction

1:00 p.m. (163) *Student projects in an algebraic and discrete structures course.*
William A. Marion, Valparaiso University

1:25 p.m. (164) *Community college calculus collaborative computer projects.*
Lawrence Sher, Manhattan Community College

1:45 p.m. (165) *Computer projects in calculus and differential equations.*
William W. Farr* and **Paul W. Davis**, Worcester Polytechnic Institute

2:05 p.m. (166) *A projects-based calculus.* II.
John C. Maceli, Ithaca College

2:25 p.m. (167) *Using student projects in the first two years of the curriculum.*
Shrinivas S. Dalal, Embry-Riddle Aeronautical University

MAA Undergraduate Student Paper Session, I

1:00 p.m.–3:55 p.m.

1:00 p.m. (168) *Residual lifetimes in large random parallel systems.*
Kiran L. Shrestha, Gustavus Adolphus College

1:20 p.m. (169) *Relations between YAG Ramsey numbers and the classical Ramsey numbers.* **Michael A. Falcone**, Wesleyan University

1:40 p.m. (170) *Dihedral rewritability.* **Cheryl Grood**, University of Michigan, Ann Arbor

2:00 p.m. (171) *Tests for randomness in spatial distributions: A new statistical method for testing small samples.* **Steven Kushner**, George Washington High School and Hahnemann University

2:20 p.m. (172) *Power in the British Parliament: Will reform be more "Democratic"?* **Robin Taylor**, Drake Univesity

2:40 p.m. (173) *Fibonacci sequences modulo m.* **Marion Shirley**, Kansas Wesleyan University

3:00 p.m. (174) *Application of differential equations to naval aircraft launching.* **Jeremy Wayne Chapman**, Embry-Riddle Aeronautical University

3:20 p.m. (175) *Increased fuel efficiency in automobiles.* **Steven Richard Lehr**, Embry-Riddle Aeronautical University

3:40 p.m. (176) *Monopoly variations and Markov chains.* **Laurence Murphy**, Wittenberg University

Pi Mu Epsilon Contributed Paper Session

1:00 p.m.–6:00 p.m.

National Science Foundation Informal Discussion Group

1:00 p.m.–2:00 p.m.

MAA CUPM Subcommittee on the Undergraduate Major Panel Discussion

1:00 p.m.–2:30 p.m.

The major in the mathematical sciences–Looking forward.

AMS Special Session on Variational Methods, Differential Analysis and Symmetry, II

1:30 p.m.–4:20 p.m.

1:30 p.m. (177) *Some examples of non-minimal solutions of the Higgs equations.* Preliminary report. **L. M. Sibner***, Polytechnic University of New York, and **Janet C. Talvacchia**, Swarthmore College (867-53-142)

2:00 p.m. (178) *A non-standard elliptic theory: Boundary value problems for connections.* **Antonella Marini**, Courant Institute of Mathematical Sciences, New York University (867-35-157)

2:30 p.m. (179) *An equivariant Morse theory for Yang-Mills.* **Thomas H. Parker**, Michigan State University (867-53-107)

3:00 p.m. (180) *Constructing approximate monopoles on certain 3-manifolds.* Preliminary report. **L. M. Sibner**, Polytechnic University of New York, and **R. J. Sibner***, Brooklyn College, City University of New York (867-53-143)

3:30 p.m. (181) *On the essential spectrum of a class of Laplaceans.* **Robert Lockhart**, United States Naval Academy (867-58-98)

4:00 p.m. (182) *Singularities and the conformal Scalar curvature equation.* **Robert C. McOwen**, Northeastern University (867-35-136)

MAA Science Policy Committee & AMS Committee on Science Policy Panel Discussion

2:45 p.m.–4:30 p.m.

Report on MS 2000.

MAA Minicourse #1: Part B

4:00 p.m.–6:00 p.m.

Julia sets and the Mandelbrot set. **Robert L. Devaney**, Boston University

MAA Minicourse #2: Part B

4:00 p.m.–6:00 p.m.

Integrating calculus and physics for freshmen. **Joan R. Hundhausen** and **F. Richard Yeatts**, Colorado School of Mines

MAA Minicourse #3: Part B

4:00 p.m.–6:00 p.m.

Making mathematics more concrete. **Agnes Azzolino**, Mathematical Concepts

MAA SUMMA Workshop

4:00 p.m.–6:00 p.m.

Intervention Programs.

MAA Session

4:30 p.m.–5:30 p.m.

1991 Mathematical Contest in Modeling.

Friday, August 9 (cont'd)

MAA Committee on Assessment Panel Discussion

4:45 p.m.–6:00 p.m.

Mathematics assessment: A national perspective.

CBMS Session

6:00 p.m.–7:00 p.m.

1990 CBMS Survey of Undergraduate Programs in the Mathematical Science and Computer Science.

MAA Committee on the Participation of Women Presentation

7:00 p.m.–8:30 p.m.

Changing the Climate – Repeat of 1990 skits.

Joint Policy Board for Mathematics and Office of Governmental and Public Affairs Forum

7:15 p.m.–8:15 p.m.

The academic employment situation for mathematicians.

PME J. Sutherland Frame Lecture

8:30 p.m.–9:30 p.m.

(183) *Some mathematics of baseball.*
Henry O. Pollak, Bell Communications Research and Teacher's College, Columbia University

Saturday, August 10

AMS-MAA Invited Address

8:30 a.m.–9:20 a.m.

(184) *Laplacians of graphs and hypergraphs.*
Fan R. K. Chung, Bell Communications Research, Morristown, New Jersey

MAA Earle Raymond Hedrick Lecture: Lecture III

9:35 a.m.–10:25 a.m.

(185) *The sensual (quadratic) form. Can you speak its soul?*
John Horton Conway, Princeton University

AMS Progress in Mathematics Lecture

10:40 a.m.–12:10 p.m.

(186) *The theory and applications of harmonic mappings between Riemannian manifolds.*
Richard M. Schoen, Stanford University (867-35-101)

MAA Business Meeting

12:25 p.m.–12:55 p.m.

National Science Foundation Informal Discussion Group

1:00 p.m.–2:00 p.m.

AMS Special Session on Problems in Number Theory, II

1:40 p.m.–7:00 p.m.

1:40 p.m. (187) *Some determinant identities.*
George E. Andrews*, Pennsylvania State University, University Park, and **William H. Burge**, IBM T. J. Watson Research Center, Yorktown Heights, New York (867-11-58)

2:10 p.m. (188) *Fermat's last theorem in reverse.*
Murray S. Klamkin* and **John R. McGregor**, University of Alberta (867-11-68)

2:40 p.m. (189) *A road from Pythagoras to Pell, via continued fractions.*
A. G. Schaake, Waikato Polytechnic, New Zealand, and **J. C. Turner***, University of Waikato, New Zealand (867-11-135) (Sponsored by Joseph Arkin)

3:10 p.m. (190) *Arrowhead curves in a tree of Pythagorean triples.*
A. G. Shannon*, University of Technology, Australia, and **A. F. Horadam**, University of New England, Australia (867-11-37) (Sponsored by Joseph Arkin)

3:40 p.m. (191) *Good Pixel permutations for expensive computer graphics.*
Peter G. Anderson, Rochester Institute of Technology (867-11-63) (Sponsored by Joseph Arkin)

4:10 p.m. (192) *Triangular numbers and primes.* Preliminary report.
Joseph Arkin*, **David C. Arney**, **Frank R. Giordano** and **Rickey A. Kolb**, United States Military Academy (867-11-46)

4:40 p.m. (193) *Some properties of numbers revealed on a cylindrical point-lattice.*
Irving Adler, North Bennington, Vermont (867-11-09)

5:10 p.m. (194) *Necessary and sufficient conditions for simple $\mathscr{A}$-bases.*
Calvin Long*, Washington State University, and **Carl Swenson**, Seattle University (867-11-11)

5:40 p.m. (195) *Generalized multinacci numbers combined with generalized Pascal triangles.* Preliminary report.
Joseph Arkin, **David C. Arney**, **Frank R. Giordano*** and **Rickey A. Kolb**, United States Military Academy (867-11-13)

6:10 p.m. (196) *Divisiblility of terms in Lucas sequences by their subscripts.*
Lawrence Somer, Catholic University of America (867-11-47)

6:40 p.m. (197) *Unexpected applications of number theory.*
Stefan A. Burr, City College, City University of New York (867-11-193)

AMS Special Session on Commutative Noetherian Rings with Applications in Algebraic Geometry, III

1:40 p.m.–5:30 p.m.

1:40 p.m. (198) *Cohen-Macaulay properties of local homomorphisms.*
Luchezar L. Avramov*, Purdue University, West Lafayette, and **Hans-Bjorn Foxby**, University of Copenhagen, Denmark (867-13-20)

2:10 p.m. (199) *On symbolic algebras of monomial primes.*
Hema Srinivasan, University of Missouri, Columbia (867-13-124)

2:40 p.m. (200) *Depth properties of graded rings associated to an ideal.*
Sam Huckaba, Florida State University, and **Thomas Marley***, University of Nebraska, Lincoln (867-13-38)

3:10 p.m. (201) *Rees algebras of ideals having small analytic deviation.*
Sam Huckaba*, Florida State University, and **Craig Huneke**, Purdue University, West Lafayette (867-13-27)

3:40 p.m. (202) *One dimensional local rings of maximal and almost maximal length.* Preliminary report.
William C. Brown*, Michigan State University, and **Jürgen Herzog**, Universität Gesamthochschule Essen, Germany (867-13-15)

4:10 p.m. (203) *Betti numbers of modules of finite length.*
Hara Charalambous, State University of New York, Albany (867-13-181)

4:40 p.m. (204) *Fundamental groups of surface singularities.*
Steven Dale Cutkosky, University of Missouri, Columbia (867-13-123)

5:10 p.m. (205) *The Hilbert-Loewy function, and deformations of a local algebra.*
A. Iarrobino, Northeastern University (867-13-84)

AMS Special Session on Continuum Theory and Dynamical Systems, III

1:40 p.m.–3:00 p.m.

1:40 p.m. (206) *Linear patterns of periodic points on dendrites.* Preliminary report.
Stewart Baldwin, Auburn University, Auburn (867-58-165)

2:10 p.m. (207) *A tree-like continuum admitting fixed point free maps with arbitarily small trajectories.*
Piotr Minc, Auburn University, Auburn (867-54-146)

2:40 p.m. (208) *Convex metrics for separable metric spaces.*
J. Nikiel, **H. M. Tuncali** and **E. D. Tymchatyn***, University of Saskatchewan (867-54-95)

AMS Special Session on Analytic Number Theory, II

1:40 p.m.–5:00 p.m.

1:40 p.m. (209) *Some asymptotic expansions of Ramanujan.*
Bruce C. Berndt*, University of Illinois, Urbana-Champaign, and **Ronald J. Evans**, University of California at San Diego, La Jolla (867-11-150)

2:10 p.m. (210) *Calculation of a sieve auxiliary function.*
Harold G. Diamond*, **H. Halberstam**, University of Illinois, Urbana-Champaign, and **H.-E. Richert**, University of Ulm, Germany (867-11-126)

2:40 p.m. (211) *Primitive points on elliptic curves.* II.
Ram Murty, McGill University (867-11-127)

3:10 p.m. (212) *Limiting distributions of additive functions.*
Adolf J. Hildebrand, University of Illinois, Urbana-Champaign (867-11-128)

3:40 p.m. (213) *Iterations of multiplicative functions.* Preliminary report.
Don Redmond, Southern Illinois University, Carbondale (867-11-185)

4:10 p.m. (214) *On the frequencies of large values of divisor functions.*
Karl K. Norton, Bangor, Maine (867-11-99)

4:40 p.m. (215) *The number of relatively prime solutions to a Diophantine approximation of Hurwitz numbers.* Preliminary report.
John Sadowsky, Johns Hopkins University, Laurel (867-11-29)

Saturday, August 10 (cont'd)

AMS Special Session on Variational Methods, Differential Analysis and Symmetry, III

1:40 p.m.–4:30 p.m.

1:40 p.m. (216) *Nonsingular group actions.* Preliminary report.
Arthur G. Wasserman, University of Michigan, Ann Arbor (867-57-64)

2:10 p.m. (217) *Geometric and differential properties of subanalytic sets.*
Edward Bierstone and **Pierre Milman***, University of Toronto (867-32-36)

2:40 p.m. (218) *Spacelike isoparametric submanifolds of Lorentzian spaces.*
Bing Le Wu, Brandeis University (867-53-57)

3:10 p.m. (219) *Lipschitz equisingularity, subanalytic case.* Preliminary report.
Adam Parusiński, University of Georgia (867-32-173)

3:40 p.m. (220) *Polar actions on compact Lie groups.* Preliminary report.
Gudlaugur Thorbergsson, University of Notre Dame (867-53-125)

4:10 p.m. (221) *Connections on split trivial bundles over homogeneous spaces, and locally symmetric spaces.*
Lance D. Drager*, Texas Tech University, and **Robert L. Foote**, Wabash College (867-53-93)

AMS Special Session on Function Algebras and Function Spaces, III

1:40 p.m.–4:30 p.m.

1:40 p.m. (222) *An open mapping theorem in homogeneous spaces.* Preliminary report.
Shozo Koshi, Hokkaido University, Japan (867-46-74) (Sponsored by Toma V. Tonev)

2:10 p.m. (223) *A new function space on Lorentzian 3-manifolds.* Preliminary report.
Phillip E. Parker, Wichita State University (867-33-109)

2:40 p.m. (224) *The heat equations and Berezin-Toeplitz estimates.*
L. A. Coburn, State University of New York, College at Buffalo (867-46-23)

3:10 p.m. (225) *Part metric and conformal mapping.*
H. S. Bear, University of Hawaii, Honolulu (867-30-76)

3:40 p.m. (226) *Bergman type spaces on hyperbolic spaces.*
John E. Gilbert*, University of Texas, Austin, **Ray A. Kunze**, University of Georgia, and **Christopher Meaney**, Macquarie University, Australia (867-42-96) (Sponsored by Joseph Arkin)

4:10 p.m. (227) *Moebius invariant function spaces on the open unit ball in C^n.*
K. T. Hahn and **E. H. Youssfi***, Pennsylvania State University, University Park (867-32-118)

AMS General Session, III

1:40 p.m.–5:05 p.m.

1:40 p.m. (228) *Monopoly variations and Markov chains.*
Laurence Murphy, Wittenberg University (867-60-148) (Sponsored by Douglas M. Andrews)

1:55 p.m. (229) *Recurrence relations for moments of order statistics in the presence of an outlier.*
Kandasamy Selvavel, Claflin College (867-62-34)

2:10 p.m. (230) *Comparison of simultaneity tests for combined experiments.*
Jack Tomsky, Lockheed Missiles & Space Company (867-62-03)

2:25 p.m. (231) *A new method for derivation of continuous Runge-Kutta formulas.*
Leroy Derr, **Curtis Outlaw** and **Diran Sarafyan***, University of New Orleans (867-65-114)

2:40 p.m. (232) *Threshold-range scaling for two-dimensional cyclic cellular automata.* Preliminary report.
Robert Fisch, Colby College (867-68-71)

2:55 p.m. (233) *A wave method for analyzing the spectrum of a vibrating thin plate.*
Goong Chen, Texas A & M University, College Station, **Matthew P. Coleman***, Fairfield University, and **Jianxin Zhou**, Texas A & M University, College Station (867-73-163)

3:10 p.m. (234) *On a pulsatile flow of a two-phase viscous fluid in a tube of elliptic cross-section.*
Lokenath Debnath, University of Central Florida (867-76-32)

3:25 p.m. (235) *Interaction of laser light and amorphous and/or polycrystalline barium titanate films.* Preliminary report.
Terry Logan, University of Akron (867-78-166)

3:40 p.m. (236) *Models of premeal and postmeal heart rate power spectra in young normals.*
Jerry Collins*, **Tushar Desai**, **Italo Biaggioni**, **Richard Shiavi**, **Virginia Haile** and **David Robertson**, Vanderbilt University (867-92-92)

3:55 p.m. (237) *A system approach to representing the sum of two nth powers as an nth power.*
C. Musès, Mathematics & Morphology Research Centre, Canada (867-93-72) (Sponsored by K. Demys)

4:10 p.m. (238) *The bump in the carpet, Fermat's last theorem, and Kasner's kindergarten.*
Herbert E. Salzer, Brooklyn, New York (867-98-104)

4:25 p.m. (239) *Graphing calculators and workshops in large calculus classes.* Preliminary report.
Al Shenk, University of California at San Diego, La Jolla (867-98-113)

4:40 p.m. (240) *Nonstandard solutions to standard problems.* Preliminary report.
Joe Thrash, University of Southern Mississippi (867-98-115)

4:55 p.m. (241) *Series for Euler's constant and Log n.*
Jonathan D. Sondow, Yeshiva University (867-11-194)

MAA Session on Computer Software for Classroom Use, I

1:40 p.m.–5:55 p.m.

1:40 p.m. Introduction "On Lecture Hardware and Software at the University of Maine"

2:05 p.m. (242) *A computer on every desk: The impact on mathematics students, faculty, and curriculum.* **Stan Seltzer** and **Constance Elson***, Ithaca College

2:30 p.m. (243) *Computer software for classroom use.* **Leslie Hogben**, Iowa State College, Ames

2:55 p.m. (244) *Ralph, a simulated computer.* **Charles A. Green**, Blackburn College

3:20 p.m. (245) *GASP: Graphical aids for stochastic processes.* **Robert Fisch**, Colby College

3:40 p.m. Break

3:55 p.m. (246) *Fourier analysis software* (FAS). **James S. Walker**, University of Wisconsin, Eau Claire and Washington University

4:20 p.m. (247) *Using LINDO in an undergraduate optimization course.* **Elaine Hubbard**, Kennesaw State College

4:45 p.m. (248) *Illustrating cubic splines and Lagrange interpolating polynomials.* **Shepley L. Ross, II**, Bates College

5:10 p.m. (249) *Using MATLAB in a first course in linear algebra.* **George Mackiw**, Loyola College in Maryland

5:35 p.m. (250) *Using MATLAB to compute the Jordan form of a matrix.* **Richard Barshinger**, Pennsylvania State University, Worthington Scranton

MAA Undergraduate Student Paper Session, II on Algebraic Graph Theory (NSF Undergraduate Research Program-REU)

1:40 p.m.–2:55 p.m.

1:40 p.m. (251) *Topics in algebraic graph theory.* I. **Joshua Brandon**, Harvard University

1:55 p.m. (252) *Topics in algebraic graphy theory.* II. **Lana Holmes**, Hanover College

2:10 p.m. (253) *Topics in algebraic graph theory.* III. **Alan Jaffray**, Sonoma State University

2:25 p.m. (254) *Topics in algebraic graph theory.* IV. **Ian Robertson**, Oberlin College

2:40 p.m. (255) *Topics in algebraic graph theory.* V. **Marc Douglass Wallace**, Washington University

MAA CUPM Subcommittee on Quantitative Literacy Informal Discussion

1:40 p.m.–3:00 p.m.

Quantitative Literacy.

MAA Student Workshop

1:40 p.m.–4:40 p.m.

Using the DERIVE computer algebra system to generate conjectures.

MAA Minicourse #4: Part C

1:45 p.m.–3:45 p.m.

Teaching mathematical modeling. **Frank Giordano**, U.S. Military Academy, and **Maurice Weir**, Naval Postgraduate School

MAA Minicourse #5: Part B

1:45 p.m.–3:45 p.m.

Conceptualizing, organizing, and seeking funding for teacher education projects. **Joan Ferrini-Mundy**, University of New Hampshire, and **Carole Lacampagne**, National Science Foundation

MAA Minicourse #6: Part B

1:45 p.m.–3:45 p.m.

Symmetry analysis of repeated patterns. **Donald Crowe**, University of Wisconsin, Madison

MAA Minicourse #7: Part B

1:45 p.m.–3:45 p.m.

Great theorems from mathematical analysis: 1689-1881. **William Dunham**, Hanover College

MAA Session on Computer Software for Classroom Use, II

2:05 p.m.–5:55 p.m.

2:05 p.m. (256) *Software use at Centre College.* I. **Bill Johnston**, Centre College

2:30 p.m. (257) *Software at Centre College.* II. **John Wilson**, Centre College

2:55 p.m. (258) *MPP, graphical software for calculus.* **Howard Lewis Penn**, United States Naval Academy

3:20 p.m. (259) *Computer plotting for mathematics insight.* **Mark Bridger**, Northeastern University

3:40 p.m. Break

3:55 p.m. (260) *Understanding surfaces through animation.* **Maurino P. Bautista**, Rochester Institute of Technology

Saturday, August 10 (cont'd)

4:20 p.m. (261) *GyroGraphics™ in the calculus classroom.* **Jerry Johnson**, Oklahoma State University, Stillwater

4:45 p.m. (262) *Using DERIVE in mathematics courses for liberal arts students.* **Kay Gura**, Ramapo College of New Jersey

5:10 p.m. (263) *First year experiences using symbolic software in calculus.* **Lisa Townsley Kulich*** and **Barbara Victor**, Illinois Benedictine College

5:35 p.m. (264) *Using DERIVE to simplify an integral of Lubin.* **Dave Trautman**, The Citadel

MAA Undergraduate Student Paper Session, III on Cooperative Game Theory (NSF Undergraduate Research Program-REU)

3:00 p.m.–4:30 p.m.

3:00 p.m. (265) *Topics in cooperative game theory.* I. **Thomas Ventrudo**, Loyola College of Maryland

3:15 p.m. (266) *Topics in cooperative game theory.* II. **Stephanie Merki**, Eastern Nazarene College

3:30 p.m. (267) *Topics in cooperative game theory.* III. **Owen Patashnick**, Brandeis University

3:45 p.m. (268) *Topics in cooperative game theory.* IV. **Brett Allan Saraniti**, Harvey Mudd College

4:00 p.m. (269) *Topics in cooperative game theory.* V. **Jodi P. Wallman**, Bryn Mawr College

4:15 p.m. (270) *Topics in cooperative game theory.* VI. **Daniel S. Arthur**, Miami University, Ohio

MAA Minicourse #8: Part B

4:00 p.m.–6:00 p.m.

Knot theory for undergraduates. **Stefanos Gialamas**, Columbia College

MAA Minicourse #9: Part B

4:00 p.m.–6:00 p.m.

Unifying themes for discrete mathematics. **Ralph Grimaldi**, Rose-Hulman Institute of Technology

Joseph A. Cima
AMS Associate Secretary
Chapel Hill, North Carolina

Kenneth A. Ross
MAA Associate Secretary
Eugene, Oregon

Presenters of Papers

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

◇ AMS-MAA Invited Lecturer
• AMS Invited Lecturer
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Fargo, North Dakota
North Dakota State University
October 25–26

First Announcement

The eight-hundred-and-sixty-ninth meeting of the American Mathematical Society will be held at North Dakota State University, Fargo, North Dakota on Friday, October 25, and Saturday, October 26, 1991. All sessions will be held in the Memorial Union, the Family Life Center, and South Engineering buildings.

Invited Addresses

By invitation of the Central Section Program Committee, there will be four invited one-hour addresses. The speakers, their affiliations, and the titles of their talks where available are:

Ian D. Macdonald, Queen Mary College, *title to be announced.*

Harald Upmeier, University of Kansas, *Operator theory and quantization in several complex variables.*

Henry C. Wente, University of Toledo, *Constant mean curvature immersions.*

Sylvia M. Wiegand, University of Nebraska, Lincoln, *title to be announced.*

Special Sessions

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

Commutative algebra, **Joseph P. Brennan**, North Dakota State University, Fargo, and **Sylvia M. Weigand**.

Ergodic theory, **Dogan Comez**, North Dakota State University, Fargo.

The geometry of equilibrium configurations, **Robert D. Gulliver**, University of Minnesota, Minneapolis, and **Henry C. Wente**.

Algebraic geometry, **David B. Jaffe**, University of Nebraska, Lincoln.

Nonlinear wave equations, **Satyanad Kichenassamy**, University of Minnesota, Minneapolis.

Operations research, **Kendall Nygard**, North Dakota State University, Fargo.

Mathematical foundations of computer graphics, **James H. Olsen**, and **Mark Pavicic**, North Dakota State University, Fargo.

Nonselfadjoint operator algebras, **Justin R. Peters III**, and **Warren R. Wogen**, University of North Carolina, Chapel Hill.

Multidimensional complex analysis and operator theory, **Norberto Salinas**, University of Kansas, and **Harald Upmeier**.

Graph theory, **Warren E. Shreve**, North Dakota State University, Fargo.

Approximation theory, **Vasant A. Ubhaya**, North Dakota State University, Fargo.

Lorentz transformations and spacetime geometry, **Abraham Ungar**, North Dakota State University, Fargo.

Abstracts for consideration for these sessions should have been submitted by the **July 11, 1991** deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited Speakers and Special Sessions section of *Notices*.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in Departments of Mathematics. Abstracts should be sent to the Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, **so as to arrive before the August 1, 1991 abstract deadline**. Participants are reminded that a charge of $16 is imposed for retyping abstracts that are not in camera-ready form. Late papers will not be accommodated.

Electronic Submission of Abstracts

This service is available to those who use the TEX typesetting system and can be used with abstracts of papers to be presented at the sectional meetings of the AMS. Requests to obtain the package of files may be sent electronically on Internet to **abs-request@math.ams.com**. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940, USA. When requesting the abstracts package, users should be sure to specify whether they want the plain TEX, AMS-TEX, or the LATEX package.

Registration

The meeting registration desk will be located on the third floor of the Memorial Union building and will be open from 8:00 a.m. to 5:00 p.m. on Friday, October 25, and from 8:00 a.m. to noon on Saturday, October 26. The registration fees are $30 for members of the AMS, $45 for nonmembers, and $10 for students or unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Orono Mathfest announcement in the April 1991 issue of *Notices*.

Accommodations

Rooms have been blocked for participants at the following hotels or motels in Fargo. Participants should make their own arrangements directly with the hotel of their choice and ask for the special AMS meeting rate. The Best Western-Doublewood Inn, Holiday Inn, and the Kelly Inn are located along I-29. The Radisson Inn and the Townhouse Inn are located in downtown Fargo. **The AMS is not responsible for rate changes or the quality of the accommodations offered by these hotels/motels.**

Radisson Inn (1.5 miles from campus)
201 5th Street North, Fargo, ND 58102
Telephone: 219-232-3941 or Toll-free: 800-333-3333
Deadline for reservations is September 24, 1991.

Flat rate $54 Single, Double, Triple
Restaurant, lounge/casino, weight room, and free van transportation from airport.

The Townhouse Inn (1.5 miles from campus)
301 3rd Avenue North, Fargo, ND 58102
Telephone: 701-232-8851 or Toll-free: 800-437-4682
Deadline for reservations is September 25, 1991.

Flat rate $48 Single, Double, Triple
Restaurant/lounge, indoor pool, sauna, and casino. Free airport transportation.

The Kelly Inn (3 miles from campus)
3800 Main Avenue, Fargo, ND 58103
Telephone: 701-282-2143 or Toll-free: 800-635-3559
Deadline for reservations is October 3, 1991.

Single $35 Double $40

The Holiday Inn (4 miles from campus)
3803 13th Avenue South, Fargo, ND 58103
Telephone: 701-282-2700 or Toll-free: 800-465-4329
Deadline for reservations is October 3, 1991.

Flat rate $58 One to four people
Casino, indoor pool, and free airport transportation.

Best Western-Doublewood Inn (4 miles from campus)
3333 13th Avenue South, Fargo, ND 58103
Telephone: 701-235-3333 or Toll-free: 800-528-1234
Deadline for reservations is October 10, 1991.

Flat rate $59 One to four people
Casino, indoor pool, and free airport transportation.

Food Service

The Atrium Dining Center, located in the basement of the NDSU Memorial Union, will be open for lunch on Friday and closed on Saturday. This facility receives very heavy use and it is **highly** recommended that participants look to off-campus facilities for the noon meal on Friday and Saturday. An extensive list of restaurants will be available at the meeting registration desk.

Parking

Free parking will be available to participants in the Visitors Parking Lot and its overflow lots in the NDSU campus. These lots are located within close proximity to the Memorial Union. Permits will be available at the registration desk.

Travel and Local Information

Hector International Airport is served by Northwest (via Minneapolis) and United (via Denver/Sioux Falls) Airlines. The airport is immediately adjacent to the NDSU campus. The airport is served by Hertz, Avis, and National car rental agencies. Transportation from the airport to area hotels is best accomplished by hotel courtesy van. Participants should make inquiries of the hotel when making reservations. Taxi service is available from Doyle's Yellow Checker Cab (telephone 701-235-5535). A courtesy phone is available in the vestibule of the airport. The taxis will pick up passengers only if a reservation is made with the dispatcher.

DRIVING INSTRUCTIONS: Fargo is located at the intersection of I-29 and I-94 on the border of North Dakota and Minnesota. The university is located approximately two miles east of I-29 at the 12th Avenue North exit (Exit 66).

BY TRAIN: Daily train service to Fargo from Minneapolis/Chicago and Seattle/Portland is provided by Amtrak's Empire Builder.

Local transportation is provided by Doyle's Yellow Checker Cab and the Metropolitan Area Transit Bus Service. Bus schedules will be available at the registration desk.

Weather and Local Attractions

October weather in Fargo is extremely variable. The mean maximum temperature for October 25th is 51°F with a standard deviation of 12 degrees while the mean minimum temperature is 31°F with a standard deviation of nine degrees. The mean precipitation for the month of October is 1.53 inches with a standard deviation of 1.18 inches. There is an average of one inch of snow. The wind for October averages thirteen miles per hour. Thanks are due to John Wheeler for providing this information.

Andy R. Magid
Associate Secretary
Norman, Oklahoma

Santa Barbara, California
University of California at Santa Barbara
November 9–10

First Announcement

The eight-hundred-and-seventieth meeting of the American Mathematical Society will be held at the University of California at Santa Barbara (UCSB) on Saturday, November 9, and Sunday, November 10, 1991. All special sessions will be held in Girvetz Hall and all invited addresses will be in the auditoriums of Girvetz and North Halls.

Invited Addresses

By invitation of the Western Section Program Committee, there will be three invited one-hour addresses. The speakers, their affiliations, and the titles of their talks where available are:

Daryl Cooper, University of California at Santa Barbara, *title to be announced.*

Richard S. Elam, University of California, Los Angeles, *Invariants and the algebraic theory of quadratic forms.*

Stanley J. Osher, University of California, Los Angeles, *Numerically capturing shocks and fronts with applications to physics, engineering, geometry and image processing.*

Special Sessions

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

Low dimensional topology and negatively curved groups, **Daryl Cooper** and **Darren Long**, University of California at Santa Barbara.

Applied probability, **Anant Godbole** and **Svetlozar T. Rachev**, University of California at Santa Barbara.

Noncommutative homological algebras, **Kenneth Goodearl**, **Birge Zimmermann-Huisgen**, and **Julius M. Zelmanowitz**, University of California at Santa Barbara.

Quadratic forms, **William B. Jacob**, University of California at Santa Barbara.

Knotting phenomena in the natural sciences, **Kenneth C. Millett**, University of California at Santa Barbara, and **Louis Kauffman**, University of Illinois at Chicago.

Abstracts for consideration for these sessions should have been submitted by the **July 11, 1991** deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited Speakers and Special Sessions section of *Notices*.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in Departments of Mathematics. Abstracts should be sent to the Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, **so as to arrive before the August 1, 1991 abstract deadline**. Participants are reminded that a charge of $16 is imposed for retyping abstracts that are not in camera-ready form. Late papers will not be accommodated.

Electronic Submission of Abstracts

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Activities of Other Organizations

The Southern California Section of the Mathematical Association of America (MAA) will meet on Saturday, November 9. Speakers will include **Michael Freedman**, University of California, San Diego, **Paul Halmos**, Santa Clara University, and **Michael Townsend**, Harvey Mudd College. A panel discussion on issues related to the mathematical preparation of school teachers, a workshop on computers in mathematics instruction, and activities for students will also be on the program.

There will be an MAA contributed paper session on *Mathematical gems*. Submissions are due by **Friday, August 30, 1991**. Submission requirements may be obtained from John Langer, Mail Stop M3-173, The Aerospace Corporation,

PO Box 92957, Los Angeles, CA 90009-2957, or by email: langer@aerospace.aero.org

Registration

The meeting registration desk will be located in room 1106 of Girvetz Hall The registration desk will be open from 8:30 a.m. to 2:00 p.m. on both Saturday and Sunday, November 9 and 10. The registration fees are $30 for both days for members of the AMS, $45 for nonmembers, and $10 for students or unemployed mathematicians. There is a special one-day fee of $15 for MAA members for Saturday only.

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 Orono Mathfest meeting announcement in the April 1991 issue of *Notices*.

Accommodations

There are many motels in the Santa Barbara area, and those nearest UCSB are in Goleta on Calle Real. Calle Real is immediately adjacent (parallel) to Freeway 101. The room tax is included in all prices below. **The AMS is not responsible for rate changes or the quality of the accommodations offered by these hotels/motels.**

The following motels are located on State Street in Santa Barbara and are further from UCSB and the airport than those hotels located in the town of Goleta: Pepper Tree (805-687-5511); Sandman (805-687-2468); Sandpiper (805-687-5326); and El Prado Motor Inn located in downtwon Santa Barbara (805-966-0807).

Goleta Valley Inn
Fairview Avenue at Hollister, Goleta, CA
Telephone: 805-967-5591
Single $45 Double $55

Hampton Inn
5620 Calle Real, Goleta, CA
Telephone: 805-967-3200
Single $80 Double $86

The Airbus (surface transportation) to and from Los Angeles Airport (LAX) makes a stop at this hotel.

Holiday Inn
5650 Calle Real, Goleta, CA
Telephone: 805-964-6241
Single $102 Double $112

Motel 6
5897 Calle Real, Goleta, CA
Telephone: 805-964-3596
Single $40 Double $45

Pilot House Motel
Fairway Avenue, Goleta, CA
Telephone: 805-967-2336
Single $32 Double$36

Cathedral Oaks Lodge
4770 Calle Real, Goleta, CA
Telephone: 805-964-3511
Closest to UCSB (moderately long walking distance to campus).
Single $78 Double $88

Food Service

The Deli, located in the University Center, sells freshly made sandwiches and light meal items and is open Saturday from 11:00 a.m. to 4:00 p.m. (closed on Sundays). The Country Store, also located in University Center, is a mini-market and coffee shop and is open Saturday and Sunday from 7:30 a.m. to 9:00 p.m. The Arbor, located northwest of the library, serves prepared sandwiches, soup, pizza, and assorted fast food items. The Arbor is open Saturday from 8:30 a.m. to 6:00 p.m. and Sunday from 9:30 a.m. to 11:00 p.m.

Santa Barbara has many excellent restaurants, but most are not within walking distance from the campus. Participants may want to walk to Isla Vista, the student ghetto west of the campus. The food served there is inexpensive and often interesting. It is suggested that participants walk over and see what's cooking.

Travel and Local Information

The University of California at Santa Barbara is located eight miles northwest of Santa Barbara, near the town of Goleta, adjacent to Isla Vista, and near the Santa Barbara Airport. The airport is served by United, American, and several commuter airlines. The airport terminal is within easy taxi distance of the UCSB campus and the Goleta motels listed previously. Santa Barbara Airbus (805-964-7759) offers transportation between Los Angeles International Airport and Santa Barbara, Goleta, and Isla Vista (closest to campus for $52 roundtrip).

When arriving by car from the north on 101, exit at Storke Road and make a right turn off the exit ramp. Follow Storke Road approximately one mile to the end after a sharp left turn, it becomes El Colegio. Follow El Colegio another one-and-one half miles to the campus. Participants may obtain a campus map from the kiosk at the west entrance and may inquire about parking. When arriving by car from the south on 101, continue past Santa Barbara until the Highway 217 sign to UCSB is reached. The correct exit from 101 is immediately after the exit for Patterson Avenue. Follow Ward Memorial Boulevard (this is also Highway 217) to the kiosk located at the east entrance to the campus.

Lance W. Small
Associate Secretary
La Jolla, California

Philadelphia, Pennsylvania
Temple University, Philadelphia
October 12–13

First Announcement

The eight-hundred-and-sixty-eighth meeting of the American Mathematical Society will be held at Temple University, Philadelphia, Pennsylvania on Saturday and Sunday, October 12 and 13, 1991. All special sessions will held in the Temple University Center City Campus (TUCC) building located at 1616 Walnut Street in downtown Philadelphia. The invited addresses will be in room 501 of the TUCC building located at 1619 Walnut Street.

Invited Addresses

By invitation of the Eastern Section Program Committee, there will be four invited one-hour addresses. The speakers, their affiliations, and the titles of their talks where available are:

Abbas Bahri, Rutgers University, New Brunswick, *Critical points at infinity in some variational problems.*

Michael T. Anderson, SUNY at Stony Brook, *title to be announced.*

Marjorie Senechal, Smith College, *Aperiodicity and order: tilings and quasicrystals.*

Panagiotis E. Souganidis, Brown University, *Phase transitions and front propagation.*

Special Sessions

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

Recent progress in Ricci curvature and related topics, **Michael T. Anderson**, and **Jeff Cheeger**, NYU-Courant Institute.

Nonlinear partial differential equations, **Abbas Bahri**.

Modular forms, arithmetic algebraic geometry, **Boris A. Datskovsky** and **Marvin I. Knopp**, Temple University.

Surgery theory and singular spaces, **James F. Davis**, Indiana University, Bloomington, **Ronnie Lee**, Yale University, and **Julius L. Shaneson**, University of Pennsylvania.

Geometric analysis, **Leon Ehrenpreis** and **Eric L. Grinberg**, Temple University.

Extreme value theory, **Janos Galambos**, Temple University.

Applications of microlocal analysis to partial differential equations, **Nicholas Hanges**, CUNY, Herbert H. Lehman College, **A. Alexandrou Himonas**, University of Notre Dame.

Variational problems in low dimensional geometry, **Bruce A. Kleiner**, University of Pennsylvania, and **Robert B. Kusner**, University of Massachusetts, Amherst.

Rings and representations, **Martin Lorenz** and **Shari A. Prevost**, Temple University.

Tilings, **Doris Schattschneider**, Moravian College, and **Marjorie Senechal**.

Phase transitions and/or front propagation, **Halil Mete Soner**, Carnegie Mellon University, and **Panagiotis E. Souganidis**.

Numerical linear algebra, **Daniel B. Szyld**, Temple University.

Abstracts for consideration for these sessions should have been submitted by the **July 11, 1991** deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited Speakers and Special Sessions section of *Notices*.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in Departments of Mathematics. Abstracts should be sent to the Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, **so as to arrive before the August 1, 1991 abstract deadline**. Participants are reminded that a charge of $16 is imposed for retyping abstracts that are not in camera-ready form. Late papers will not be accommodated.

Electronic Submission of Abstracts

This service is available to those who use the TEX typesetting system and can be used with abstracts of papers to be presented at the sectional meetings of the AMS. Requests

to obtain the package of files may be sent electronically on Internet to **abs-request@math.ams.com**. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940, USA. When requesting the abstracts package, users should be sure to specify whether they want the plain TEX, $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX, or the LATEX package.

Registration

The meeting registration desk will be located in room 5B of the TUCC building located at 1616 Walnut Street and will be open from 8:30 a.m. to 4:30 p.m. on Saturday, October 12, and from 8:00 a.m. to noon on Sunday, October 13. The registration fees are $30 for members of the AMS, $45 for nonmembers, and $10 for students or unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Orono Mathfest meeting announcement in the April 1991 issue of *Notices*.

Accommodations

Rooms have been blocked for participants at the Holiday Inn - Center City and the Radisson Suite Hotel. Participants should make their own reservations and directly mention the AMS meeting to obtain the rates listed below. All rates are subject to a room tax. **The AMS is not responsible for rate changes or the quality of the accommodations offered by these hotels/motels.**

Holiday Inn - Center City (A five-minute walk from the TUCC)
1800 Market Street, Philadelphia, PA
Telephone: 215-561-7500
Deadline for reservations is September 11, 1991.
Flat rate $75 Single or Double

Radisson Suite Hotel (approximately a 15-minute walk frm TUCC)
18th Street and Benjamin Franklin Parkway, Philadelphia, PA
Telephone: 215-963-2222 (Participants should ask for Keith Rist)
Deadline for reservations is September 28, 1991.
Flat rate $80 Single or Double

Food Service

A complete listing of local restaurants will be available at the meeting registration desk.

Travel and Local Information

Philadelphia International Airport is served by most major airlines. Taxi and limousine service can be arranged from the airport to the downtown area. A more detailed listing of available transportation and driving instructions will appear in the September issue of *Notices*.

Weather

Philadelphia tends to be rather dry in October. The average minimum temperature is 49°F and the average maximum temperature is 66°F. Average total precipitation is 2.82 inches. Up to the minute weather information can be obtained by calling 215-627-5575.

W. Wistar Comfort
Associate Secretary
Middletown, Connecticut

Joint Mathematics Meetings in Baltimore
AMS Special Sessions and Contributed Papers
MAA Contributed Papers

The Joint Mathematics Meetings in Baltimore, Maryland, will be held January 8–11 (Wednesday–Saturday), 1992. The first full announcement of the meetings will appear in the October 1991 issues of *Notices* and *Focus*. This preliminary announcement is made to encourage member participation and to provide lead time for submission of abstracts for consideration for presentation in AMS Special Sessions and for submission of abstracts for AMS and MAA Contributed Paper Sessions.

AMS Special Sessions

A list of Special Sessions for this meeting can be found in the **Invited Addresses and Special Sessions** section of this issue.

Most of the papers to be presented at these Special Sessions will be by invitation; however, anyone contributing an abstract for the meeting who feels that his or her paper would be particularly appropriate for one of these sessions should indicate this clearly on the abstract, **and should submit it by September 11, 1991, three weeks earlier than the normal deadline for contributed papers,** in order that it be considered for inclusion.

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. A charge of $16 is imposed for retyping abstracts that are not in camera-ready form.

AMS Contributed Paper Sessions

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 2, 1991.** A charge of $16 is imposed for retyping abstracts that are not in camera-ready form. **Late papers will not be accepted.**

MAA Contributed Papers

Contributed papers are being accepted on several topics in collegiate mathematics for presentation in contributed paper sessions at the meeting. The topics, organizers, their affiliations, addresses and proposed day(s) of the sessions are:

- *Environmental mathematics*, **Ben A. Fusaro**, Mathematical Sciences Department, Salisbury State University, Salisbury, MD 21801, Thursday morning and Saturday. Papers are invited that treat topics that are suitable for a liberal arts mathematics course or for a modeling course, preferably at the sophomore-junior level.
- *Research in undergraduate education*, **Ed Dubinsky**, Department of Mathematics, Purdue University, West Lafayette, IN 47907, Thursday and Friday morning. Presentations are invited that describe research on the learning and teaching of any aspect of undergraduate mathematics. Descriptions of courses taught must be in the context of investigations into such questions as to how mathematics is learned, methods of teaching, effectiveness of the approach, and similar issues.
- *Mathematics placement testing programs: Their organization, administration and problems*, **Rose Hamm**, Honors Program, College of Charleston, Charleston, SC 29424, and **John G. Harvey**, Department of Mathematics, University of Wisconsin, Madison, 480 Lincoln Drive, Madison, WI 53706, Wednesday. Papers on various aspects of placement testing programs are welcome. Of especial interest are the test(s) used and the other data used (e.g., aptitude scores, high school GPA's), as well as the problems that arise and the ways of solving them.
- *The "seven-into-four" problem*, **David H. Carlson**, Mathematical Sciences Department, San Diego State University, San Diego, CA 92182, and **Ann Watkins**, California State University, Northridge. Mailing address: 5929 Elba Place, Woodland Hills, CA 91367, Wednesday and Friday afternoon. This session was organized by the Committee on Calculus Reform and the First Two Years (CRAFTY). Papers are invited which present innovative ways of solving the seven-into-four problem. Seven courses (Calculus I, II, and III, Differential Equations, Discrete Mathematics, Linear Algebra, and Probability/Statistics) have been recommended for the first four semesters of college mathematics. Is it possible to squeeze them all in? What are some good partial solutions to the problem?
- *Innovations in mathematics courses for business*, **Wade Ellis, Jr.**, West Valley College, 14000 Fruitvale Avenue, Saratoga, CA 95070-5698, and **Barbara A. Jur**, Macomb Community College. Mailing address: 14500 12 Mile Road, Apartment E219, Warren, MI 48093, Wednesday morning and Thursday afternoon. This session is orga-

nized by the CUPM Subcommittee on Service Courses, which focuses on service courses for business students. Contributed papers may address issues of specialized business subject matter, innovative instructional techniques, the relationship of business oriented courses to the mathematics curriculum, or other related topics.

- *Actuarial mathematics*, **James W. Daniel**, University of Texas, Austin, RLM 8-100, Austin, TX 78712, Saturday. Contributions should address educational (or research) issues in actuarial mathematics, including such topics as curricula, teaching methods, program organization, textbooks, software, professional exams, and research.
- *A toolbox for liberal arts mathematics courses*, **John Emert** and **Kay Meeks**, Department of Mathematical Sciences, Ball State University, Muncie, Indiana 47306-0490, Thursday afternoon and Friday morning. Liberal arts mathematics courses generally include as goals the changing of students' perception of mathematics and the illumination of relationships between mathematics and other disciplines. The purpose of this session is to share innovative, yet practical and transferable, ideas and techniques which can aid in the development and realization of these common goals. Topics for discussion may include: creative classroom techniques and assignments; fresh, unusual topics for inclusion in courses; and specific ways to encourage students' discovery of the usefulness of mathematics in their own fields of study.
- *Mathematics for the health sciences*, **Henry C. Foehl**, Philadelphia College of Pharmacy and Science, Woodland Avenue at 43rd Street, Philadelphia, PA 19104, Friday. Papers contributed for this session should describe the content of courses or sequences of courses that constitute part or all of the mathematics requirements for degree programs in the health or health related sciences. Of particular interest are criteria for selecting the appropriate content for such courses and methods for integrating the content into the curricula of various degree programs, especially where the courses also serve as the mathematics component of a core curriculum.
- *Using spreadsheets to teach mathematics*, **Robert S. Smith**, Department of Mathematics & Statistics, Miami University, Oxford, OH 45056, Wednesday morning and Thursday afternoon. The spreadsheet is a powerful and versatile–yet easy to use–software tool that has become increasingly popular in the teaching of the mathematical sciences. It is ideal for implementing algorithms which rely upon iterative procedures or recurrence relations, and is a natural tool for solving many types of applied problems. This session invites papers which illustrate the spreadsheet as a problem solving, data analysis, or graphing tool. Papers are also invited which demonstrate how the spreadsheet can be used to prove theorems, discover patterns and results, or illustrate mathematical concepts. Papers which describe courseware that is developed around the spreadsheet are strongly encouraged.

Presentations are normally limited to ten minutes, although selected contributors may be given up to twenty minutes. Individuals wishing to submit papers for any of these sessions should note the following **NEW PROCEDURES**: The name(s) and address(es) of the author(s) and a **one-page summary** of the paper should be sent **directly to the organizer of the session by September 11. Proposals should NOT be sent to the MAA Washington office.** The organizer will acknowledge receipt of the proposal; if the proposal is accepted, the organizer will send the contributor an abstract form. The abstract form must be sent to the **AMS in Providence prior to October 2**. In an effort to save time, if the contributor has access to the new MAA abstract form, the original can be sent to the AMS and a copy of it to the organizer along with the one-page summary. (If the paper is not accepted, the abstract will be omitted from the program.) The abstract will be photographically reproduced from the copy supplied by the author on the MAA abstract form, which is similar to the abstract forms used for contributed papers by the AMS. They will be published in an abstract journal, copies of which are available in the registration area during the meetings. The MAA abstract form may be requested from the AMS or the MAA.

Rooms where sessions of contributed papers will be held are equipped with an overhead projector and screen. Blackboards are **not** available. Persons having other equipment needs should contact the MAA Associate Secretary (Kenneth A. Ross, Department of Mathematics, University of Oregon, Eugene, OR 97403-1222; electronic mail: ross@math.uoregon.edu) as soon as possible, but in any case **prior to November 9**. Upon request, the following will be made available: one additional overhead projector/screen, 35mm carousel slide projector, or $1/2''$ or $3/4''$ VHS video cassette recorder with one color monitor.

Electronic Submission of AMS and MAA Abstracts

This service is available to those who use the TEX typesetting system and can be used for abstracts of papers to be presented at this meeting. Requests to obtain the package of files may be sent by electronic mail on the Internet to **abs-request@math.ams.com**. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Secretary to Director of Publication, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940. When requesting the abstracts package, users should be sure to specify whether they want the plain TEX, $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX, or the LATEX package. Only abstracts should be sent to abs-submit@math.ams.com. Questions regarding an abstract should be addressed to abs-misc@math.ams.com. Questions regarding meetings should be addressed to meet@math.ams.com.

Call for Papers – Poetry Reading

On Friday evening, January 10, from 7:30 p.m. to 10:30 p.m., the Humanistic Mathematics Network is sponsoring

a poetry reading session. This session is being organized by **JoAnne S. Growney**, Bloomsburg University; **Daniel Kalman**, Aerospace Corporation; and **Elena A. Marchisotto**, California State University, Northridge. There is special interest in original poetry, about mathematics, read by the authors, although the presentation of work by other poets will be considered if time permits. At the session, authors will be invited to read or recite their poetry, and a booklet of the presented poetry will be distributed to the audience. To submit poetry for consideration, send **three copies** of each poem to JoAnne S. Growney, Department of Mathematics, Bloomsburg University, Bloomsburg, PA 17815. Indicate the amount of time each poem will take to recite or read. Authors may submit more than one poem, but should indicate their order of preference in case time limitations do not permit acceptance of all submissions. The deadline for receipt is **October 31**.

Symposium on Some Mathematical Questions in Biology

Theoretical approaches for predicting spatial effects in ecological systems

San Antonio, Texas, August 8, 1991

The twenty-fifth annual Symposium on Some Mathematical Questions in Biology on *Theoretical approaches for predicting spatial effects in ecological systems* will be held on Thursday, August 8, in Centro Room D during the Annual Meeting of the Ecological Society of America, August 4–8, 1991 in the San Antonio Convention Center in San Antonio, Texas.

The symposium is sponsored by the American Mathematical Society, the Society for Industrial and Applied Mathematics (SIAM), and the Society for Mathematical Biology (SMB).

The AMS-SIAM-SMB Committee on Mathematics in the Life Sciences serves as the Organizing Committee for the symposium. The committee at the time this topic was selected consisted of Jack D. Cowan, James W. Curran, Marcus B. Feldman, Eric S. Lander, Marc Mangel, and James D. Murray. Robert H. Gardner serves as organizer.

The theme of the symposium is *Theoretical approaches for predicting spatial effects in ecological systems.* There will be one afternoon session including six 30-minute lectures.

Proceedings of the symposium will be published by the AMS in the series *Lectures on Mathematics in the Life Sciences.*

Information about registration and housing can be found in the March issue of *Bulletin of the Ecological Society of America* or by contacting the Mathematical Biology Symposium Conference Coordinator, AMS, Post Office Box 6887, Providence, RI 02940, by telephone 401-455-4138, by electronic mail BAV@MATH.AMS.COM, or by FAX 401-455-4004.

Program

The names and affiliations of the speakers, their titles and times of their talks are as follows (* denotes presenter):

1:00 p.m. **Simon A. Levin**, *Spatial phenomena in ecological systems – Some introductory remarks*

1:15 p.m. **John Pastor***, **John Bonde**, **C. A. Johnston** and **R. J. Naiman**, University of Minnesota, Duluth, *A mathematical treatment of the spatially dependent stabilities of beaver ponds*

1:45 p.m. **Bruce T. Milne**, University of New Mexico, Albuquerque, *Renormalization relations for spatial models*

2:15 p.m. **Debra P. Coffin***, **William K. Lauenroth**, and **Ingrid C. Burke**, Colorado State University, *Spatial dynamics in recovery of shortgrass steppe ecosystems*

2:45 p.m. Recess

3:00 p.m. **Stephen W. Pacala**, University of Connecticut, Storrs, *Neighborhood population dynamics models*

3:30 p.m. **Virginia H. Dale***, **Frank Southworth**, **Robert V. O'Neill**, and **Robert Frohn**, Oak Ridge National Laboratory, *Simulating spatial patterns and socio-economic and ecologic effects of land use change in Rondonia, Brazil*

4:00 p.m. **Wilfred F. Wolff**, University of Tennessee, Knoxville, *A spatial individual-oriented model for a wading bird nesting colony*

4:30 p.m. **Robert H. Gardner**, Oak Ridge National Laboratory, *The analysis of spatial systems – Some concluding remarks*

Invited Addresses and Special Sessions

Invited Addresses 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.

Philadelphia, PA, October 1991

Please refer to the first announcement elsewhere in this issue.

Fargo, ND, October 1991

Please refer to the first announcement elsewhere in this issue.

Santa Barbara, CA, November 1991

Please refer to the first announcement elsewhere in this issue.

Baltimore, MD, January 1992

Joan S. Birman (AMS-MAA)
William Browder (Retiring Presidential Address)
Ya M. Eliashberg
Michael E. Fisher (Gibbs Lecture)
Robert P. Langlands (Colloquium Lectures)
Marina Ratner
Michael Shearer
J. Ernest Wilkins, Jr. (AMS-MAA)

Springfield, MO, March 1992

Alexander Eremenko
Julia Knight
Peter J. Olver
Ernst A. Ruh

Tuscaloosa, AL, March 1992

Jane M. Hawkins
Charles A. Micchelli
Serge Ochanine
Peter M. Winkler

Bethlehem, PA, April 1992

Jean-Luc Brylinski
Ingrid Daubechies
Edward Y. Miller
Douglas C. Ravenel

Cambridge, England, June 1992

(Joint meeting with the London Mathematical Society)

John M. Ball
Lawrence Craig Evans
Benedict H. Gross
Nigel J. Hitchin
Edward Witten

Dayton, OH, October 1992

Martin Golubitsky
Jonathan I. Hall
Louis H. Kauffman
J. T. Stafford

Invited addresses at Sectional Meetings are selected by the Section Program Committee, usually twelve to eighteen months in advance of a meeting. Members wishing to nominate candidates for invited addresses should send the relevant information to the Associate Secretary for the Section who will forward it to the Section Program Committee.

Organizers and Topics of Special Sessions

The list below contains all the information about Special Sessions at meetings of the Society available at the time this issue of *Notices* went to the printer. The section below entitled **Information for Organizers** describes the timetable for announcing the existence of Special Sessions.

October 1991 Meeting in Philadelphia, Pennsylvania

Eastern Section
Associate Secretary: W. Wistar Comfort
Deadline for organizers: Expired
Deadline for consideration: Expired

Please refer to the first announcement elsewhere in this issue.

October 1991 Meeting in Fargo, North Dakota

Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: Expired
Deadline for consideration: Expired

Please refer to the first announcement elsewhere in this issue.

November 1991 Meeting in Santa Barbara, California
Western Section
Associate Secretary: Lance W. Small
Deadline for organizers: Expired
Deadline for consideration: Expired

Please refer to the first announcement elsewhere in this issue.

January 1992 Meeting in Baltimore, Maryland
Associate Secretary: Lance W. Small
Deadline for organizers: Expired
Deadline for consideration: September 11, 1991

Bettye Anne Case, *Preparing the college mathematics teachers of the future*
John Dillon, *Design and codes*
Peter L. Duren and Boris Korenblum, *Bergman spaces*
Florence D. Fasanelli, Victor J. Katz and David E. Rowe, *History of mathematics*
Naomi Fisher, Harvey B. Keynes and Philip D. Wagreich, *Mathematics and education reform*
B. A. Fusaro, *Environmental mathematics*
Frank Grosshans, *Invariant theory*
Paul D. Humke and Brian S. Thomson, *Classical real analysis*
Zhong Li and C.-C. Yang, *Iteration and factorization of entire and meromorphic functions*
Peter A. McCoy, *Function theoretic methods in partial differential equations*
M. Zuhair Nashed, *Interaction of harmonic analysis, signal processing and computational mathematics*
Jonathan M. Rosenberg, *Index theory*
Seenith Sivasundaram, *Stability and control*
W. Stephen Wilson, *Algebraic topology*

March 1992 Meeting in Tuscaloosa, Alabama
Southeastern Section
Associate Secretary: Joseph A. Cima
Deadline for organizers: Expired
Deadline for consideration: December 12, 1991

Richard C. Brown, *Spectral theory of ordinary and partial differential operators*
Jon M. Corson, Martyn Russell Dixon, Martin J. Evans and Frank Roehl, *Infinite groups and group rings*
Alan Hopenwasser and Cecelia Laurie, *Operator algebras*
Vo Thanh Liem and Bruce S. Trace, *Geometric topology*
Kai-Ching Lin, *Harmonic analysis and related topics*

March 1992 Meeting in Springfield, Missouri
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: Expired
Deadline for consideration: December 12, 1991

Nakhle Habib Asmar and Stephen John Montgomery-Smith, *Harmonic analysis*
Wenxiang Chen and Shou Chuan Hu, *Partial differential equations*
William J. Heinzer, Craig Hunecke and Kishor M. Shah, *Commutative algebra*
Jerry A. Johnson and Benny D. Evans, *Microcomputers in the upper division and graduate curriculum*
Ellen Maycock Parker, *C^*– algebras and algebraic topology*
Boris M. Schein, *Semigroups*
Vera B. Stanojevic, *Fourier analysis*
Xingping Sun and Xiang Min Yu, *Approximation theory*
David Wright, *Automorphisms of affines spaces*

April 1992 Meeting in Bethlehem, Pennsylvania
Eastern Section
Associate Secretary: W. Wistar Comfort
Deadline for organizers: Expired
Deadline for consideration: January 2, 1992

Edward F. Assmus, Jr. and Jennifer D. Key, *Finite geometry*
Grahame Bennett, Jeffrey S. Connor and Andrew K. Snyder, *Sequence spaces*
Jean-Luc Brylinski and Dennis A. McLaughlin, *Characteristic classes, algebraic K-theory and field theory*
Donald M. Davis and Douglas C. Ravenel, *Homotopy theory*
David L. Johnson and Penny D. Smith, *To be announced*
Xiao-Song Lin, *New invariants of links and 3-manifolds*
Lee J. Stanley, *Combinatorial set theory*
Joseph E. Yukich, *Stochastic processes*

June 1992 Meeting in Cambridge, England
(Joint Meeting with the London Mathematical Society)
Associate Secretary: Robert M. Fossum
Deadline for organizers: September 28, 1991
Deadline for consideration: February 7, 1992

Béla Bollobás and Ronald L. Graham, *Probabilistic combinatorics*
John Coates, *Number theory*
Richard D. James, *The microstructure of crystals*
W. B. Raymond Lickorish, *Geometric topology in low dimensions*
Jan Saxl, *To be announced*

October 1992 Meeting in Dayton, Ohio
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: January 30, 1992
Deadline for consideration: July 13, 1992

Joanne M. Dombrowski and Richard Mercer, *Operator theory and operator algebras*
Anthony B. Evans and Terry A. McKee, *Combinatorics and graph theory*
Louis H. Kauffman, *Knots and topological quantum field theory*

January 1993 Meeting in San Antonio, Texas
Associate Secretary: W. Wistar Comfort
Deadline for organizers: April 13, 1992
Deadline for consideration: September 17, 1992

March 1993 Meeting in Knoxville, Tennessee
Southeastern Section
Associate Secretary: Joseph A. Cima
Deadline for organizers: June 26, 1992
Deadline for consideration: To be announced

May 1993 Meeting in DeKalb, Illinois
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: August 21, 1992
Deadline for consideration: To be announced

August 1993 Meeting in Vancouver, British Columbia, Canada
Associate Secretary: Lance W. Small
Deadline for organizers: November 11, 1992
Deadline for consideration: To be announced

October 1993 Meeting in College Station, Texas
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: January 22, 1993
Deadline for consideration: To be announced

January 1994 Meeting in Cincinnati, Ohio
Associate Secretary: Joseph A. Cima
Deadline for organizers: April 5, 1993
Deadline for consideration: To be announced

March 1994 Meeting in Lexington, Kentucky
Southeastern Section
Associate Secretary: Joseph A. Cima
Deadline for organizers: June 18, 1992
Deadline for consideration: To be announced

March 1994 Meeting in Manhattan, Kansas
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: June 25, 1993
Deadline for consideration: To be announced

January 1995 Meeting in Denver, Colorado
Associate Secretary: Andy R. Magid
Deadline for organizers: April 20, 1994
Deadline for consideration: To be announced

January 1996 Meeting in Orlando, Florida
Associate Secretary: Lance W. Small
Deadline for organizers: April 12, 1995
Deadline for consideration: To be announced

Information for Organizers

Special Sessions at Annual and Summer Meetings are held under the supervision of the Program Committee for National Meetings (PCNM). 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 PCNM from a list of proposed Special Sessions in essentially the same manner as individuals are selected to give Invited Addresses. 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 can be found in "Rules for Special Sessions" on page 614 in the April 1988 issue of *Notices*.

Each person selected to give an Invited Address 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 PCNM 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 PCNM at least nine months prior to the meeting at which the Special Session is to be held in order that the committee may consider all the proposals for Special Sessions simultaneously. Proposals that are sent to the Providence office of the Society, to *Notices*, or directed to anyone other than the Associate Secretary will have to be forwarded and may not be received in time to be considered for acceptance.

It should be noted that Special Sessions must be announced in *Notices* in such a timely fashion that any member of the Society who so wishes may submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration. This deadline is usually three weeks before the deadline for abstracts for the meeting in question.

Special Sessions are very effective at Sectional Meetings and can usually be accommodated. The processing of proposals for Special Sessions for Sectional Meetings is handled in essentially the same manner as for Annual and Summer Meetings by the Section Program Committee. Again, 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.

Proposals for Special Sessions to the Associate Secretaries

The programs of Sectional Meetings are arranged by the Associate Secretary for the section in question:

Western Section

Lance W. Small, Associate Secretary
Department of Mathematics
University of California, San Diego
La Jolla, CA 92093
Electronic mail: g_small@math.ams.com
(Telephone 619–534–3590)

Central Section

Andy R. Magid, Associate Secretary
Department of Mathematics
University of Oklahoma
601 Elm PHSC 423
Norman, OK 73019
Electronic mail: g_magid@math.ams.com
(Telephone 405–325–6711)

Eastern Section

W. Wistar Comfort, Associate Secretary
Department of Mathematics
Wesleyan University
Middletown, CT 06457
Electronic mail: g_comfort@math.ams.com
(Telephone 203-347-9411)

Southeastern Section

Joseph A. Cima, Associate Secretary
Department of Mathematics
University of North Carolina, Chapel Hill
Chapel Hill, NC 27599-3902
Electronic mail: g_cima@math.ams.com
(Telephone 919-962-1050)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

Proposals for Special Sessions at the June 29-July 1, 1992, meeting in Cambridge, England, only, should be sent to Professor Fossum at the Department of Mathematics, University of Illinois, Urbana, IL 61801, Telephone: 217-244-1741, Electronic mail: rmf@math.ams.com

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.

Electronic submission of abstracts is available to those who use the TEX typesetting system. Requests to obtain the package of files may be sent electronically via the Internet to **abs-request@math.ams.com.** Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Electronic Abstracts, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940, USA. When requesting the abstracts package, users should be sure to specify whether they want the plain TEX, $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX, or the LATEX package.

Number of Papers Presented
Joint Authorship

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

An individual may contribute only one abstract by title in any one issue of *Abstracts*, but joint authors are treated as a separate category. Thus, in addition to abstracts from two individual authors, one joint abstract by them may also be accepted for an issue.

Site Selection for Sectional Meetings

Sectional Meeting sites are recommended by the Associate Secretary for the Section and approved by the Committee of Associate Secretaries and Secretary. Recommendations are usually made eighteen to twenty-four months in advance. Host departments supply local information, ten to twelve rooms with overhead projectors for contributed paper sessions and Special Sessions, an auditorium with twin overhead projectors for invited addresses, and registration clerks. The Society partially reimburses for the rental of facilities and equipment, and for staffing the registration desk. Most host departments volunteer; to do so, or for more information, contact the Associate Secretary for the Section.

Call For Topics For 1993 Conferences

Suggestions are invited from mathematicians, either singly or in groups, for topics for the various conferences that will be organized by the Society in 1993. The deadlines for receipt of these suggestions are given below, as well as some relevant information about each of the conferences. An application form to be used when submitting suggested topic(s) for any of these conferences (except the Short Course Series) may be obtained by writing to the Meetings Department, American Mathematical Society, P.O. Box 6887, Providence, RI 02940; telephoning 401-455-4146; or sending electronic mail to MEET@MATH.AMS.COM.

Individuals willing to serve as organizers should be aware that the professional meetings staff in the Society's Providence office will provide full support and assistance before, during, and after each of these conferences thereby relieving the organizers of most of the administrative detail. Organizers should also note that for all conferences, except Summer Research Conferences, it is required that the proceedings be published by the AMS and that proceedings of Summer Research Conferences are frequently published. A member of the Organizing Committee must be willing to serve as editor of the proceedings.

All suggestions must include (1) the names and affiliations of proposed members and the chairman of the Organizing Committee; (2) a one- to two-page description addressing the focus of the topic, including the importance and timeliness of the topic, and estimated attendance; (3) a list of the recent conferences in the same or closely related areas; (4) a tentative list of names and affiliations of the proposed principal speakers; and (5) a list of likely candidates who would be invited to participate and their current affiliations. Individuals submitting conference suggestions are requested to recommend sites or geographic areas which would assist the Meetings Department in their selection of an appropriate site.

1993 AMS Summer Institute

Summer Institutes are intended to provide an understandable presentation of the state of the art in an active field of research in pure mathematics and usually extend over a three-week period. Dates for a Summer Institute must not overlap those of the Society's summer meeting, which is scheduled for August 15-19. There should be a period of at least two weeks between them. Proceedings are published by the AMS as volumes in the series *Proceedings of Symposia in Pure Mathematics*.

Current and recent topics:

1988 – *Operator theory/Operator algebras and applications*, organized by **William B. Arveson** of the University of California, Berkeley, and **Ronald G. Douglas** of the State University of New York at Stony Brook.

1989 – *Several complex variables and complex geometry*, organized by **Steven G. Krantz** of Washington University.

1990 – *Differential geometry*, organized by **Robert E. Greene** of the University of California, Los Angeles, and **Shing-Tung Yau** of Harvard University.

1991 – *Algebraic groups and their generalizations*, **William Haboush**, University of Illinois, Urbana-Champaign

1992 – Proposal not yet selected.

Deadline For Suggestions: September 1, 1991

1993 AMS-SIAM-SMB Symposium Some Mathematical Questions in Biology

This one-day symposium, sponsored jointly by the AMS, the Society for Industrial and Applied Mathematics (SIAM), and the Society for Mathematical Biology (SMB), is usually held in conjunction with the annual meeting of a biological society closely associated with the topic. Papers from the symposia are published by the AMS as volumes in the series *Lectures on Mathematics in the Life Sciences*.

Current and recent topics:

1988 – *Dynamics of excitable media*, organized by **Hans G. Othmer** of the University of Utah.

1989 – *Sex allocation and sex change: Experiments and models*, organized by **Marc Mangel** of the University of California, Davis.

1990 – *Neural Networks*, organized by **Jack D. Cowan** of the University of Chicago.

1991 – *Theoretical approaches for predicting spatial effects in ecological systems*, organized by **Robert H. Gardner**, Oak Ridge National Laboratories.

1992 – Proposal not yet selected.

Deadline For Suggestions: September 1, 1991

1993 AMS-SIAM Summer Seminar

The goal of the Summer Seminar, sponsored jointly by the AMS and the Society for Industrial and Applied Mathematics (SIAM), is to provide an environment and program in applied mathematics in which experts can exchange the latest ideas and newcomers can learn about the field. Proceedings are published by the AMS as volumes in the series *Lectures in Applied Mathematics*.

Current and recent topics:
1988 – *Computational solution of nonlinear systems of equations*, organized by **Eugene Allgower** of Colorado State University.
1989 – *The mathematics of random media*, organized by **Werner Kohler** of Virginia Polytechnic Institute and State University and **Benjamin White** of Exxon Research & Engineering Company.
1990 – *Vortex dynamics and vortex methods*, organized by **Claude Greengard** of IBM T. J. Watson Research Center and **Christopher R. Anderson** of the University of California, Los Angeles.
1991 – No seminar held.
1992 – Proposal not yet selected.

Deadline For Suggestions: September 1, 1991

1993 AMS-IMS-SIAM Joint Summer Research Conferences in the Mathematical Sciences

These conferences, jointly sponsored by the AMS, the Institute for Mathematical Statistics (IMS), and the Society for Industrial and Applied Mathematics (SIAM), emulate the scientific structure of those held at Oberwolfach and represent diverse areas of mathematical activity, with emphasis on areas currently especially active. Careful attention is paid to subjects in which there is important interdisciplinary activity at present. A one-week or two-week conference may be proposed. Topics for the tenth series of one-week conferences, being held in 1991, are: *Stochastic modeling and statistical inference for selected problems in biology*; *Graph minors*; *Theory and applications of multivariate time series analysis*; *Stochastic inequalities*; *Biofluiddynamics*; *Motives*; *Mathematical aspects of classical field theory*; and *Systems of coupled oscillators*.

If proceedings are published by the AMS, they appear as volumes in the series *Contemporary Mathematics*.

Deadline For Suggestions: February 1, 1992

1993 Von Neumann Symposium

Through a bequest from Carroll V. Newson to memorialize the late John von Neumann and his accomplishments, the Society has established a new quadrennial symposium called the von Neumann Symposium. This new conference series will focus on concepts in the forefront of mathematics, and it is intended that they occupy a position of importance in the evolution of mathematical thought. Subjects of these one-week symposia are to be topics of emerging significance, expected to underlie future mathematical development. Ideas expressed and shared at these Symposia, and the new understandings embodied in the von Neumann proceedings, will, it is hoped, reflect exceptional mathematical leadership.

Deadline For Suggestions: September 1, 1991

Call for Topics for 1993 AMS Short Course Series

The AMS Short Courses consist of a series of introductory survey lectures and discussions which take place over a period of two days prior to and during the Joint Mathematics Meetings held in January and August each year. Each theme is a specific area of applied mathematics or mathematics used in the study of a specific subject or collection of problems in one of the physical, biological, or social sciences, technology, or business.

Current and recent topics:

Unreasonable effectiveness of number theory (August 1991), *Probabilistic combinatorics and its applications* (January 1991), *Combinatorial games* (August 1990), *Mathematical questions in robotics* (January 1990), *Cryptology and computational number theory* (August 1989), *Matrix theory and applications* (January 1989), *Chaos and fractals* (August 1988), *Computational Complexity Theory* (January 1988). Proceedings are published by the Society as volumes in the series *Proceedings of Symposia in Applied Mathematics*, with the approval of the Editorial Committee.

Deadline for Suggestions: Suggestions for the January 1993 course should have been submitted by **July 1, 1991**; suggestions for the August 1993 course should be submitted by **December 1, 1991**.

Submit suggestions to: AMS Meetings Department, P.O. Box 6887, Providence, RI 02940 or by electronic mail to MEET@MATH.AMS.COM.

EMPLOYMENT SERVICES

August 8 - 10, 1991

AT THE ORONO MATHFEST

Did you know there are job placement services at the Orono Mathfest?

The Mathematical Sciences Employment Register would like to make employers and applicants aware of the job placement services that will be provided at the Orono Mathfest in Orono, Maine, August 8 - 10, 1991.

Unlike the Employment Register during the January Joint Mathematics Meetings, the summer job placement services **do not involve scheduled interviews**. Instead, there will be a central location at Orono where applicants may post their résumés and employers may list job openings. It is then up to employers and applicants to schedule their own interviews. Individuals can contact each other using the Message Center provided in the registration area.

In addition, a Summer List of Applicants, containing résumés of mathematical scientists seeking employment, will be published and available at Orono.

More information on the employment services available at the Orono Mathfest may be found in the program in the April 1991 issue of *Notices*, page 328.

Professional Employment Opportunities Information on

e-MATH

e-MATH, a node on the INTERNET, offers convenient electronic access to AMS *Employment Opportunites in the Mathematical Sciences* services, including:

- a complete list of available employment positions posted in the current *EIMS* publication.
- the capability for employers to electronically submit a position to *EIMS* for publication as well as post it on the e-MATH system.

e-MATH also offers job applicants the ability to post a brief resume on e-MATH and have it sent to the contact e-mail address of the employment positions listed on e-MATH, if one is supplied.

To access e-MATH:

telnet e-math.ams.com

(**or telnet 130.44.1.100**). Login and password are **e-math**.

For questions or help, send e-mail to:

support@e-math.ams.com

Mathematical Sciences Meetings and Conferences

THIS SECTION contains announcements of meetings and conferences of interest to some segment of the mathematical public, including *ad hoc*, local, or regional meetings, and meetings or symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. (Information on meetings of the Society, and on meetings sponsored by the Society, will be found inside the front cover.)

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

IN GENERAL, announcements of meetings and conferences held in North America carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of *Notices*, care of the American Mathematical Society in Providence.

DEADLINES for entries in this section are listed on the inside front cover of each issue. In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence SIX MONTHS prior to the scheduled date of the meeting.

EFFECTIVE with the 1990 volume of *Notices*, the complete list of Mathematical Sciences Meetings and Conferences will be published only in the September issue. In all other issues, only meetings and conferences for the twelve-month period following the month of that issue will appear. As new information is received for meetings and conferences that will occur later than the twelve-month period, it will be announced at the end of the listing in the next possible issue. That information will not be repeated until the date of the meeting or conference falls within the twelve-month period.

Spring 1991. **IMACS International Symposium on Iterative Methods in Linear Algebra**, Brussels Free Univ., Brussels, Belgium. (Mar. 1990, p. 334)

1991–1992. **Mittag-Leffler Institute Academic Program for 1991–1992: Combinatorics**, Djursholm, Sweden. (Apr. 1991, p. 359)

July 1991

21–24. **Third Annual ACM Symposium on Parallel Algorithms & Architecture**, Hilton Head, SC. (May/Jun. 1991, p. 470)

21–25. **Renormalization and Rigidity**, Dynamical Systems Institute, Boston University, Boston, MA. (Feb. 1991, p. 143)

21–26. **SPIE's International Symposium on Optical Applied Science and Engineering**, San Diego, CA. (Jan. 1991, p. 49)

21–27. **Halbgruppentheorie**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 744)

22–24. **First International Workshop on Logic Programming and Non-Monotonic Reasoning**, Washington, DC. (Feb. 1991, p. 143)

22–26. **Thirteenth IMACS World Congress on Computation and Applied Mathematics**, Trinity College, Dublin University, Dublin, Ireland. (Apr. 1990, p. 502)

28–August 2. **Conference on Symbolic Dynamics and its Applications**, Yale University, New Haven, CT. (Nov. 1990, p. 1287)

28–August 2. **SIGGRAPH-Eighteenth International Conference on Computer Graphics and Interactive Techniques**, Las Vegas, Nevada. (Jan. 1991, p. 49)

28–August 3. **Gruppen und Geometrien**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 502)

29–August 9. **SMS-NATO ASI: Universal Algebra and Orders**, Université de Montréal, Montréal, Canada. (Dec. 1990, p. 1456)

*30–August 9. **Tenth International Congress on Mathematical Physics**, University of Leipzig, Germany.

INVITED SPEAKERS: K.D. Elworthy (Warwick), G. Neugebauer (Jena), Y. Kifer (Ithaca), S.B. Shlosman (Moscow), A. Kupiainen (Helsinki), J. Fritz (Budapest), I. Herbst (Charlottesville), M. Combescure (Paris), V. Enß (Berlin), D. Iagolnitzer (Saclay), E. Seiler, K. Gawetzki (Bures-sur-Yvette), S.L. Woronowitz (Warsaw).
INFORMATION: c/o G. Hofmann, Univ. Leipzig, Naturwissenschaftlich Theoretisches Zentrum, Augustusplatz 10, Leipzig, D-0-7010, Germany; (Leipzig) 719 2495/96/97; Telex: 51350 uni dd; Fax: 719 2499; voigt@uni-leipzig.dbp.de (c=de; a=dbp; p=uni-leipzig; ou=ntz; s=voigt).

August 1991

1–2. **Workshop on Non-Stationary Stochastic Process and Their Applications**, Hampton University, Hampton, Virginia. (May/Jun. 1991, p. 470)

3–7. **Interamerican Conference on Mathematics Education**, Univ. of Miami, Coral Gables, FL. (Apr. 1990, p. 502)

4–10. **Effiziente Algorithmen**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 744)

4–24. **SIMS Tutorial: Mathematical Sciences in Genomic Analysis**, Stanford University, Stanford, CA. (May/Jun. 1991, p. 470)

5–8. **ICMI-China Regional Conference on Mathematics Education**, Beijing, China. (Jul./Aug. 1990, p. 744)

5–9. **Fourteenth International Symposium on Mathematical Programming**, Amsterdam, The Netherlands. (Jul./Aug. 1990, p. 745)

5–10. **NSF-CBMS Regional Research Conferences in the Mathematical Sciences: K-Homology and Index Theory**, University of Colorado, CO. (Dec. 1990, p. 1456)

5–11. **Working Conference on Mapping Class Groups and Moduli Spaces**, University of Washington, Seattle, WA. (Mar. 1991, p. 241)

5–30. **Algebraic Geometry Summer Semi-**

nar, University of Utah, Salt Lake City, UT. (May/Jun. 1991, p. 471)

6–7. **AMS Short Course on the Unreasonable Effectiveness of Number Theory**, University of Maine, Orono, ME.

INFORMATION: M. Foulkes, American Mathematical Society, P.O. Box 6887, Povidence, RI 02940.

7–10. **Conference on Finite Fields, Coding Theory, and Advances in Communication and Computing**, University of Nevada, Las Vegas. (Feb. 1991, p. 143)

7–14. **1991 ASL European Summer Meeting (Logic Coloquium '91) in conjunction with the Ninth International Congress of Logic, Methodology and Philosophy of Science**, Uppsala, Sweden. (Dec. 1990, p. 1456)

8. **AMS-SIAM-SMB Symposium on Some Mathematical Questions in Biology: Theoretical Approaches for Predicting Spatial Effects in Ecological Systems**, San Antonio, TX.

INFORMATION: B. Verducci, American Mathematical Society, P.O. Box 6887, Providence, RI 02940.

8–10. **Joint Mathematics Meetings**, University of Maine, Orono, ME. (including the summer meetings of the AMS, AWM, MAA, and PME)

INFORMATION: H. Daly, AMS, P.O. Box 6887, Providence, RI 02940.

11–15. **Eleventh Annual Crypto Conference (Crypto '91)**, University of California, Santa Barbara. (Feb. 1991, p. 143)

11–17. **European Young Statisticians Meeting**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 745)

12–16. **Workshop on p-adic Monodromy and the Birch-Swinnerton-Dyer Conjecture**, Boston University, Boston, MA. (Feb. 1991, p. 143)

12–17. **NSF-CBMS Regional Research Conferences in the Mathematical Sciences: Higher Order Asymptotics with Applications to Statistical Inference**, University of North Carolina, NC. (Dec. 1990, p. 1456)

12–18. **Third International Symposium on Systems Research, Informatics and Cybernetics**, Baden-Baden, Germany. (May/Jun. 1991, p. 471)

13–16. **Third Finnish-Soviet Symposium on Probability Theory and Mathematical Statistics**, Turku/Abo, Finland. (May/Jun. 1991, p. 471)

14–16. **Short Conference on Uniform Mathematics and Applications (International Conference on Quasi-Uniformities and Related Structures)**, Bern, Switzerland. (Sep. 1990, p. 937)

18–24. **The Navier-Stokes Equations: Theory and Numerical Methods**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 745)

18–24. **The Third Conference of the Canadian Number Theory Association**, Queen's University, Kingston, Ontario. (Mar. 1991, p. 242)

* 18–24. **International Conference on Potential Theory 1991**, Conference Center Euroase, Amersfoort, The Netherlands.

PROGRAM: The conference, organized on the occasion of the 355th anniversary of the University of Utrecht, continues a tradition of international meetings related to potential theory. It covers new developments in potential theory and its applications. The program contains a series of one hour lectures and two parallel sections of 30-minute lectures.

INVITED SPEAKERS: (Provisionally): A. Ancona (Paris), D. Feyel (Paris), M. Fukushina (Osaka), T. Kilpeläinen (Jyväskylä), T. Lyons (Edinburgh), N. Makarov (Leningrad), V. Mazýa (Linköping), N. Nadirashvili (Bielefeld), H. Stahl (Berlin).

INFORMATION: A. Kuijlaars, Math. Inst., P.O. Box 80.010, 3508 TA Utrecht, The Netherlands, email: ptcngrss@math.ruu.nl; Fax: 31.30.518394.

18–30. **Molecular Evolution**, Marine Biological Laboratory, Woods Hole, MA. (May/Jun. 1991, p. 471)

18–September 4. **Twenty-first Summer Ecole de Calcul des Probabilités**, Saint Flour, France. (Jul./Aug. 1990, p. 745)

19–22. **1991 Joint Statistical Meetings**, Atlanta, GA. (Mar. 1988, p. 466)

19–23. **NSF-CBMS Regional Research Conferences in the Mathematical Sciences: Qualitative and Structured Matrix Theory**, Georgia State University, GA. (Dec. 1990, p. 1456)

19–23. **The Seventh Prague Topological Symposium**, Prague, Czechoslovakia. (Dec. 1990, p. 1456)

19–23. **International Conference on Nonlinear Analysis and Microlocal Analysis**, Nankai Institute of Math., Tianjin, China. (Apr. 1991, p. 364)

19–24. **NSF/CBMS Regional Conference on Qualitative and Structured Matrix Theory**, Georgia State University, Atlanta, GA. (Mar. 1991, p. 242)

19–24. **Second Colloquium on Differential Equations**, Plovdiv, Bulgaria. (Apr. 1991, p. 364)

19–30. **Course in Functional Integration and its Applications**, Trieste, Italy. (Jan. 1991, p. 49)

19–September 6. **College on Singularity Theory**, Trieste, Italy. (Sep. 1990, p. 938)

20–25. **The II International Conference on Algebra in Honor of A.I. Shirshov (1921–1981)**, Altai University, Barnaul, USSR. (May/Jun. 1991, p. 471)

20–27. **Sixth Workshop on Hadronic Mechanics**, San Marino, Italy. (Mar. 1991, p. 242)

20–30. **Third Pan-African Congress of Mathematicians**, Nairobi, Kenya. (Mar. 1991, p. 242)

21–23. **Thirteenth Boundary Element Method International Conference**, Tulsa, OK. (Nov. 1990, p. 1288)

21–24. **Colloquium on Differential Equations and Applications**, Budapest, Hungary. (Dec. 1990, p. 1457)

24–30. **Twelfth International Joint Conference on Artificial Intelligence (IJCAI-91)**, Sydney, Australia. (Mar. 1991, p .242)

25–31. **Klassifikation Komplex-Algebraischer Varietäten**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 745)

25–31. **Conference on Classifying Spaces of Compact Lie Groups and Finite Loop Spaces**, Göttingen University. (Nov. 1990, p. 1288)

* 26–29. **Second European Conference on Concurrency Theory**, Amsterdam, The Netherlands.

CHAIRMAN: J.C.M. Baeten, Amsterdam.

INFORMATION: CONCUR '91, c/o CWI, Kruislan 413, Postbus 4079, NL-1009 AB Amsterdam, The Netherlands.

26–31. **International Conference on Differential Equations: EQUADIFF 91**, Barcelona, Spain. (Feb. 1991, p. 144)

* 27–31. **Sixth Annual Conference of the European Consortium for Mathematics in Industry**, Limerick, Republic of Ireland.

CHAIRMAN: F. Hodnett.

ORGANIZERS: M. Burke, L. Crane, A. Hegarty, J. Kinsella, E. Murphy, M. Wallace, A. Wood.

INFORMATION: Secretariat ECMI '91, Dept. of Math., Univ. of Limerick, Plassey Technological Park, Limerick, Republic of Ireland.

* 29–September 7. **Sixth Ecole de Didactique des Mathematiques**, Plestine les Greves, France.

ORGANIZER: M. Artigue, Paris; A. Bodin, Besancon; R. Gras, Rennes; M. Legrand, Grenoble; M. Rogalski, Villeneuve d'Asq; J. Tonnelle, Marseille.

INFORMATION: M. Eberhard, Equipe de Didactique des Math., Laboratoire L.S.D.2, Univ. J. Fourier, BP 53 X, F-38041, Grenoble Cedex, France.

September 1991

1–5. **Colloquium on Intuitive Geometry**, Balatonaliga, Hungary. (Mar. 1991, p. 242)

1–7. **Topologie**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 745)

2–6. **Théorie Additive des Nombres**, Centre International de Rencontres Mathématiques. (May/Jun. 1991, p. 472)

*2–9. **Les Mathematiques et L'Art**, Paris, France.

INFORMATION: Centre Culturel International de Cerisy-la-salle, 27 rue de Boullainvilliers, F-75016 Paris, France.

3–6. **Seventeenth International Conference on Very Large Data Bases (VLDB '91)**, Barcelona, Spain. (Jan. 1991, p. 49)

3–6. **Functional Integration and its Applications**, Trieste, Italy. (Jan. 1991, p. 50)

3–10. **Applied Mathematics in the Aerospace Field**, Erice (Trapani), Sicily. (Jan. 1991, p. 50)

4–6. **Twenty-fifth Annual DOD Cost Analysis Symposium**, Xerox International Center for Training and Management Development, Leesburg, VA. (Feb. 1991, p. 144)

*4–7. **Fourth International Meeting of Statistics in the Basque Country**, Bilbao, Spain.

INFORMATION: J.P. Vilaplana, Faculty of Math. Sci., Univ. of Bilbao, E-48070 Bilbao, Spain.

4–10. **IMA Tutorial**, University of Minnesota, Minneapolis, MN. (Oct. 1990, p. 1139)

7–9. **International Workshop on Software for Automatic Control Systems**, Irkutsk, USSR. (Oct. 1990, p. 1139)

8–14. **Niedrigidimensionale Topologie**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 745)

8–14. **Knoten und Verschlingungen**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 745)

*9–11. **Sixteenth Symposium on Operations Research**, Trier, Germany.

ORGANIZERS: R. Hettich, R. Horst, E. Sachs, D. Baum, H. Czap, D. Sadowski, E. Sonnemann.
INFORMATION: R. Horst, Univ. Trier, FB IV Math., Postfach 3825, D-5500 Trier, Germany.

9–13. **Journées Arithmétiques**, Geneva, Switzerland. (Dec. 1990, p. 1457)

9–13. **ICMTA 5 Teaching Mathematics by Applications**, Noordwijkerhout, The Netherlands. (Jan. 1991, p. 50)

9–13. **Twenty-second Conference on Differential Geometry and Topology, Applications in Physics and Technics**, Polytechnic Institute of Bucharest, Romania. (May/Jun. 1991, p. 472)

9–13. **Arithmétique et Dynamique Symbolique**, Centre International de Rencontres Mathématiques. (May/Jun. 1991, p. 472)

*9–13. **Fundamentals of Computation Theory (FCT '91)**, Gosen (near Berlin), Germany.

PROGRAM COMMITTEE: L. Budach (Chair), R.G. Bukharajev, L. Czaja, H. Ehrig, Z. Esik, P. Flajolet, J. Gruska, J. Heintz, J. Sakarovitch, H. Thiele, I. Wegener.
INFORMATION: B. Molzan or L. Budach, Karl Weierstrass Institut für Mathematik and Institute für Informatik und Rechentechnik, PF 1304, Rudower Chaussee 5, D-0-1086, Berlin, Germany; email: budach@db0adw11.bitnet or budach@iir-berlin.adw.dbp.de; Fax: (0372) 200 49 75 or (0372) 676 22 00; phone: (0372) 203 77 305 or (0372) 674 59 61.

9–27. **School on Dynamical Systems**, Trieste, Italy. (Sep. 1990, p. 938)

10–13. **IFAC/IMACS Symposium on Fault Detection, Supervision and Safety for Technical Processes-SAFEPROCESS '91**, Baden-Baden, Federal Republic of Germany. (Apr. 1990, p. 502)

10–13. **International Conference on Parallel Methods for Ordinary Differential Equations the State of the Art**, Grado, Italy. (May/Jun. 1991, p. 472)

11–14. **Fourth SIAM Conference on Applied Linear Algebra**, Univ. of Minnesota, Minneapolis, MN. (Nov. 1990, p. 1288)

13–15. **Representation Theory Conference**, University of Oregon, Eugene, OR. (Nov. 1990, p. 1288)

14–27. **An International Conference on Theoretical Aspects of Computer Software**, Tohoku University, Sendai, Japan. (Feb. 1991, p. 144)

*15–19. **Annual Meeting of the German Mathematical Society (DMV)**, Universität Bielefeld, Jahrestagung, Bielefeld.

INVITED SPEAKERS: J. Cuntz (Heidelberg), Ch. Deninger (Münster), P. Diaconis (Cambridge), H.M. Edwards (NY), A. Floer (Bochum), U. Hamenstädt (Bonn), R. Howe (New Haven), R. Kühnau (Halle), K. Mehlhorn (Saarbrücken), R. Racke (Bonn), J.W. Schmidt (Dresden), K. Stein (München), H. Strade (Hamburg), E. Scholz (Wuppertal), T. tom Dieck (Göttingen), G. Dueck (IBM), R. Janßen (IBM), R. Klass (Mercedes-Benz).
INFORMATION: DMV-Tagung 1991, Fakultät für Mathematik, Univ. Bielefeld, W-4800 Bielefeld 1, (Rép. Féd. d'Allemagne).

15–20. **DMV-Jahrestagung 1991**, Bielefeld, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

15–21. **Geometrie der Banachräume**, Oberwolfachk Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

*15–21. **Fifth International Conference on Complex Analysis and Applications '91 with a Symposium on Generalized Functions**, Varna, Bulgaria. (Please note change in date from Mar. 1991, p. 243)

16–18. **IFAC/IFIP/IMACS Symposium on Robot Control (SYROCO '91)**, Vienna, Austria. (May/Jun. 1991, p. 472)

16–20. , **Summer School on Minimal Models, Lie Groups and Differential Geometry**, Universidad de Santiago de Compostela, Spain. (Feb. 1991, p. 144)

16–20. **Géométrie des Équations Différentielles**, Centre International de Rencontres Mathématiques. (May/Jun. 1991, p. 473)

*16–21. **Minimal Models, Lie Groups, and Differential Geometry**, Santiago de Compostela, Spain.

INFORMATION: A.G. Tato, Dept. de Xeome tria e Topoloxia, Faculdad de Matematica, Univ. de Santiago de Compostela, E-15707 Santiago de Compostela, Spain.

16–27. **Seventh International Summer School on Probability Theory and Mathematical Statistics**, Varna-Golden Sands, Bulgaria. (Please note date change from Mar. 1991, p. 243)

22–28. **Nonlinear and Random Vibrations**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

23. **One Day Function Theory Meeting**, University of Lancaster, Lancaster, England. (May/Jun. 1991, p. 473)

23–25. **International Conference on Mathematical Modelling of Materials Processing**, Bristol, United Kingdom. (May/Jun. 1991, p. 473)

23–27. **Cryptographie**, Centre International de Rencontres Mathématiques. (May/Jun. 1991 p. 473)

*23–27. **Third Workshop on Data, Expert Knowledge, and Decision**, Schloß Reisensburg, Germany.

ORGANIZERS: W. Gaul, Karlsruhe; F.J. Radermacher, Ulm; M. Schader, Hamburg; D. Solte, Ulm.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau. By invitation only.

23–29. **Sixth Symposium on Classical Analysis**, Kazimierz Dolny, Poland. (Apr. 1990, p. 502)

24–27. **International Conference on Theoretical Aspects of Computer Software**, Tohoku Univ., Sendai, Japan. (Sep. 1990, p. 938)

*24–27. **Perspectives in Nonlinear Analysis**, Carnegie Mellon University, Pittsburgh, PA. (Please note change in email address from May/Jun. 1991, p. 473)

INFORMATION: cn0s@andrew.cmu.edu.

25–27. **Ninth GAMM Conference on Numerical Methods in Fluid Mechanics**, Lausanne, Switzerland. (May/Jun. 1990, p. 613)

*26–28. **Workshop on Stochastic Theory-Adaptive Control**, University of Kansas, Lawrence, KS.

PROGRAM: The workshop is sponsored by the NSF and the Univ. of Kansas. It will cover topics on recent and future directions in stochastic modelling and control with an emphasis on adaptive control. The goal of the meeting is to bring together people working on stochastic control and various aspects of adaptive control to provide an effective interaction.

INFORMATION: Chairpersons: T. Duncan and B. Pasik-Duncan, tel: 913-864-3651; Fax: 913-864-5255; email: (bitnet) mailbox@ukanvax.bitnet; (internet) mailbox@kuhub.cc.ukans.edu.

27–28. **Nineteenth Annual Conference on Statistics and its Applications**, Miami University, Oxford, OH. (Apr. 1991, p. 365)

27–29. **Mid-Atlantic Algebra Conference: Developments in Algebra Related to Quantum Groups**, Wake Forest University, Winston-Salem, N.C. (May/Jun. 1991, p. 473)

29–October 5. **Kombinatorik Geordneter Mengen**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

30–October 2. **First International Conference of the Austrian Center for Parallel Computation (ACPC)**, Salzburg, Austria. (Feb. 1991, p. 145)

*30–October 2. **The Fall '91 Meeting of SUP'EUR**, Rome, Italy.

PROGRAM: The basic objectives set for this meeting are: provide a forum where European IBM users and support staff can exchange their experiences and problems; review the progress achieved by the SUP'EUR collaboration in fulfilling its mandate, which is to assist supercomputer users in academia and research to make the best use of their hardware and software resources; and to present the SUP'EUR organization to potential members.

INFORMATION: TWT Conventions/ SUP'EUR Fall '91, Palazzo Specchi, via degli Specchi n.3, 00186 Roma (Italy); tel: 06/6833776-6548352; Fax: 06/6873091.

30–October 4. **Journées de Probabilités**, Centre International de Rencontres Mathématiques. (May/Jun. 1991, p. 473)

October 1991

1–4. **SCAN-91 IMACS-GAMM International Symposium on Computer Arithmetic and Scientific Computation**, Universität Oldenburg, Germany. (Feb. 1991, p. 145)

*5. **Thirty-Third Algebra Day-Trends in Linear Algebra**, Centre for Research in Algebra and Number Theory, Carleton University-University of Ottawa, Canada.

INVITED SPEAKERS AND TOPICS: E.L. Green (V.P.I.) - Groebner bases and computational aspects of representation theory; J.A. de la Pena (U.N.A.M.) - Finite dimensional algebras and Coxeter transformations; J.J. Rotman (Urbana) - Projective planes, graphs and simple algebras.

INFORMATION: V. Dlab, Dept. of Math. and Stat., Carleton Univ., Ottawa, Ontario K1S 5B6, Canada; vlasta@carleton.ca; Fax: 613-788-3536.

6–12. **Arbeitsgemeinschaft mit Aktuellem Thema (wird in den Mitteilungen der DMV Heft 3/1991 bekanntgegeben)**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

7–9. **Second Symposium on High Performance Computing**, Montpellier, France. (Feb. 1991, p. 145)

7–10. **The Ninth International Symposium on Applied Algebra, Algebraic Algorithms, and Error Correcting Codes**, New Orleans, LA. (Dec. 1990, p. 1458)

7–11. **Workshop on Stochastic and Deterministic Models**, Trieste, Italy. (Sep. 1990, p. 938)

7–11. **IMA-INRIA Workshop on Transfer of Mathematics to Industry in the U.S. and France**, University of Minnesota, Minneapolis, MN. (Dec. 1990, p. 1458)

*7–11. **Computer Science Logic '91**, Berne, Switzerland.

CHAIRMAN: G. Jaeger, Bern.

INFORMATION: G. Jaeger, CSL '91, Inst. für Informatik und Angewandte Math., Univ. Bern, Switzerland.

12–13. **Eastern Section**, Temple University, Philadelphia, PA.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6887, Providence, RI 02940.

13–19. **Geometrie**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

14–16. **Mathématique et Informatique**, Centre International de Rencontres Mathématiques. (May/Jun. 1991, p. 473)

14–18. **IMA Workshop on Sparse Matrix Computations: Graph Theory Issues and Algorithms**, University of Minnesota, Minneapolis, MN. (Oct. 1990, p. 1140)

16–18. **SIAM Workshop on Micromechanics**, Leesburg, VA. (Nov. 1990, p. 1288)

16–18. **IFAC/IMACS/IFIP Workshop on Cultural Aspects of Automation**, Krems, Austria. (May/Jun. 1991, p.473)

18–19. **Differential and Delay Equations**, Iowa State University, Ames, Iowa. (Jan. 1991, p. 50)

*18–19. **Thirteenth Midwest Probability Colloquium**, Northwestern University, Evanston, IL.

INVITED SPEAKERS: Principle speaker: R. Durrett (two lectures); R. Lyons and J.C. Hansen (hour lectures).

INFORMATION: M. Pinsky, Dept. of Math., Northwestern Univ., Evanston, IL 60208; email: m_pinsky@math.nwu.edu.

*18–19. **1991 Mathematical Sciences Department Chairs Colloquium**, Arlington, VA.

PROGRAM: The theme of the '91 colloquium is "Encouraging talent into the Mathematical Sciences Pipeline." The program is designed to provide information and materials chairs may use in the design of recruiting and nurturing programs for their depts. The keynote speaker is Mary Good, chair of the National Science Board. The program also includes sessions providing information on encouraging members of underrepresented groups in the mathematical sciences, the Ph.D. job market, and the pipeline in statistics.

INFORMATION: Board on Mathematical Sciences, National Research Council, 2101 Constitution Avenue, NW, Room NAS 312, Washington, DC 20418; 202-334-2421.

20–26. C^***-Algebren**, Oberwolfach, Federal Republic of Germany. (Jan. 1991, p. 50)

*20–26. **Third International Workshop–Conference on Evolution Equations, Control Theory, and Biomathematics**, Han-sur-Lesse, Belgium. (Please note changes from Nov. 1990, p. 1288)

PROGRAM: This workshop-conference will be mainly devoted to the recent advances in the area of evolution equations and its applications. In particular, it will be strongly related to the work done and the problems investigated under the EC project "Evolutionary Systems: deterministic and stochastic evolution equations, control theory and mathematical biology."

WORKSHOPS: Nonlinear parabolic equations, evolution equations, control theory, mathematical biology.

INVITED SPEAKERS: *Workshop Lecturers*: S. Albeverio, F. Altomare, H. Amann, Ph. Bénilan, Ph. Clément, G. Da Prato, M. Demuth, W. Desch, O. Diekmann, A.

Favini, J. Goldstein, G. Greiner, P. Grisvard, K. Hadeler, P. Hess, R. deLaubenfels, S. Londen, G. Lumer, A. Lunardi, W. Luxemburg, R. Nagel, S. Nicaise, S. Oharu, B. de Pagter, M. Pierre, G. Rieder, W. Schappacher, H. Thieme, R. Triggiani, J. Van Casteren, V. Vasiliev, J. Vazquez, L. Weis, S. Tasaki, S. Zaidman, H. Fattorini, M. Gyllenberg, M. Hieber, J. Prüss, F. Hirsch, E. Mitidieri, V. Phong. *General Lecturers*: W. Arendt, M. Crandall, W. Jäger, S. Krein, P. Malliavin, V. Maslov, F. Neubrander, E. Sinestrari, P. Sobolevskii, W. von Wahl, R. Thom.

INFORMATION: G. Lumer, Third International Conference on Evolution Equations, Inst. de Math., Univ. de Mons, Place du Parc, 20, B-7000 MONS, Belgium; email: sdufou@bmsuem11; telefax: 32-65-373054; tel: 32-65-373507.

21–25. **Analyse Algébrique des Perturbations Singulières**, Centre International de Rencontres Mathématiques. (May/Jun. 1991, p. 473)

25–26. **Central Section**, North Dakota State University, Fargo, ND.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6887, Providence, RI 02940. Please note corrected date of meeting from previous *Notices* listings.

25–26. **Eleventh Annual Southeastern-Atlantic Regional Conference on Differential Equations**, Mississippi State University, Mississippi State, MS. (Apr. 1991, p. 365)

*26–27. **West Coast Operator Algebra Seminar**, University of California, Los Angeles.

INFORMATION: M. Takesaki, Dept. of Math., Univ. of California, Los Angeles, CA 90024-1555.

27–November 2. **Statistische Entscheidungstheorie**, Oberwolfach, Federal Republic of Germany. (Jan. 1991, p. 50)

27–November 2. **Convergence Structures in Topology and Analysis**, Oberwolfach, Federal Republic of Germany. (Jan. 1991, p. 50)

29–31. **Second Congress of the Italian Association for Artificial Intelligence (AI*IA)**, Palermo, Italy. (Mar. 1991, p. 243)

November 1991

1–3. **Partial Differential Equations and Mechanics**, Southern Illinois University, Carbondale, IL. (May/Jun. 1991, p. 474)

3–6. **ORSA/TIMS Joint National Meeting**, Anaheim, CA. (May/Jun. 1991, p. 474)

3–9. **Mengenlehre**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

4–8. **Second SIAM Conference on Geometric Design**, Tempe, AZ. (Nov. 1990, p. 1289)

4–8. **Les Processus Stochastiques en Théorie des Épidémies**, Centre International de Rencontres Mathématiques. (May/Jun. 1991, p. 474)

9. **Differential Geometry Day**, Eastern Illinois University, Charleston, IL. (May/Jun. 1991, p. 474)

9–10. **Western Section**, University of California, Santa Barbara.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6887, Providence, RI 02940.

11–15. **IMA Workshop on Combinatorial and Graph-Theoretic Problems in Linear Algebra**, University of Minnesota, Minneapolis, MN. (Oct. 1990, p. 1140)

*15–17. **Fourth Annual International Conference on Technology in Collegiate Mathematics**, Portland, OR.

PROGRAM: There will be fifty invited presentations on topics such as the use of technology in collegiate and high school mathematics from high school algebra through linear algebra, differential equations, and abstract algebra; testing with technology; current research and future trends in the role of technology in mathematics learning; and the role of technology in calculus. In addition there will be 44 free two-hour "hands-on" graphing calculator workshops and 20 two-hour "hands-on" computer minicourses.

CALL FOR PAPERS: Interested persons may submit a one-page abstract for the paper sessions or a proposal for the poster sessions along with two self-addressed stamped envelopes to L. Lum, Math. and Comp. Sci. Dept., Univ. of Portland, 5000 North Willamette Blvd., Portland, OR 97203. Abstracts and proposals must be received by October 1, 1991.

INFORMATION: F. Demana and B.K. Waits, Dept. of Math., The Ohio State Univ., 231 West 18th Ave., Columbus, OH 43210.

17–23. **Singularitäten der Kontinuumsmechanik: Numerische und Konstruktive Methoden zu Ihrer Behandlung**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

18–22. **Workshop on Discrete Groups, Number Theory and Ergodic Theory**, Mathematical Sciences Research Institute (MSRI), Berkeley, CA. (May/Jun. 1991, p. 474)

18–22. **Supercomputing '91**, Albuquerque, NM. (Mar. 1991, p. 243)

20–26. **C^*-Algebren**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

24–30. **Numerische Methoden der Approximationstheorie**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

25–29. **Séminaire Sud-rhodanien de Géométrie**, Centre International de Rencontres Mathématiques. (May/Jun. 1991, p. 474)

26–29. **Conference on Representation Theories of Lie Groups and Lie Algebras**, Misasa, Tottori, Japan. (May/Jun. 1991, p. 474)

December 1991

Fourth International Conference on Numerical Combustion, St. Petersburg, FL. (Feb. 1991, p. 146)

1–7. **Statistik Stochastischer Prozesse**, Oberwolfach, F.R.G. (Jul./Aug. 1990, p. 746)

2–4. **Fourth International Conference on Numerical Combustion**, St. Petersburg, FL. (May/Jun. 1991, p. 474)

2–4. **Titre à Préciser**, Centre International de Rencontres Mathématiques. (May/Jun. 1991, p. 474)

2–6. **Workshop on Statistical Methods in Imaging**, Mathematical Sciences Research Institute, Berkeley, CA. (Oct. 1990, p. 1140)

2–9. **SIAM Conference on Combustion**, St. Petersburg, FL. (Nov. 1990, p. 1289)

*6–7. **The Midwest Conference on Differential Equations**, University of Iowa, Iowa City, IA.

PROGRAM: This meeting will honor P. Waltman's 60th birthday.

PRINCIPLE SPEAKERS: F. Hoppensteadt, J. Hale.

CALL FOR PAPERS: Deadline for submission of contributed papers: October 15, 1991. Graduate students are encouraged to present papers dealing with their dissertation research and some funds are expected to help some students with their expenses while in Iowa City.

INFORMATION: J.A. Gatica, Dept. of Math., The Univ. of Iowa, Iowa City, IA 52242; jgatica@umaxc.weeg.uiowa.edu; or D. Dawes, Univ. of Iowa Conference Center, Iowa City, IA 52242; 319-335-3234; Fax: 319-335-3533.

7–10. **Canadian Mathematical Society Winter Meeting**, Victoria, B.C., Canada. (Oct. 1990, p. 1141)

8–14. **Stochastic Geometry, Geometric Statistics, Stereology**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

9–13. **Femmes et Mathématiques–Congrès Européen**, Centre International de Rencontres Mathématiques. (May/Jun. 1991, p. 475)

10–12. **Ninth Biennial Conference on Modelling and Simulation**, Queensland, Australia. (May/Jun. 1991, p. 475)

*12–16. **NATO Advanced Research Workshop: Algebraic Topology and Algebraic**

K-Theory, Lake Louise, Alberta, Canada.

INVITED SPEAKERS: S. Bloch (Chicago), G. Carlsson (Princeton), J.-L. Colliot-Thelene (Paris-Sud), C. Deninger (Münster), W. Dwyer (Notre Dame), E. Friedlander (Northwestern), T. Goodwillie (Brown), J. Lannes (Paris VII), S. Mitchell (Washington), F. Morel (Paris VII), E. Pedersen (SUNY/Binghamton), D. Ravenel (Rochester), P. Schneider (Köln), V. Snaith (McMaster), A. Suslin (Leningrad), R. Thomason (Paris-Sud).
INFORMATION: J.F. Jardine, Math. Dept., Univ. of Western Ontario, London, Ontario N6A 5B7, Canada; Tel: 519-661-3638; Fax: 519-661-3292; email: jardine@hydra.uwo.ca.

15–21. **Quantenstochastik**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

23–26. **International Conference on Generalized Functions and Their Applications**, Banaras Hindu University, Varanasi, India. (Dec. 1990, p. 1458)

27–31. **Holiday Symposium on the Impact of Software Systems in Mathematical Research**, New Mexico State Univ., Las Cruces, NM. (Jul./Aug. 1990, p. 746)

1992

1992. **IMACS Symposium on Symbolic Computation in Engineering Design**, IDN, Lille, France. (Jul./Aug. 1990, p. 746)

IMACS International Conference on Computational Physics, University of Colorado, Boulder, CO. (Oct. 1990, p. 1141)

Spring 1992. **International Conference on Finite Elements and Boundary Elements in Geophysics**, Monteray, CA. (Oct. 1990, p. 1141)

Spring 1992. **IMACS Symposium on Mathematical Modelling**, Wiener Neustadt, Germany. (May/Jun. 1991, p. 475)

Spring 1992. **Third IMACS International Conference on Expert Systems in Numerical Computing**, Purdue University, West Lafayette, IN. (May/Jun. 1991, p. 475)

January 1992

1–11. **Mathematische Optimierung**, Oberwolfach, Federal Republic of Germany. (Jan. 1991, p. 51)

5–8. **Second Caribbean Conference on the Fluid Dynamics**, University of the West Indies, St. Augustine, Trinidad. (Jan. 1991, p. 51)

* 6–7. **AMS Short Course on "New Scientific Applications of Geometry and Topology"**, Baltimore, MD.

ORGANIZER: De Witt Sumners, Florida State University.
INVITED SPEAKERS: L.H. Kauffman, J.K. Simon, J.H. White, N.R. Cozzarelli.
INFORMATION: Meetings Dept., American Mathematical Society, P.O. Box 6248, Providence, RI 02940; 401-455-4000.

6–17. **Topology Workshop**, Pontifical Catholic University, Rio de Janeiro, Brazil. (Apr. 1991, p. 366)

* 6–17. **International Research Workshop on Banach Space Theory**, Merida, Venezuela.

SPONSORS: The workshop is sponsored by International Mathematical Union and support from NSF is pending.
ORGANIZING COMMITTEE: W.B. Johnson, J. Lindenstrauss, J. Palis (IMU), A. Pelezynski, H.P. Rosenthal, J. Vielma, B.-L. Lin.
INFORMATION: B.-L. Lin, Dept. of Math., Univ. of Iowa, Iowa City, IA 52242; 319-335-0784; email: bllin@math.uiowa.edu; Fax: 319-335-0627.

8–11. **Joint Mathematics Meetings**, Baltimore, MD. (including the annual meetings of the AMS, AWM, MAA and NAM)

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

12–18. **Applied Dynamics and Bifurcation**, Oberwolfach, Federal Republic of Germany. (Jan. 1991, p. 51)

13–17. **IMA Workshop on Linear Algebra, Markov Chains, and Queuing Models**, University of Minnesota, Minneapolis, MN. (Oct. 1990, p. 1141)

15–17. **Workshop on Stochastics and Analysis**, Universität Zürich, Zürich, Switzerland. (May/Jun. 1991, p. 475)

19–25. **Modelltheorie**, Oberwolfach, Federal Republic of Germany. (Jan. 1991, p. 51)

26–February 1. **Applied and Computational Convexity**, Oberwolfach, Federal Republic of Germany. (Jan. 1991, p. 51)

27–29. **Third ACM-SIAM Symposium on Discrete Algorithms**, Orlando, FL. (Feb. 1991, p. 146)

* 30–February 1. **International Meeting on Nonlinear Boundary Value Problems in Science and Engineering: Analytic Methods**, University of Wollongong, New South Wales, Australia.

INVITED SPEAKERS: C. Rogers, Loughborough; A. Donato, Messina; A.C. Newell, Tuscon; A. McNabb and G. Wake, Palmerston North; J.R. Philip, Canberra; R. Ogden, Glasgow; E.O. Tuck, Adelaide; W.F. Ames, Atlanta; G. Bluman, Vancouver.
INFORMATION: P. Broadbridge and J.M. Hill, Dept. of Math., Univ. of Wollongong, P.O. Box 1144, Wollongong NSW 2500 Australia; Fax: 042-213262; email: pbroad@its.uow.edu.au.

February 1992

2–8. **Thermodynamische Materialtheorien**, Oberwolfach, Federal Republic of Germany. (Jan. 1991, p. 51)

* 3–7. **Eighth International Conference on Data Engineering**, Phoenix, AZ.

PROGRAM: The purpose of this conference is to provide a forum for the sharing of practical experiences and research advances from an engineering point of view among those interested in automated data and knowledge management. The expectation is that this sharing will enable future information systems to be more efficient and effective, and future research to be more relevant and timely.
CONFERENCE TOPICS: AI and knowledge based systems, applications and application systems, benchmarks and performance evaluation, design and human interfaces, data engineering tools and techniques, database design and modeling, database management and structure, deductive and extensive databases, multimedia database systems, distributed database systems, integrity and security techniques, learning and discovery in databases, object-oriented database systems, query languages and processing, scientific databases, supercomputer databases.
INFORMATION: F. Golshani, Dept. of Comp. Sci. and Engineering, Arizona State Univ., Tempe, AZ 85287-5406; 602-965-2855; email: golshani@asuvax.eas.asu.edu.

9–15. **Numerical Methods for Parallel Computing**, Oberwolfach, Federal Republic of Germany. (Jan. 1991, p. 51)

10–11. **Workshop on Amenable Ergodic Theory**, Mathematical Sciences Research Institute (MSRI), Berkeley, CA. (May/Jun. 1991, p. 475)

16–22. **Funktiontheorie**, Oberwolfach, Federal Republic of Germany. (Jan. 1991, p. 51)

23–29. **p-Adische Analysis und Anwendungen**, Oberwolfach, Federal Republic of Germany. (Jan. 1991, p. 51)

24–28. **IEEE Computer Society COMPCON Spring '92**, San Francisco, CA. (Jan. 1990, p. 62)

* 24–March 1. **IMA Workshop on Iterative Methods for Sparse and Structured Problems**, University of Minnesota, Minneapolis, MN. (Please note addition to May/Jun. 1991, p. 475)

SPONSORS: This workshop is co-sponsored with the Minnesota Supercomputer Institute.

March 1992

March 1992. **1992 ASL Annual Meeting**, Duke University, Durham, NC. (Apr. 1991, p. 366)

1–7. **Klassifizierende Räume und Anwendungen der Steenrod-Algebra**, Oberwolfach, Germany. (Jan. 1991, p. 52)

*3–5. **ACM 1992 Computer Science Conference**, Kansas City, MO.

PROGRAM: The general theme for this conference is *Communications*, with particular interest on "breaking down the barriers of time and distance to communications."This theme has been chosen to focus on the trend in developing faster, more efficient computer techniques and applying these advanced techniques to achieve faster and better universal communications between a). man and man, b). man and machine, and c). machine and machine.
CONFERENCE TOPICS: Telecommunications and computer networking, data engineering, knowledge engineering, software engineering, parallel and distributed systems.
CALL FOR PAPERS: Research papers, survey and tutorial articles, case studies, and novel implementation/applications are invited in all the computer science and telecommunications research areas for inclusion in CSC '92. Length of papers should not exceed 20 double-spaced pages using a 12-point font. Five copies of completed papers in format suitable for review must be received by August 1, 1991. Send to: J. Agrawal, Comp. Sci. Telecommunications Program, Univ. of Missouri-Kansas City, 5100 Rockhill Rd., Kansas City, MO 64110-2499; 816-235-2360; email: agrawal@vax2.cstp.umkc.edu.
INFORMATION: ACM CSC '92, 11 West 42nd St., New York, NY 10036.

*5–6. **Twenty-third SIGCSE ('92) Technical Symposium**, Kansas City, MO.

CONFERENCE TOPICS: Concurrency, software engineering advances, OOD/OOP, human factors, curriculum designs, and unique instructional methods.
CALL FOR PAPERS: Submit four copies of a double-spaced paper by September 1, 1991 to C.M. White, Dept. of Comp. Sci., Indiana Univ.-Purdue Univ. at Fort Wayne, 2101 E. Coliseum, Fort Wayne, IN 46805; 219-481-6867; email: white@ipfwcvax.bitnet.
INFORMATION: M. Mansfield, School of Engineering and Tech., Indiana Univ.-Purdue Univ. at Fort Wayne, Fort Wayne, IN 46805; 219-481-6839; email: mansfield@ipfwcvax.bitnet.

8–14. **Mathematische Stochastik**, Oberwolfach, Federal Republic of Germany. (Jan. 1991, p. 52)

13–14. **Southeastern Section**, University of Alabama, Tuscaloosa, AL.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6887, Povidence, RI 02940.

15–21. **Regelungstheorie**, Oberwolfach, Federal Republic of Germany. (Jan. 1991, p. 52)

20–21. **Central Section**, Southwest Missouri State University, Springfield, MO.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

*21–27. **Workshop on Fluid Dynamics and Statistical Physics**, Institute for Advanced Study, Princeton, NJ.

PURPOSE: The purpose of this workshop is to discuss theoretical, experimental, numerical and applied aspects of fluid dynamics. Special emphasis will be placed on turbulence and connections to statistical physics.
ORGANIZERS: T. Spencer, G. Papanicolaou.
INFORMATION: T. Spencer, Institute for Advanced Study, School of Mathematics, Olden Lane, Princeton, NJ 08540; 609-734-8110; spencer@guinness.ias.edu.

22–28. **Teichmüller-Theorie und Modulraume Riemannscher Flachen**, Oberwolfach, Federal Republic of Germany. (Jan. 1991, p. 52)

*22–28. **Georgia Tech.-UAB International Conference on Differential Equations and Mathematical Physics**, Atlanta, GA.

PROGRAM: This conference will broadly cover differential equations and their applications to mathematical physics. It continues the series of conferences that have been held in the past at the University of Alabama in Birmingham at 2-3 year intervals.
ORGANIZING COMMITTEE: W.F. Ames, C. Bennewitz, E.M. Harrell, J.V. Herod, Y. Saito.
PLENARY SPEAKERS: E.B. Davies, L.C. Evans, C. Foias, F. Gesztesy, N.H. Ibragimov, E. Lieb, P.L. Lions, J. Mallet-Paret, H. Matano, L. Payne, J. Rauch, J. Serrin, B. Simon, M. Wheeler.
INFORMATION: E. Harrell, School of Math., Georgia Institute of Technology, Atlanta, GA 30332-0160; email: gituab@math.gatech.edu.

29–April 4. **Topologische Methoden in der Gruppentheorie**, Oberwolfach, Federal Republic of Germany. (Jan. 1991, p. 52)

*29–April 5. **Sixth International Conference on Geometry**, University of Haifa, Israel (postponed from March 1991 because of the Gulf War).

CONFERENCE TOPICS: Foundations of geometry, geometric algebra, combinatorial geometry, convexity and convex polytopes. *Special section*: Geometry and school.
INFORMATION: R. Artzy or J. Zaks, Dept. of Math., Univ. of Haifa, 31999 Haifa, Israel.

30–April 3. **Workshop on Statistical Methods in Molecular Biology**, Mathematical Sciences Research Institute, Berkeley, CA. (Oct. 1990, p. 1141)

April 1992

April 1992. **Eighth International Conference on Mathematical and Computer Modelling**, United States. (Sep. 1990, p. 939)

5–11. **Algebraische K-Theorie**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 146)

*5–11. **Informationstheorie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: R. Ahlswede, Bielefeld; J.H. van Lint, Eindhoven; J. Massey, Zürich.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

6–10. **IMA Workshop on Linear Algebra for Signal Processing**, University of Minnesota, Minneapolis, MN. (Oct. 1990, p. 1141)

11–12. **Eastern Section**, Lehigh University, Bethlehem, PA.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6887, Povidence, RI 02940.

12–18. **Mathematische Logik**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 146)

13–17. **Workshop on Lie Groups, Ergodic Theory, and Geometry**, Mathematical Sciences Research Institute (MSRI), Berkeley, CA. (May/Jun. 1991, p. 476)

19–25. **Arbeitsgemeinschaft mit Aktuellem Thema**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 146)

26–May 2. **Gruppentheorie**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 146)

*30–May 1. **Twenty-third Annual Pittsburgh Conference on Modeling and Simulation**, University of Pittsburgh, PA.

PROGRAM: Emphasis for the 1992 Conference will be microprocessors, personal computer applications and software, artifi-

cial intelligence, expert systems, robotics and all aspects of control theory and applications, as well as social, economic, geography, regional science, and global modeling and simulation. Special sessions are planned on Microprocessors in Education.

CALL FOR PAPERS: Only papers not published previously will be considered. These papers should describe significant contributions which add to the knowledge in a particular area or which describe progress of research currently being conducted. Two copies of titles, authors, all author's addresses, abstracts and summaries should be submitted by January 31, 1992. The abstract should be approximately 50 words in length and the summary should be of sufficient length and detail to permit careful evaluation.

INFORMATION: W.G. Vogt or M.H. Mickle, Modeling and Simulation Conference, 348 Benedum Engineering Hall, Univ. of Pittsburgh, Pittsburgh, PA 15261.

May 1992

May 1992. **Conference on Classification of Algebraic Varieties**, L'Aquila, Italy. (Apr. 1991, p. 366)

3–9. **Wavelett (Signalverarbeitung)**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 146)

10–16. **Geschichte der Mathematik**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 146)

11–13. **Fourth SIAM Conference on Optimization**, Chicago, IL. (Feb. 1991, p. 146)

17–23. **Quadratische Formen**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 146)

* 18–23. **Second European Conference on Computer Vision**, Santa Margherita Ligure, Italy.

CHAIRMAN: G. Sandini, Genova.

INFORMATION: G. Sandini, DIST Univ. of Genova, via Opera Pia 11A, I-16145 Genova, Italy.

24–30. **Kommutative Algebra und Algebraische Geometrie**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 146)

29–31. **Twenty-first International Symposium on Multi-Valued Logic**, Sendai 980, Japan. (Jan. 1990, p. 62)

31–June 6. **Singularitaten**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

31–June 6. **Free Resolutions in Algebraic Geometry and Representation Theory**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

June 1992

June 1992. **IMACS Symposium on Numerical Computing and Mathematical Modelling**, Bangalore, India. (Oct. 1990, p. 1141)

1–5. **Seventh International Conference on Graph Theory, Combinatorics, Algorithms, and Applications**, Western Michigan University, Kalamazoo, MI. (May/Jun. 1991, p. 476)

1–5. **IMA Workshop on Linear Algebra for Control Theory**, University of Minnesota, Minneapolis, MN. (Oct. 1990, p. 1141)

7–13. **Computational Group Theory**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

8–11. **Sixth SIAM Conference on Discrete Mathematics**, University of British Columbia, Vancouver, Canada. (May/Jun. 1991, p. 476)

12–14. **Canadian Mathematical Society Summer Meeting**, York University, North York, Ontario, Canada. (Nov. 1990, p. 1289)

14–20. **Fifth International Symposium on Statistical Decision Theory and Related Topics**, Purdue University, West Lafayette, IN. (Sep. 1990, p. 938)

14–20. **Freiformkurven und Freiformflachen**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

15–19. **Twenty-first International Conference on Stochastic Processes and their Applications**, Toronto, Canada. (May/Jun. 1990, p. 613)

17–20. **Fourth International Conference on Computers and Learning, ICCAL '92**, Acadia University, Nova Scotia, Canada. (Feb. 1991, p. 147)

21–27. **Porous Media**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

* 23–26. **Homotopy Theory**, Sorrento, Italy.

CHAIRMEN: I.M. James, E.H. Brown, R.A. Piccinini.

ORGANIZERS: R.A. Piccinini, S. Buoncristiano, L. Lomonaco.

INFORMATION: R.A. Piccinini, Univ. di Milano, Dipt. di Matematica, Via C. Saldini 50, I-20133 Milano, Italy.

28–July 4. **Hyperbolic Systems of Conservation Laws**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

29–July 1. **Joint Meeting with the London Mathematical Society**, Cambridge, England.

INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

29–July 5. **Nineteenth International Colloquium on "Group Theoretical Methods in Physics"**, Salamance, Spain. (May/Jun. 1991, p. 476)

July 1992

* 1–10. **Stochastic Analysis Workshop of Guadeloupe-Silivri**, Pointe-à-Pitre, France.

PROGRAM: Due to the 500th anniversary of the discovery of Guadeloupe, the scientific committee, in collaboration with C. Martias, has decided to organize the fourth Silivri workshop. E. Perkins (Canada), P. Molchanov and N. Krylov (U.S.A.) are expected as the main speakers of the first week. The second week shall be devoted to the contributed papers of the participants.

INFORMATION: C. Martias, Univ. des Antilles et de la Guyanne, Faculté des Sciences, BP 592, 97167 Pointe-à-Pitre Cedex or A.S. Ustunel, ENST, Dept. Reseaux, 46, rue Barrault, 75013 Paris; email: ustunel@liszt.enst.fr.

* 5–11. **Mathematische Modellierung und Simulation Elektrischer Schaltungen**, Oberwolfach, Germany.

CHAIRMEN: R.E. Bank, La Jolla; R. Bulirsch, München; H. Gajewski, Berlin; K. Merten, München.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

6–10. **European Congress of Mathematics**, Paris, France. (May/Jun. 1991, p. 476)

* 11–18. **St. Andrews Colloquium**, University of St. Andrews, Scotland.

PROGRAM: The colloquium is organized under the auspices of the Edinburgh Mathematical Society and has taken place almost every four years since 1926. In the mornings, there will be short lectures aimed at a general audience to be given by: A.M. Davie (Edinburgh Univ.), R.L.Graham (Bell Labs), and V.F.R. Jones (Berkeley). In the afternoons, there will be seminars in algebra (organized by J. Howie) and analysis (organized by A. Sinclair) at which participants may present papers. The colloquium will take place after the joint LMS/AMS meeting in Cambridge (June 29 - July 1) and the European Mathematical Congress in Paris (July 2 - July 11). It is organized 'back-to-back' with the meeting of the Fibonacci Assoc. also to be held in St. Andrews from July 18 - 25.

INFORMATION: J.M. Howie or J.J. O'Connor, St. Andrews Colloquium 1992, Mathematical Institute, North Haugh, St. Andrews, KY16 9SS, Scotland.

* 12–17. **International Colloquium on Automata, Languages and Programming,**

Vienna, Austria.

CHAIRMAN: W. Kuich, Vienna.
INFORMATION: W. Kuich, Technische Univ. Wien, Wiedner Hauptstraße 8-10, A-1040 Wien, Austria.

12–18. **Arithmetic Algebraic Geometry**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

19–24. **SIAM Annual Meeting (SIAM's 40th Anniversary)**, Los Angeles, CA. (Feb. 1991, p. 147)

19–25. **Lower-Dimensional Theories and Domain Decomposition Methods in Mechanics**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

* 19–25. **Applications of Nonstandard-Analysis to Analysis, Functional Analysis, and Probability Theory**, Heinrich Fabri-Institut der Universität Tübingen, Blaubeuren (Ulm), Federal Republic of Germany.

ORGANIZING COMMITTEE: California Inst. of Tech.: W.A.J. Luxemburg; Federal Republic of Germany: S. Albeverio, Univ. of Bochum; D. Laugwitz, Univ. of Darmstadt; and M. Wolff, Univ. of Tübingen.
INFORMATION: M. Wolff, Mathematisches Institut der Universität Tübingen, Auf der Morgenstelle 10, D-74 Tübingen, FRG.

20–24. **The Fifth International Conference on Fibonacci Numbers and their Applications**, University of St. Andrews, St. Andrews, Scotland. (May/Jun. 1991, p. 476)

20–26. **International Conference on Algebraic Geometry**, Université Paris-Sud. (Please note date change from Apr. 1991, p. 363)

26–31. **Eighteenth International Symposium on Rarefied Gas Dynamics (RGD18)**, University of British Columbia, Vancouver, Canada. (May/Jun. 1991, p. 477)

26–August 1. **Variationsrechnung**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

August 1992

August 1992. **The International Conference Lobachevsky and Modern Geometry devoted to the 200th Anniversary of Lobachevsky's birthday**, Kazan, USSR. (Feb. 1991, p. 147)

2–8. **Algebraische Zahlentheorie**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

3–7. **Sixth Workshop on Lie-Admissible Formulations**, Clearwater, FL. (Mar. 1991, p. 244)

* 3–7. **Fifth International Meeting of Statistics in the Basque Country**, San Sebastin, Spain.

INFORMATION: J.P. Vilaplana, Faculty of Math. Sci., Univ. of Bilbao, E-48070, Bilbao, Spain.

9–15. **Jordan-Algebren**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

* 16–22. **Reelle Analysis**, Oberwolfach, Germany.

CHAIRMEN: D. Müller, Bielefeld; E.M. Stein, Princeton.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

16–23. **Seventh International Congress on Mathematical Education (ICME-7)**, Québec, Canada.

19–26. **World Congress of Nonlinear Analysts**, Melbourne, FL. (Nov. 1990, p. 1289)

22–28. **Eighteenth International Congress of Theoretical and Applied Mechanics**, Technion–Israel Institute of Technology, Haifa, Israel. (Jan. 1991, p. 52)

23–29. **Mathematical Finance**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

26–28. **IMACS RM2S '92 Kobe**, Kobe University, Kobi, Japan. (May/Jun. 1991, p. 477)

30–September 5. **Komplexe Analysis**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

September 1992

* 17–19. **International Conference on Group Theory**, University of Timisoara, Romania.

CONFERENCE SECTIONS: Finite group theory, infinite group theory, computational theory of groups.
CALL FOR PAPERS: Deadline for submission of manuscripts: March 31, 1992.
INFORMATION: "The Group Theory Conference," Division of Algebra, Dept. of Math., Univ. of Timisoara, Bd. V. Parvan, 4, 1900-Timisoara, Romania.

The following new announcements will not be repeated until the criteria in the last paragraph in the box at the beginning of this section are met.

October 1992

* 16–19. **Second SIAM Conference on Dynamical Systems**, Salt Lake City, UT.

ORGANIZERS: P.W. Bates, Brigham Young Univ. and Christopher K.R.T. Jones, Brown Univ.
CALL FOR PAPERS: Abstract deadline: March 13, 1992.
INFORMATION: SIAM Conference Department, 3600 University City Science Center, Philadelphia, PA 19104-2688; 215-382-9800; Fax: 215-386-7999; email: siamconfs@wharton.upenn.edu.

November 1992

* 16–20. **International Congress on Numerical Methods in Engineering and Applied Sciences**, University of Concepción, Concepción, Chile.

ORGANIZING COMMITTEE: H. Alder, J.C. Heinrich, S. Lavanchy, E. Onate.
CONFERENCE TOPICS: Adaptive techniques, approximation theory, boundary elements, finite differences, finite elements, flow in porous media, fluid mechanics, mathematical modelling, optimization, soil mechanics, solid and structural mechanics, solution of large systems of equations, thermal problems and biomechanics.
CALL FOR PAPERS: Abstracts deadline: February 1, 1992.
INFORMATION: B. Suárez, Centro Internacional de Métodos Numéricos en Ingeniería: Módulo C1, Campus Norte U.P.C. Gran Capitán s/n, 08034 Barcelona, Espana; Fax: 34-3-401 65 17; or Sergio Lavanchy, Facultad de Ingeniería; Casilla 53-C, Concepción, Chile; Fax: 56-41-22 27 12.

March 1994

25–26. **Central Section**, University of Kansas, Manhattan, KS.

INFORMATION: W.S. Drady, AMS, P.O. Box 6887, Providence, RI 02940.

New AMS Publications

STRUCTURAL PROPERTIES OF POLYLOGARITHMS
Leonard Lewin, Editor
(Mathematical Surveys and Monographs, Volume 37)

About ten years ago, the handful of peculiar numerical dilogarithmic identities, known since the time of Euler and Landen, gave rise to new discoveries concerning cyclotomic equations and related polylogarithmic ladders. These discoveries were made mostly by the methods of classical analysis, with help from machine computation. About the same time, starting with Bloch's studies on the application of the dilogarithm in algebraic K-theory and algebraic geometry, many important discoveries were made in diverse areas.

This book seeks to provide a synthesis of these two streams of thought. In addition to an account of ladders and their association with functional equations, the chapters include applications to volume calculations in Lobatchevsky geometry, relations to partition theory, connections with Clausen's function, new functional equations, and applications to K-theory and other branches of abstract algebra. This rapidly-expanding field is brought up to date with two appendices, and the book concludes with an extensive bibliography of recent publications. About two-thirds of the material is accessible to mathematicians and scientists in many areas, while the remainder requires more specialized background in abstract algebra.

Contents

L. Lewin, *The evolution of the ladder concept*; **L. Lewin**, *Dilogarithmic ladders*; **M. Abouzahra and L. Lewin**, *Polylogarithmic ladders*; **M. Abouzahra and L. Lewin**, *Ladders in the trans-Kummer region*; **M. Abouzahra and L. Lewin**, *Supernumary ladders*; **L. Lewin**, *Functional equations and ladders*; **G. A. Ray**, *Multivariable polylogarithm identities*; **G. Wechsung**, *Functional equations of hyperlogarithms*; **G. Wechsung**, *Kummer-type functional equations of polylogarithms*; **Zdsislaw Wojtkowiak**, *The basic structure of polylogarithmic functional equations*; **J. Browkin**, *K-theory, cyclotomic equations, and Clausen's function*; **Spencer Bloch**, *Function theory of polylogarithms*; **J. H. Loxton**, *Partition identities and the dilogarithm*; **Ruth Kellerhals**, *The dilogarithm and volumes of hyperbolic polytopes*; **Richard M. Hain and Robert MacPherson**, *Introduction to higher logarithms*; **L. Lewin**, *Some miscellaneous results*; **Don Zagier**, *Appendix A: Special values and functional equations of polylogarithms*; **Robert MacPherson and Han Sah**, *Appendix B: Summary of the informal polylogarithm workshop*.

1980 *Mathematics Subject Classification*: 39
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SEVERAL COMPLEX VARIABLES AND COMPLEX GEOMETRY
Eric Bedford, John P. D'Angelo, Robert E. Greene, and Steven G. Krantz, Editors
(Proceedings of Symposia in Pure Mathematics, Volume 52)

This three-volume set contains the proceedings of the Summer Research Institute on Several Complex Variables and Complex Geometry, held at the University of California at Santa Cruz in July, 1989. The institute explored recent developments in the geometry and function theory of several complex variables. An attempt was made to stimulate interactions among the different methodologies in the subject, such as differential geometry, algebraic geometry, partial differential equations, harmonic analysis, and classical methods. The topics covered include function theory, complex geometry, partial differential equations, functional analysis, and analysis on manifolds. With contributions by some of the world's top experts in several complex variables and complex geometry, this book provides readers with insight into the current state of this field.

Contents

PART 1

David E. Barrett, *Uniqueness for the Dirichlet problem for harmonic maps from the annulus into the space of planar discs*; **Steve Bell**, *CR maps between hypersurfaces in $\mathbb{C}^n$*; **Carlos A. Berenstein and Alain Yger**, *Bounds for the degrees in polynomial equations*; **Thomas Bloom**, *Lagrange interpolants for entire functions on $\mathscr{E}^n$*; **Urban Cegrell**, *An inequality for analytic functions*; **J. A. Cima and W. R. Derrick**, *Some solutions of the Beltrami equation with $||\mu||_\infty = 1$*; **V. Ezhov**, *On the problem of the linearization of the stability group of a real-analytic hypersurface*; **Franc Forstneric**, *Mappings of strongly pseudoconvex Cauchy-Riemann manifolds*; **S. M. Ivashkovich**, *Rational curves and extensions of holomorphic mappings*; **Jacob Korevaar**, *Applications of $\mathbb{C}^n$ capacities*; **Steven G. Krantz**, *Convexity in complex analysis*; **Donna Kumagai**, *Solutions of $\partial^2\mu/\partial z\partial\overline{z} = e^{2u}$ and analytic multivalued functions*; **Alan Noell**, *Local versus global convexity of pseudoconvex domains*; **Sergey Pinchuk**, *The scaling method and holomorphic mappings*; **Evgeny A. Poletsky**, *Plurisubharmonic functions as solutions of variational problems*; **A. G. Sergeev**, *On complex analysis in tube cones*; **Bernard Shiffman**, *Separately meromorphic functions and separately holomorphic mappings*; **Nessim Sibony**, *Some aspects of weakly pseudoconvex domains*; **Pascal J. Thomas**, *Unions minimales de n-plans Réels d'enveloppe égale à $\mathbb{C}^n$*; **Jan Wiegerinck and Rein Zeinstra**, *Separately subharmonic functions: When are they subharmonic*; **Kehe Zhu**, *Functions of bounded mean oscillation in the Bergman metric on bounded symmetric domains*;

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Robert E. Greene, *The geometry of complex manifolds: an overview*; **Marco Abate**, *Angular derivatives in strongly pseudoconvex domains*; **Yukinobu Adachi and Masakazu Suzuki**, *Degeneracy points of the Kobayashi pseudodistances on complex manifolds*; **Takao Akahori**, *On the construction of the moduli space for strongly pseudoconvex domains*; **Andrew Balas**, *On the holomorphic sectional curvature of complete domains in $\mathbb{C}^n$ that are not Stein*; **J. Bland and T. Duchamp**, *Normal forms for convex domains*; **Ciprian Borcea**, *Homogeneous vector bundles and families of Calabi–Yau threefolds.* II; **Jean Pierre Demailly**, *Holomorphic Morse enequalities*; **Pierre Dolbeault**, *Some problems*; **Michael G. Eastwood and C. Robin Graham**, *Invariants of CR densities*; **Yakov Eliashberg and Mikhael Gromov**, *Convex symplectic manifolds*; **H. R. Fischer and R. J. Fisher, Jr.**, *Simple partial connections and the Einstein condition*; **Sidney Frankel**, *Applications of affine geometry to geometric function theory in several complex variables Part* I. *Convergent rescalings and intrinsic quasi-isometric structure*; **Akito Futaki**, *A Lie algebra character and Kähler-Einstein metrics of positive scalar curvature*; **Bruce Gilligan**, *On the ends of complex manifolds homogeneous under a Lie group*; **James F. Glazebrook and Franz W. Kamber**, *Determinant line bundles for Hermitian foliations and a generalized Quillen metric*; **Ian Graham**, *Sharp constants for the Koebe theorem and for estimates of intrinsic metrics on convex domains*; **Chong-Kyu Han**, *Rigid immersions of G-structures and analyticity of CR mappings into spheres*; **J. William Helton and Orlando Merino**, *Optimal analytic disks*; **Marek Jarnicki and Peter Pflug**, *Some remarks on the product property for invariant pseudometrics*; **Shanyu Ji**, *Smoothing of currents and Moišezon manifolds*; **Kang-Tae Kim**, *Biholomorphic mappings between quasicircular domains in C^n*; **Akio Kodama**, *Characterizations of certain weakly pseudoconvex domains in C^n from the viewpoint of biholomorphic automorphism groups*; **Claude LeBrun**, *Complete Ricci-flat Kähler metrics on* $\mathbf{C}^n$ *need not be flat*; **Steven Shin-Yi Lu**, *On meromorphic maps into varieties of log-general type*; **Ngaiming Mok**, *Aspects of Kähler geometry on arithmetic varieties*; **J. Noguchi**, *Moduli spaces of holomorphic mappings into hyperbolic spaces and its applications*; **Salomon Ofman**, *The analytic radon transform*; **Takeo Ohsawa**, *Applications of the $\overline{\partial}$ technique in L^2 Hodge theory on complete Kähler manifolds*; **Marius Overholt**, *Bounds on the derivatives of holomorphic endomorphisms*; **Giorgio Patrizio and Pit-Mann Wong**, *Monge-Ampère functions with large center*; **Mathias Peternell**, *A characterization of affine varieties*; **Thomas Peternell and Michael Schneider**, *Compactifications of $\mathbb{C}^n$: A survey*; **T. Ratiu and A. Todorov**, *An infinite-dimensional point of view on the Weil-Petersson metric*; **Min Ru and Wilhelm Stoll**, *The Cartan conjecture for moving targets*; **Morihiko Saito**, *On Kollár's conjecture*; **Leslie Saper and Steven Zucker**, *An introduction to L^2-cohomology*; **Vo Van Tan**, *On the compactification problems for Stein* 3*-folds*; **Gang Tian**, *On one of Calabi's problems*; **T. Tonev**, *Multi-dimensional analytic structures and uniform algebras*; **J. Varouchas**, *The $\partial\overline{\partial}$-equation on complex spaces*; **Jean-Pierre Vigué**, *Fixed points of holomorphic mappings in a bounded convex domain in $\mathbb{C}^n$*; **L. Waelbroeck**, *Holomorphic functions taking their values in a q-space and the Cauchy-Fantappiè formula*; **B. Wong**, *Schwarz's lemma and Hermitian manifolds with constant holomorphic curvature*; **H. Wu**, *Polynomial functions on complete Kähler manifolds*; **Kichoon Yang**, *The Chern numbers of projective algebraic hypersurfaces*; **Shing-Tung Yau**, *A review of complex differential geometry*;

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1980 *Mathematics Subject Classifications*: 32D, 32E, 32F, 32H (Part 1), 32B, 32C, 32G, 32H, 32J, 32K, 32L, 32M, 53C (Part 2), 35N15, 32F20, 53B, 32A, 32F, 32C (Part 3)
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SELFADJOINT AND NONSELFADJOINT OPERATOR ALGEBRAS AND OPERATOR THEORY

Robert S. Doran, Editor

(Contemporary Mathematics, Volume 120)

This book contains papers presented at the NSF/CBMS Regional Conference on Coordinates in Operator Algebras, held at Texas Christian University in Fort Worth in May 1990. During the conference, in addition to a series of ten lectures by Paul S. Muhly (which will be published in a CBMS Regional Conference Series volume), there were twenty-eight lectures delivered by conference participants on a broad range of topics of current interest in operator algebras and operator theory. This volume contains slightly expanded versions of most of those lectures. Participants were encouraged to bring open problems to the conference, and, as a result, there are over one hundred problems and questions scattered throughout this volume.

Readers will appreciate this book for the overview it provides of current topics and methods of operator algebras and operator theory.

Contents

Lawrence Baggett and Judith Packer, *C^*-algebras associated to two-step nilpotent groups*; **David P. Blecher**, *Some applications of a recent characterization of operator algebras*; **Raúl E. Curto**, *Problems in multivariable operator theory*; **Raúl E. Curto and Keren Yan**, *The Taylor spectrum of infinite direct sums*; **John Froelich**, *Operator algebras and differential topology*; **Frank L. Gilfeather and Roger R. Smith**, *Operator algebras with arbitrary Hochschild cohomology*; **Palle E. T. Jorgensen**, *Representation of symplectic vector spaces obtained as unitary dilations*; **Palle E. T. Jorgensen**, *Imprimitivity systems associated to regions in $\mathbb{R}^n$, connections between geometry and spectrum, a sample of problems*; **Richard V. Kadison**, *Triangular algebras—another chapter*; **A. Katavolos**, *Decomposability of operators relative to two subspaces*; **E. G. Katsoulis**, *The equation $Tx = y$ in nest algebras*; **David R. Larson and David R. Pitts**, *Some questions concerning nest algebras*; **David R. Larson and Warren R. Wogen**, *Some problems on triangular and semi-triangular operators*; **Richard A. Linden and Héctor Salas**, *Two problems on almost diagonalization of normal operators*; **Michael McAsey**, *Spatial implementation of lattice isomorphisms*; **Paul S. Muhly, Chaoxin Qiu, and Baruch Solel**, *Intrinsic isomorphism invariants for some triangular operator algebras*; **William L. Paschke**, *Some operator-algebraic aspects of the theory of infinite graphs*; **Justin R. Peters**, *On analytic subalgebras of* UHF *algebras*; **N. C. Phillips**, *Five problems on operator algebras*; **Yiu Tung Poon**, *Analytic triangular algebras with integer valued cocycle*; **Arlan Ramsay and Martin E. Walter**, *Fourier-Stieltjes algebras of locally compact groupoids*; **Zhong-Jin Ruan**, *On the preduals of dual algebras and their tensor products*; **Kichi-Suke Saito**, *An introduction to Toeplitz operators associated with analytic crossed products*; **Baruch Solel**, *Distance formula and contractive projections*; **Sze-Kai Tsui**, *Constructions of extreme n-positive linear maps*; **Takehiko Yamanouchi**, *Duality for actions and coactions of measured groupoids on von Neumann algebras*; **Guoliang Yu**, *Cyclic cohomology and the index theory of transversely elliptic operators*; **Shuang Zhang**, *Ideals of generalized Calkin algebras*; **Shuang Zhang**, *Problems on C^*-algebras of real rank zero and their multiplier algebras*; **David Blecher, Kenneth R. Goodearl, Richard V. Kadison, Kathy Merrill, William L. Paschke, Alan L. T. Paterson, Frederick W. Shultz, Baruch Solel,**, *A collection of problems on operator algebras; The Texas groupoid in King Robert's Court*.

1980 *Mathematics Subject Classifications*: 22D10, 22D20, 22D25, 46H05, 46L05, 47C05, 47B25, 47D25, 47D35; 05C25, 06A23, 18G35, 20M30, 46H70, 57R30, 57S10
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DYNAMICAL SYSTEMS AND STATISTICAL MECHANICS
Ya. G. Sinaĭ, Editor

(Advances in Soviet Mathematics, Volume 3)

Dynamical systems and statistical mechanics have been developing in close interaction during the past decade, and the papers in this book attest to the productiveness of this interaction.

The first paper in the collection contains a new result in the theory of quantum chaos, a burgeoning line of inquiry which combines mathematics and physics and which is likely in time to produce many new connections and applications. Another paper, related to the renormalization group method for the study of maps of the circle with singularities due to a jump in the derivative, demonstrates that the fixed point of the renormgroup can in this case be sufficiently described. In certain situations, the renormgroup methods work better than the traditional KAM method.

Other topics covered include: thermodynamic formalism for certain infinite-dimensional dynamical systems, numerical simulation of dynamical systems with hyperbolic behavior, periodic points of holomorphic maps, the theory of random media, statistical properties of the leading eigenvalue in matrix ensembles of large dimension, spectral properties of the one-dimensional Schrödinger operator. This volume will appeal to many readers, as it covers a broad range of topics and presents a view of the some of the frontier research in the Soviet Union today.

Contents

M. L. Blank, *Phase space discretization in chaotic dynamical systems*; **V. L. Girko**, *G-consistent estimates of eigenvalues and eigenvectors of matrices*; **K. M. Khanin and E. B. Vul**, *Circle homeomorphisms with weak discontinuities*; **D. V. Kosygin**, *Multidimensional KAM theory from the renormalization group viewpoint*; **G. M. Levin**, *Symmetries on a Julia set*; **M. D. Missarov**, *Renormalization group and renormalization theory in p-adic and adelic scalar models*; **Ya. B. Pesin and Ya. G. Sinaĭ**, *Space-time chaos in chains of weakly interacting hyperbolic mappings*; **Ya. G. Sinaĭ**, *Poisson distribution in a geometric problem*; **S. Ya. Zhitomirskaya**, *Singular spectral properties of a one-dimensional Schrödinger operator with almost periodic potential*.

1991 *Mathematics Subject Classifications*: 15A52, 34L40, 58A08, 58F13, 58F99, 60D05, 60E99, 60F05, 70K50, 81Q10, 81T17, 82B28, 82C28; 58F13, 58F15, 62G20
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ALGEBRAIC K-THEORY
A. A. Suslin, Editor

(Advances in Soviet Mathematics, Volume 4)

This volume contains previously unpublished papers on algebraic K-theory written by Leningrad mathematicians over the last few years. The main topic of the first part is the computation of K-theory and K-cohomology for special varieties, such as group varieties and their principal homogeneous spaces, flag fiber bundles and their twisted forms, λ-operations in higher K-theory, and Chow groups of nonsingular quadrics. The second part deals with Milnor K-theory: Gersten's conjecture for K_3^M of a discrete valuation ring, the absence of p-torsion in K_*^M for fields of characteristic p, Milnor K-theory and class field theory for multidimensional local fields, and the triviality of higher Chern classes for the K-theory of global fields.

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Part I: Computations in K-theory.
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MATHEMATICIANS AND EDUCATION REFORM 1989–90
Naomi D. Fisher, Harvey B. Keynes, and Philip D. Wagreich, Editors
(CBMS Issues in Mathematics Education, Volume 2)

Educational issues are receiving a great deal of attention in the mathematical sciences community, as concern rises over the quality of instruction in the nation's schools, colleges, and universities. Insuring a mathematically literate population and increasing the number of students pursuing careers in mathematics, science, and engineering are high on the list of priorities. Mathematicians can make important contributions to the educational reform process.

The present volume is the second in the series *Issues in Mathematics Education*, launched in 1990 by the Conference Board of the Mathematical Sciences and published by the AMS and the Mathematical Association of America. The purpose of the series is to stimulate the flow of information among mathematical scientists, education specialists, and teachers, about innovative efforts to revitalize mathematics education.

Compiled and edited by the directors of the Mathematicians and Education Reform (MER) Network, this book contains papers by speakers and participants in MER workshops and special sessions over the last three years. Like the first volume, which also grew out of an MER workshop, this book is organized into two sections, *Projects* and *Issues and Reactions*, providing a balance between descriptions of successful existing projects and more in-depth discussion of problems and issues in mathematics education reform. With contributions by some of the major leaders in this area today, this book will likely be of interest to a broad segment of the mathematical sciences community.

Contents

Projects: Judith Mumme and Julian Weissglass, *Improving mathematics education through school-based change*; **Alfred Manaster**, *Diagnostic testing: One link between university and high school mathematics* ; **Arnold E. Ross**, *Creativity: Nature or nurture? A view in retrospect*; **Harvey B. Keynes**, *Equity and excellence in the University of Minnesota Talented Youth Mathematics Program (UMTYMP)*; **Elias Toubassi**, *A report on an entry level math program*; **Issues and reactions: Bert Fristedt**, *Pros and cons of teaching mathematics via a problem-solving approach*; **T. Christine Stevens**, *Obstacles to change: The implications of the National Council of Teachers of Mathematics (NCTM) Standards for Undergraduate Mathematics*; **Joseph G. Rosenstein**, *The role of teachers in mathematics education reform*; **Christopher Cotter and Igor Szczyrba**, *Teaching to love wisdom*; **Frank L. Gilfeather and Nancy A. Gonzales**, *Teacher networking: A corollary of junior mathematics prognostic testing*; **Carl Swenson**, *Using technology for teaching mathematics*.

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THE METRIC INDUCED BY THE ROBIN FUNCTION
Norman Levenberg and Hiroshi Yamaguchi, Editors
(Memoirs of the AMS, Number 448)

This book reveals an interesting connection between classical (Newtonian) potential theory on R^{2n} and the theory of several complex variables on pseudoconvex domains in C^n. The authors bring together many results concerning the Robin function Λ associated to the R^{2n} Laplace operator on a pseudoconvex domain in C^n. Using the technique of variation of domains, the second author proved that, under mild regularity assumptions on the domain, $-\Lambda$ and $log(-\Lambda)$ are strictly plurisubharmonic. In addition to providing a new proof of this result, the authors discuss the asymptotics of the Robin function, the relationship between the Laplacian of the Robin function and the Bergman kernel function, and the completeness of the Kähler metric associated to $log(-\Lambda)$. The book is essentially self-contained and should be accessible to those with knowledge of the basic concepts of several complex variables, classical potential theory, and elementary differential geometry.

Contents

Levi-curvature; *Smooth variation of domains*; *Boundary behavior of the Robin function* $\Lambda(\xi)$; *Proof of Lemma* 3.1; *Proof of Lemma* 3.1, *continued*; *Limiting formulas*; *Strict plurisubharmonicity of* $-\Lambda(\xi), \log(-\Lambda(\xi))$; *The Robin function and the Bergman kernel*; *Metric induced by Robin function*; *Strictly pseudoconvex boundary points*; *Explicit formulas for a half-space*; *Sufficient conditions for completeness of the* Λ*-metric*; *An example with* $\ell_2(\xi, a) \not\geq c|\ell_1(\xi, a)|^2$.

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A CLASSIFICATION THEOREM FOR HOMOTOPY COMMUTATIVE H-SPACES WITH FINITELY GENERATED MOD 2 COHOMOLOGY RINGS
Michael Slack
(Memoirs of the AMS, Number 449)

Many homological properties of Lie groups are derived strictly from homotopy-theoretic considerations and do not depend on any geometric or analytic structure. An H-space is a topological space having a continuous multiplication with unit. Generalizing from Lie group theory, John Hubbuck proved that a connected, homotopy commutative H-space which is a finite cell complex has the homotopy type of a torus. There are many interesting examples of H-spaces which are not finite complexes—loop spaces are one example.

The aim of this book is to prove a version of Hubbuck's theorem in which the condition that the H-space be a finite cell complex is replaced by the condition that it have a finitely-generated mod 2 cohomology ring. The conclusion of the theorem is slightly more general in this case, and some mild associativity hypotheses are required. The method of proof uses established techniques in H-space theory, as well as a new obstruction-theoretic approach to (Araki-Kudo-Dyer-Lashof) homology operations for iterated loop spaces.

Contents

Techniques used in the proof; *Initial study of* QH^{even}; *Initial study of* QH^{odd}; *Further study of* QH^*; QH^* *in low degrees*; *Proof of corollaries.*

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SOLUTION OF A NON-DOMESTIC TAME CLASSIFICATION PROBLEM FROM INTEGRAL REPRESENTATION THEORY OF FINITE GROUPS ($\Lambda = RC_3; v(3) = 4$)

Ernst Dieterich

(Memoirs of the AMS, Number 450)

Suppose R is a complete discrete valuation ring with exponential valuation v, G is a finite p-group. The representation type (finite, tame, or wild) of the group ring $\Lambda = RG$ had been determined in all cases but one: the case in which $G = C_3$ and $v(3) = 4$. The present book closes this gap.

The author presents an explicit classification of all indecomposable lattices, as well as a description of the Auslander-Reiten quiver of Λ, demonstrating that this is the only integral group ring whose representation type is non-domestic tame of finite growth. This book acquaints readers with various (by now classical) tame module categories, with techniques of matrix reduction, and with the interaction of basefree (category-theoretic) and base-dependent (matrix-theoretic) viewpoints and their respective relations to the combinatorial intuition provided by Auslander-Reiten quivers.

Contents

Preliminaries: *Notation and conventions*; *Generalized factorspace categories*; *Normal forms for local problems*; *Angular matrices and definition of subcategories*; *Dimension mappings*; **First reduction**; **Second reduction**; **Third reduction**; **Fourth reduction**; **The Auslander-Reiten quiver of** Λ; **Appendix**: *Complete list of all indecomposable* Λ*-lattices*; *The Auslander-Reiten quiver of* M; *Leitfaden.*

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EFFECTIVE ALGEBRAIC TOPOLOGY

Rolf Schön

(Memoirs of the AMS, Number 451)

This book contains the first four in a series of papers presenting a constructive foundation for algebraic topology. The author provides means for effective solutions to computation, construction, and decision problems, the main novelty being the comprehensive and systematic method by which ambiguity problems are removed from diagrams of exact sequences. The author treats computability problems concerning the homology and homotopy of finite, simply connected complexes. In particular, he demonstrates the computability of their homotopy groups via the homology of their iterated loop spaces, as well as the computability of the homology groups and k-invariants of their Postnikov-decompositions. Opening a wide range of potential applications, this book demonstrates that a much larger portion of algebraic topology is accessible to effective computations than was previously thought.

Contents

A five-lemma for calculations in homological algebra; *Fibrations with calculable homology*; *An algorithm for calculating homotopy groups*; *The effective computability of* k*-invariants.*

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BILLIARDS: A GENETIC INTRODUCTION TO THE DYNAMICS OF SYSTEMS WITH IMPACTS

Valeriĭ V. Kozlov and Dmitriĭ V. Treshchëv

(Translations of Mathematical Monographs, Volume 89)

Starting with the work of G. D. Birkhoff, billiards have been a popular research topic drawing on such areas as ergodic theory, Morse theory, and KAM theory. Billiard systems are also remarkable in that they arise naturally in a number of important problems of mechanics and physics.

This book is devoted to mathematical aspects of the theory of dynamical systems of billiard type. Focusing on the genetic approach, the authors strive to clarify the genesis of the basic ideas and concepts of the theory of dynamical systems with impact interactions and also to demonstrate that these methods are natural and effective. Recent limit theorems, which justify various mathematical models of impact theory, are key features. Questions of existence and stability of periodic trajectories of elastic billiards occupy a special place in the book, and considerable attention is devoted to integrable billiards. A brief survey is given of work on billiards with ergodic behavior. Each chapter ends with a list of problems.

Contents

Introduction: Elements of impact theory; *The genetic method in the dynamics of systems with one-sided constraints*; *Periodic trajectories of the Birkhoff billiard*; *The Hill equation*; *Integrable problems*; *Nonintegrable billiards*; *Appendix* I. *Systems with elastic reflections and KAM theory*; *Appendix* II. *On the connection of dynamic and geometric properties of periodic trajectories.*

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S. L. Sobolev

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This book presents the theory of functions spaces, now known as Sobolev spaces, which are widely used in the theory of partial differential equations, mathematical physics, and numerous applications. The author also treats the variational method of solution of boundary value problems for elliptic equations, including those with boundary conditions given on manifolds of different dimensions. In addition, the theory of the Cauchy problem for second-order hyperbolic equations with variable coefficients is studied. The book is intended for researchers in mathematics and mathematical physics and would be useful to undergraduate and graduate students taking advanced courses in these areas.

Contents

Special problems of functional analysis; *Variational methods in mathematical physics*; *The theory of hyperbolic partial differential equations.*

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Mamoru Mimura and Hirosi Toda

(Translations of Mathematical Monographs, Volume 91)

Lie groups are very general mathematical objects that appear in numerous areas such as topology, functional analysis, and algebra, as well as differential geometry and differential topology. The purpose of these two volumes is to provide a guide to the topology of Lie groups and homogeneous spaces by bringing together a wide range of results relating to them. The first volume thoroughly studies topological properties of the classical groups as typical examples of Lie groups. In the second volume, the authors study general properties of compact Lie groups, particularly the exceptional groups.

Contents

Contents of Part I: *Classical groups*; *Covering spaces and fibre bundles*; *Cohomology groups of classical groups and their homogeneous spaces*; *The periodicity of KF-groups and the homotopy groups*; **Contents of Part II**: *Compact Lie groups*; *The Morse-Bott theory*; *Compact Lie groups, cohomology of exceptional Lie groups.*

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HARISH-CHANDRA AND HIS WORK
Rebecca Herb

During his lifetime, Harish-Chandra was widely recognized as one of the greatest mathematicians of his time. However, his work is not well known, except to those who work in his own field of representation theory. Herb's clarity of presentation and command of the subject matter make this videotape an excellent introduction to the fundamentals of representation theory and to the work of Harish-Chandra. Herb gives the necessary background leading up to one of Harish-Chandra's greatest achievements, the harmonic analysis of $L^2(G)$ for a real reductive group G. Lecturing at a level accessible to undergraduate mathematics majors, Herb provides insight into the contributions of her "mathematical hero."

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George Daniel Mostow

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Fred Roberts, Frank Hwang, and Clyde Monma, Editors

Reliability problems arise with increasing frequency as our modern systems of telecommunications, information transmission, transportation, and distribution become more and more complex. In December 1989 at DIMACS at Rutgers University, a workshop on Reliability of Computer and Communication Networks was held to examine the discrete mathematical methods relevant to these problems. There were nearly ninety participants, including theoretical mathematicians, computer scientists, and electrical engineers from academia and industry, as well as network practitioners, engineers, and reliability planners from leading companies involved in the use of computer and communications networks. This volume, published jointly with the Association for Computing Machinery, contains the proceedings from this Workshop.

The aim of the Workshop was to identify the latest trends and important open problems, as well as to survey potential practical applications. The Workshop explored questions of computation of reliability of existing systems and of creating new designs to insure high reliability, in addition to the closely related notion of survivability. Redundancy, single stage and multistage networks, interconnected networks, and fault tolerance were also covered. The Workshop emphasized practical applications, with many invited speakers from a variety of companies which are dealing with practical network reliability problems. The success of the Workshop in fostering many new interactions among researchers and practitioners is reflected in the proceedings, which provide an exciting look at some of the major advances at the forefront of this important field of research.

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Visiting Mathematicians

(Supplementary List)

The list of visiting mathematicians includes both foreign mathematicians visiting in the United States and Canada, and Americans visiting abroad. Note that there are two separate lists.

American Mathematicians Visiting Abroad

Name and Home Country	Host Institution	Field of Special Interest	Period of Visit
Weintraub, Steven H. (U.S.A.)	Universität Hannover; Universität Göttingen	Differential Topology, Algebraic Geometry	9/91 - 12/91 1/92 - 6/92

Visiting Foreign Mathematicians

Camponino, Matsimo (Italy)	University of California, Irvine	Mathematical Physics	7/91 - 12/91
Cherkaev, Andrej (USSR)	University of Utah	Applied Mathematics	1/92 - 6/92
Ding, Guanggui (People's Republic of China)	University of Iowa	Functional Analysis	8/91 - 6/92
Doelman, Arjen (The Netherlands)	Cornell University	Applied Mathematics	7/91 - 7/92
Fang, Xiang (People's Republic of China)	Washington University	Harmonic Analysis	9/91 - 5/92
Fila, Marek (Czechoslovakia)	Iowa State University	Partial Differential Equations	8/91 - 5/92
Fouque, J.P. (France)	University of California, Irvine	Probability	8/91 - 12/91
Fuhrmann, Paul A. (Israel)	University of Texas, Dallas	Functional Analysis, Linear Algebra, and Systems Theory	9/91 - 5/92
Gueron, Shay (Israel)	Cornell University	Applied Mathematics	8/91 - 8/92
Guitierrez, Joaquim (Spain)	Kent State University	Functional Analysis	9/91 - 10/91
Harnik, Victor (Israel)	McGill University	Logic	9/91 - 12/91
Hsieh, Ying-Hen (Taiwan)	Cornell University	Mathematical Biology	8/91 - 7/92
Ivanov, Sergei (USSR)	University of Utah	Group Theory	9/91 - 6/92
Jarchow, Hans (Switzerland)	Kent State University	P-Summing Operators	8/91 - 10/91
Khalil, Roshdi (Jordan)	McGill University	Analysis	8/91 - 7/92
Kharlampovich, Olga (USSR)	McGill University	Combinatorial Algebra	9/91 - 8/92
Lu, Shan-Zheng (People's Republic of China)	Washington University	Harmonic Analysis	2/92 - 3/92
MacIntyre, Angus (England)	University of California, Irvine	Logic	1/92 - 6/92
Makroglou, Athena (Greece)	Iowa State University	Numerical Analysis	8/91 - 5/92
McKernan, James (United Kingdom)	University of Utah	Algebraic Geometry	9/91 - 6/92
Melendez, Yolande (Spain)	Kent State University	Functional Analysis	8/91 - 10/91
Mori, Shigefumi (Japan)	University of Utah	Algebraic Geometry	8/91 - 7/92
Pan, Zhongxiong (People's Republic of China)	McGill University	Differential Equations and Numerical Computations	4/91 - 12/92
Panfilov, Alexander (USSR)	University of Utah	Applied Mathematics	9/91 - 6/92
Perez, Fernando (Brazil)	University of California, Irvine	Mathematical Physics	1/92 - 3/92
Picardello, Angelo Massimo (Italy)	Washington University	Harmonic Analysis	1/92 - 6/92
Pierzchalski, A. (Poland)	University of Iowa	Differential Geometry	8/91 - 1/92
Rao, B.V. (India)	Indiana University	Probability	5/91 - 5/92

Name and Home Country	Host Institution	Field of Special Interest	Period of Visit
Ravi, M.S. (India)	University of Notre Dame	Algebraic Geometry	8/91 - 5/92
Rosenberg, Alexander (USSR)	University of Utah	Algebra	9/91 - 6/92
Schumacher, Georg B. (Germany)	University of Notre Dame	Complex Analytic/Differential Geometric Techniques	8/91 - 5/92
Stromme, Stein Arild (Norway)	University of Utah	Algebraic Geometry	9/91 - 6/92
Tchovlaevski (USSR)	University of California, Irvine	Mathematical Physics	7/91 - 6/92
Vargas, Edson (Brazil)	Cornell University	Applied Mathematics	8/91 - 8/92
Vasilescu, F.-H. (Romania)	University of Iowa	Operator Theory	1/92 - 6/92
Vijayakumar, G.R. (India)	University of Wyoming	Combinatorics/Graph Theory	8/91 - 12/91
Xu, Quanhua (France)	University of Iowa	Functional Analysis	8/91 - 1/92
Zheng, Songmu (People's Republic of China)	University of Utah	Applied Mathematics	9/91 - 12/91
Zhitomirskaya, Svetlana (USSR)	University of California, Irvine	Mathematical Physics	7/91 - 6/92

Miscellaneous

Personals

Clyde L. Monma, of Bell Communications Research (Bellcore), has been promoted to division manager of the mathematics, information sciences and operations research division of that company.

Deaths

Charles James Amick, of the University of Chicago, died on June 3, 1991, at the age of 39. He was a member of the Society for 7 years.

Karl W. Folley, of the University of Michigan-Dearborn, died on February 15, 1991, at the age of 85. He was a member of the Society for 62 years.

Harry Gonshor, of Rutgers University, died on May 15, 1991, at the age of 62. He was a member of the Society for 38 years.

Domingo A. Herrero, of Arizona State University, died on April 13, 1991, at the age of 50. He was a member of the Society for 22 years.

Magnus R. Hestenes, Professor Emeritus of the University of California, Los Angeles, died on May 31, 1991, at the age of 85. He was a member of the Society for 62 years.

Derrick H. Lehmer, of the University of California, Berkeley, died on May 22, 1991, at the age of 86. He was a member of the Society for 65 years.

Elhanan Leibowitz, of Ben-Gurion University of the Negev, died in November 1990, at the age of 47. He was a member of the Society for 16 years.

Christopher Paul Merz, of the University of Kentucky, died on December 8, 1990, at the age of 24. He was a member of the Society for one year.

Steven Orey, of the University of Minnesota, died on February 15, 1991, at the age of 62. He was a member of the Society for 39 years.

Glen E. Schober, of Indiana University, died on January 29, 1991, at the age of 52. He was a member of the Society for 28 years.

Gerald C. Schrag, of Central Missouri State University, died on March 12, 1991, at the age of 52. He was a member of the Society for 23 years.

Max Wyman, Retired Professor from the University of Alberta, died on February 9, 1991, at the age of 74. He was a member of the Society for 51 years.

Reciprocity Agreements

The American Mathematical Society has "reciprocity agreements" with a number of mathematical organizations around the world. A current list appears below.

These Reciprocity Agreements provide for reduced dues for members of these organizations who choose to join the AMS and who reside outside of the U.S. and Canada. Reciprocally, members of the AMS who reside in the U.S. or Canada may join these organizations at a reduced rate. Summaries of the privileges available to AMS members who join under the terms of reciprocity agreements are given on the following pages. Members of these organizations who join the AMS as reciprocity members enjoy all the privileges available to ordinary members of the Society. AMS dues for reciprocity members are $50 for 1991 and $52 for 1992. Each organization was asked to review and update its listing in the Spring. An asterisk (*) after the name of an organization indicates that no response to this request had been received when the July/August *Notices* went to press. A bullet (•) before the name of an organization indicates that application forms for that organization may be obtained by writing the American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940-6248.

Africa

•Nigerian Mathematical Society*

Apply to: Christopher O. Imoru (Secretary), Nigerian Mathematical Society, Department of Mathematics, University of Ife, Ile-Ife, Nigeria.

Dues: $10; payable to the Treasurer, Nigerian Mathematical Society, Department of Mathematics, University of Benin, Benin City, Nigeria.

Privileges: *Journal of the Nigerian Mathematical Society* at the price normally charged to individual members.

Officers: A. Olubummo (President), J. O. C. Ezeilo (Vice-President), C. O. Nwachuku (Treasurer), C. O. M. Imoru (Secretary), S. A. Ilori (Assistant Secretary), H. O. Tejumola (Editor-in-Chief).

Asia

•Allahabad Mathematical Society

Apply to: K. K. Azad, Secretary, Allahabad Mathematical Society, 10, C.S.P. Singh Marg, Allahabad-211 001, India.

Dues: US $20 (annual), US $150 (life); payable to Allahabad Mathematical Society.

Privileges: *Indian Journal of Mathematics.*

Officers: Pramila Srivastava (President), S. N. Bhalt, A. M. Vaidya (Vice-Presidents), Kavita Srivastava (Treasurer), K. K. Azad (Secretary), G. D. Dikshit (Editor, *Indian Journal of Mathematics*), V. Singh (Librarian).

Calcutta Mathematical Society*

Apply to: U. Basu, Secretary, Calcutta Mathematical Society, 92, Acharya Prafulla Chandra Road, Calcutta 700 009, India.

Dues: $2; payable to U. Basu, Secretary.

Privileges: *News Bulletin* (free of cost).

Officers: M. Dutta (President), P. C. Vaidya, B. R. Bhonsle, F. Harary, L. Debnath, S. P. Bandyopadhyay, (Vice-Presidents), B. K. Datta, (Treasurer), U. Basu (Secretary).

Indian Mathematical Society*

Apply to: S. P. Arya, General Secretary, Indian Mathematical Society, Department of Mathematics, Maitreyi College, Bapu Dham Complex, Chanakyapuri, New Delhi 110 021, India.

Dues: $20; payable to M. K. Singal, Hon. Treasurer, IMS, Department of Mathematics, Meerut University, Meerut-250 005, India.

Privileges: *Mathematics Student.*

Officers: V. M. Shah (President), M. P. Singh (Immediate Past President), M. K. Singal (Treasurer), S. P. Arya (General Secretary), J. N. Kapur (Academic Secretary), I. B. S. Passi (Editor of *Journal of Indian Mathematical Society*), A. M. Vaidya (Editor of *Mathematics Student*), K. S. Padmanabhan (Hony. Librarian).

Korean Mathematical Society

Apply to: Dohan Kim, 538 Dowha Dong, Mapo Ku, Sung Ji Building, Room 706, Seoul 121-742, Korea.

Dues: $20; payable to the Korean Mathematical Society.

Privileges: Free receipt of *Bulletin* (two issues per year) and *Journal of the Korean Mathematical Society* (two issues per year), half of membership dues.

Officers: Jongsik Kim (President), Chin-Ku Chu, Moo Ha Woo (Vice-President), Chong-Man Cho (Treasurer), Dohan Kim (Secretary).

•Malaysian Mathematical Society

Apply to: Hon. Secretary, Malaysian Mathematical Society, c/o Department of Mathematics, University of Malaya, 59100 Kuala Lumpur, Malaysia.

Dues: $7.50; payable to Malaysian Mathematical Society.

Privileges: *MMS Newsletter*, *Bulletin of the Malaysian Mathematical Society* (two issues per year), reduced rate for *Menemui Matematik* (three issues per year).

Officers: Sek-Wui Seah (President), Chiaw-Hock Sim, Yee-Hock Peng (Vice-Presidents), Soo-Mei Ee (Treasurer), K. Ratnavelu (Secretary), Ah-Hin Pooi (Ass. Hon. Secretary).

•Mathematical Society of Japan

Apply to: Setsuko Izawa, Secretary, Mathematical Society of Japan, 25-9-203, Hongo 4-chome, Bunkyo-ku, Tokyo 113, Japan.

Dues: US $40; payable to Mathematical Society of Japan.

Privileges: *Journal of the Mathematical Society of Japan*; *Sugaku* (in Japanese) for US $8 additional dues.

Officers: Daisuke Fujiwara (President), Yuko Mizutani (Treasurer), Setsuko Izawa (Secretary).

Mathematical Society of the Philippines*

Apply to: Membership Committee, Mathematical Society of the Philippines, Department of Mathematics, Ateneo de Manila University, P.O. Box 154, Manila, Philippines.

Dues: $5; payable to Mathematical Society of the Philippines.

Privileges: Publications and newsletter of the Mathematical Society of the Philippines.

Officers: Jose Marasigan (President), Rene P. Felix (Vice-President), Aurora Trance (Treasurer), Rolando Ramos (Secretary).

Mathematical Society of the Republic of China*

Apply to: Mathematical Society of the Republic of China, P.O. Box 23-3, Taipei, Taiwan, Republic of China.

Dues: N.T. $200 (US $5.00); payable to Mathematical Society of the Republic of China.

Privileges: *Chinese Journal of Mathematics* (two to four issues per year).

Officers: Simon C. Hsieh (President), Jau-D. Chen (Treasurer), Liang-Chi Tsao (Secretary).

•Punjab Mathematical Society

Apply to: Khalid Latif Mir, Secretary, Punjab Mathematical Society, Department of Mathematics, University of the Punjab, Quaid-I-Azam Campus, Lahore 54590, Pakistan.

Dues: US $25 for life membership; payable to Secretary or Treasurer.

Privileges: Mathematics Forum, Proceedings of the Conferences, Symposia, and Seminars arranged by the Society.

Officers: F. D. Anjum Roomani (President), Khalid Saleem, Maqbool Ahmad Ch. (Vice-Presidents), Muhammad Ashraf Jajja (Treasurer), Khalid Latif Mir (Secretary).

•Ramanujan Mathematical Society*

Apply to: E. Sampathkumar, Secretary, Ramanujan Mathematical Society, Department of Mathematics, Manasagangotri, Mysore University, Mysore-570006, India.

Dues: $15 (annual), $150 (life); payable to Secretary, Ramanujan Mathematical Society.

Privileges: *Journal of Ramanujan Mathematical Society*.

Officers: C. S. Seshadri, F.R.S. (President), J. Gopalakrishna (Vice-President), N. Ranganathan (Treasurer), E. Sampathkumar (Secretary).

•Southeast Asian Mathematical Society

Apply to: Southeast Asian Mathematical Society, c/o Department of Mathematics, Chinese University of Hong Kong, Shatin, N.T., Hong Kong.

Dues: US $5; payable to Southeast Asian Mathematical Society.

Privileges: *SEAMS Newsletter*, *Southeast Asian Bulletin of Mathematics*.

Officers: K. P. Shum (President), Y. Lam (Treasurer), P. C. Yuen (Secretary).

•Vijnana Parishad of India

Apply to: H. M. Srivastava, Foreign Secretary, VPI, Department of Mathematics, University of Victoria, Victoria, British Columbia, Canada, V8W 2Y2 or R. C. Singh Chandel, Secretary, VPI, Department of Mathematics, D. V. Postgraduate College, Orai-285001, U. P., India.

Dues: US $12 (annual), US $120 (life); payable to Vijnana Parishad, c/o Department of Mathematics, D. V. Postgraduate College, Orai-285001, U. P., India.

Privileges: *Jñānābha* (an interdisciplinary mathematical journal currently published once a year); back volumes available at 25% discount.

Officers: J. N. Kapur (President), R. P. Agarwal, M. K. Singal, V. K. Shrivastava (Vice-Presidents), R. C. Singh Chandel (Secretary-Treasurer), H. M. Srivastava (Foreign Secretary).

Europe

Asociación Matemática Española*

Apply to: Miguel de Guzmán, President, Asociación Matemática Española, Facultad de Matemáticas, Universidad Complutense, Madrid 3, Spain.

Dues: US $15 for members of the American Mathematical Society; payable to Asociación Matemática Española.

Privileges: *Boletin de la Asociación Matemática Española*; *Publicaciones de la Asociación Matemática Española* (at reduced prices).

Officers: Miguel de Guzmán, (President), Ireneo Peral (Treasurer), Maria T. Carrillo (Secretary).

•Berliner Mathematische Gesellschaft e.V.*

Apply to: R. D. Grigorieff, Fachbereich Mathematik, TU Berlin, Straße des 17.Juni 136, D-1000 Berlin 12, Federal Republic of Germany.

Dues: DM 12; payable to G. Preuss, Institut für Mathematik I, FU Berlin, Arnimallee 3, D-1000 Berlin 33, Federal Republic of Germany.

Privileges: One free copy of "Sitzungsberichte der BMG".

Officers: E.-J. Thiele (President), H.G.W. Begehr (Vice-President), G. Preuss (Treasurer), R. D. Grigorieff (Secretary).

•Dansk Matematisk Forening*

Apply to: Mogens Esrom Larsen, Secretary, Dansk Matematisk Forening, Universitetsparken 5, 2100 Køben- havn Ø, Denmark.

Dues: D.kr. 50; payable to Erik Christensen, Treasurer.

Privileges: *Mathematica Scandinavica* (D.kr. 183 per volume), *Nord. Mat. Tidss.* (*Normat*) (N.kr. 130 per volume). (Members of the American Mathematical Society do not have to join Dansk Matematisk Forening to obtain the journals. Subscription orders should be sent directly to the journals: *Normat*, Universitetsforlaget, Avd. for tidsskrifter, Postbox 2959 Tøyen, Oslo 6, Norway; *Mathematica Scandinavica*, Matematisk Institut, Aarhus Universitet, 8000 Aarhus C, Denmark.)

Officers: Kjeld Bagger Laursen (President), Mogens Esrom Larsen (Vice-President), Erik Christensen (Treasurer), Mogens Esrom Larsen (Secretary), Ebbe Thue Poulsen, Sten Markvorsen.

•Deutsche Mathematiker-Vereinigung e.V.*

Apply to: Deutsche Mathematiker-Vereinigung e.V., Albertstraße 24, 7800 Freiburg, Federal Republic of Germany.

Dues: DM 30.- (for reciprocity members); payable to Kreissparkasse Tübingen 16269 (BLZ 641 500 20), Federal Republic of Germany or Postscheckamt Stuttgart 18517-706 (BLZ 600 100 70), Federal Republic of Germany.

Privileges: *Mitteilungen der Deutschen Mathematiker-Vereinigung* (four issues a year), *Jahresbericht der Deutschen Mathematiker-Vereinigung* (four issues a year).

Officers: W. Törnig (President), K. P. Grotemeyer (Treasurer), J. Flum (Secretary).

•Edinburgh Mathematical Society

Apply to: The Honorary Secretary, Edinburgh Mathematical Society, James Clerk Maxwell Building, King's Buildings, Mayfield Road, Edinburgh, EH9 3JZ, Scotland.

Dues: $8 (preferably £3 sterling); payable to the Honorary Secretary.

Privileges: *Proceedings* at reduced rate of $17 (preferably £7 sterling) per annum.

Officers: E. G. Rees (President), A. C. McBride (Vice-President), A. D. Sands (Treasurer), J. Martin, C. J. Shaddock (Secretaries).

•Gesellschaft für Angewandte Mathematik und Mechanik (GAMM)*

Address for mail: Reinhard Mennicken, University of Regensburg, D-8400 Regensburg, Federal Republic of Germany.

Apply to: R. Ansorge, Institut für Angewandte Mathematik, Universität, Hamburg, Bundesstr. 55, D-2000 Hamburg 13, Federal Republic of Germany.

Dues: 25.-DM; payable to J. Siekmann, FB 12 - Maschinentechnik, Universität - GHS Essen, Schützenbahn 70, D-4300 Essen, Federal Republic of Germany.

Privileges: Regular publications of GAMM and participation in scientific meetings at a reduced rate.

Officers: O. Mahrenholtz (President), W. Walter (Vice-President), J. Siekmann (Treasurer), R. Mennicken (Secretary), R. Ansorge (Vice-Secretary).

•Glasgow Mathematical Association

Apply to: K. A. Lindsay, Glasgow Mathematical Association, Department of Mathematics, University of Glasgow, University Gardens, Glasgow G12 8QW, Scotland.

Dues: £25.00; payable to Glasgow Mathematical Association.

Privileges: *Glasgow Mathematical Journal.*

Officers: S. G. Hoggar (President), M. Hamson (Vice-President), K. A. Lindsay (Treasurer), S. J. Rowan (Secretary).

•Irish Mathematical Society

Apply to: Irish Mathematical Society, G. Ellis, Secretary, Mathematics Department, University College, Galway, Ireland.

Dues: US $10; payable to D. Tipple, IMS Treasurer, Department of Mathematics, University College, Dublin 4, Ireland.

Privileges: Right to receive the *Bulletin of the Irish Mathematical Society*; right to subscribe to the *Proceedings of the Royal Irish Academy* (Section A) at a reduced rate.

Officers: R. M. Timoney (President), B. Goldsmith (Vice-President), D. Tipple (Treasurer), G. Ellis (Secretary).

Íslenzka Stærðfræðafélagið

Apply to: Raunvísindastofnun Háskólans, Dunhaga 3, IS-107 Reykjavik, Iceland.

Dues: $10; payable to Íslenzka Stærðfræðafélagið.

Privileges: Reduced subscription rate on *Mathematica Scandinavica* and *Nordisk Tidskrift* (*Normat*), subscription orders should be sent directly to the journals.

Officers: Jón R. Stefánsson (President), Jón Hafsteinn Jónsson (Treasurer), Sven Sigurdsson (Secretary).

•János Bolyai Mathematical Society*

Apply to: Secretary General, J. Bolyai Mathematical Society, Anker Köz 1--3, Budapest, Hungary H-1061.

Dues: Are voluntary but should minimally cover duplication and mailing costs; Reciprocity members (residing outside Hungary) suggested fee is 1/8 of one percent of the member's net income; sponsoring members pay at least US $180 or equivalent per year.

Privileges: Upon request–Matematikai Lapok (twice a year), Középiskolai Matematikai Lapok (monthly), and Matematikai Tanitása (bimonthly). If sufficient interest is expressed, a Bulletin in English will be available. In addition, the JBMS is negotiating to obtain discounts for its reciprocity and sponsoring members on several serial publications and periodicals appearing in Hungary. Contact the JBMS secretary for more information regarding this and other priviledges of membership.

Officers: András Hajnal (President), Gyula Katona (Secretary General), Cecilia Szabados (Vice-Secretary General), András Recski (Treasurer).

•London Mathematical Society

Apply to: Miss S.M. Oakes, London Mathematical Society, Burlington House, Piccadilly, London W1V 0NL, United Kingdom.

Dues: £5; payable to London Mathematical Society. (New members should not send payment until elected.)

Privileges: *LMS Newsletter*. Reduced rates for the *Bulletin*, *Journal*, and *Proceedings of the LMS*; *Nonlinearity*; *Journal of Applied Probability*; *Mathematika*; *Mathematical Proceedings of the Cambridge Philosophical Society*; *Quarterly Journal of Mathematics*; LMS Lecture Notes; LMS Student Texts; LMS Monographs. (Please write to the LMS for complete details.)

Officers: J.F.C. Kingman (President), J. M. Howie, P. M. Neumann (Vice-Presidents), J.D.M. Wright (Treasurer), R. Y. Sharp, A. R. Pears (Secretaries), D. A. Brannan (Publications Secretary).

•Norsk Matematisk Forening

Apply to: Gerd Salter, Norsk Matematisk Forening, Matematisk Institutt, Postboks 1053 Blindern, N-0316 Oslo 3, Norway.

Dues: N.kr. 50 or N.kr. 500 for permanent membership; payable to Gerd Salter, Norsk Matematisk Forening.

Privileges: Reduced subscription rate on *Mathematica Scandinavica* and *NORMAT* (*Nordisk Matematisk Tidskrift*), free monthly information bulletin "Infomat" about the activities of the Society.

Officers: Ragni Piene (President), Tom Lindstrøm (Vice-President), Bjørn Jahren (Treasurer), Jon Reed (Secretary).

•Österreichische Mathematische Gesellschaft*

Apply to: Ludwig Reich, President, Österreichische Mathematische Gesellschaft, Technische Universität Wien, Wiedner Hauptstraße 8-10, A-1040 Wien, Austria.

Dues: öS 150; payable to Inge Troch, Treasurer.

Privileges: *Internationale Mathematische Nachrichten* (IMN).

Officers: Ludwig Reich (President), Werner Kuich (Vice-President), Inge Troch (Treasurer), Hans Reichel (Secretary).

Polskie Towarzystwo Matematyczne*

Apply to: Polskie Towarzystwo Matematyczne, Śniadeckich 8, 00-950 Warszawa, Poland.

Dues: $8; payable to Polskie Towarzystwo Matematyczne.

Privileges: Participation in scientific conferences organized by the Polish Mathematical Society and in its scientific sessions; in addition, members receive one of the following five series of the publication *Annales Societatis Mathemat-*

icae Polonae: Commentationes Mathematicae in congress languages, *Wiadomości Matematyczne* (Mathematical News) in Polish, *Matematyka Stosowana* (Applied Mathematics) in Polish, *Fundamenta Informaticae* in congress languages, *Dydaktyka Matematyki* (Didactics of Mathematics) in Polish.

Officers: Andrzej Pelczar (President), Roman Duda, Adam Piskorek (Vice-Presidents), Maciej Bryński (Secretary), Janusz Kowalski (Vice Secretary), Maciej Maczynski (Treasurer).

•Real Sociedad Matemática Española*

Apply to: J. Llovet, Secretario General de la Real Sociedad Matemática Española, Dept. Matematicas, Universidad Alcala, 28871 Alcala Henares (Madrid) Spain.

Dues: $30; payable to Secretario, R. S. M. E.

Privileges: *Gaceta Matemática* and *Revista Matemática Ibero Americana.*

Officers: J. M. Aroca (President), Juan Llovet Verdugo (Secretary).

•Sociedade Portuguesa de Matemática*

Apply to: J. E. Valença, Sociedade Portuguesa de Matemática, Av. da República 37 4°, 1000 Lisboa, Portugal.

Dues: 600 Portuguesa Escudos; payable to Sociedade Portuguesa de Matemática.

Privileges: *Boletim da Sociedade Portuguesa de Matemática*, free; discount of 70% in the subscription fees for *Portugaliae Matemática.*

Officers: A. Ribeiro Gomes (President), J. E. Valença, J. C. Silva, J. F. Queiró (Vice-Presidents), A. M. Cadete (Treasurer).

Societat Catalana de Matemàtiques*

Apply to: Secretari de la Societat Catalana de Matemàtiques, Carrer del Carme 47, 08001 Barcelona, Spain.

Dues: 1000 pessetes for members of the AMS, payable to the Societat Catalana de Matemàtiques.

Privileges: *Butlettí de la Societat Catalana de Matemàtiques*, (2 numbers a year).

Officers: J. Girbau (President), Carles Perelló (Secretary), Rubi Corberó (Associated Secretary).

Société Mathématique de Belgique*

Apply to: Guy Hirsch, Secretary, Société Mathématique de Belgique, 317/11, Avenue Charles Woeste, 1090 Brussels, Belgium.

Dues: $25; payable to Société Mathématique de Belgique, preferably by International Money Order, VISA, MasterCard, or American Express.

Privileges: *Bulletin de la Société Mathématique de Belgique* (6 numbers per year in 1989 and 1990). Series A and Series B, totalling about 800 pages.

Officers: A. Verschoren (President), L. Lemaire (Vice-President), G. Hirsch (Secretary-Treasurer).

•Société Mathématique de France

Apply to: Société Mathématique de France, Claire Ropartz, Ecole Normale Supérieure, Tour L, 1 rue Maurice Arnoux, 92120 Montrouge, France.

Dues: $37; payable to American Mathematical Society or S.M.F.

Privileges: Individuals who pay dues of $37 are entitled to receive the *Gazette*. Other publications may be purchased at the following prices: *Officiel* (surface mail) $19, *Officiel* (air mail) $28, *Bulletin* (without Mémoirs) $46, *Bulletin & Mémoires* $75. *Astérique* may be purchased at a discount price. (Members in the U.S., Canada, or Mexico should order their copies from the AMS. See the AMS *Catalogue of Publications.*)

Officers: J. P. Bourguignon (President), J. Detraz, J. M. Lemaire (Vice-Presidents), A. Millet, F. Gramain (Treasurer), P. Arnoux, J. Faraut (Secretaries).

•Société Mathématique Suisse

Apply to: F. Sigrist, Secretary SMS, Institut de Mathématiques Chantemerle 20, CH-2007 Neuchâtel, Switzerland.

Dues: SFr. 25.- for members of the AMS residing outside Switzerland; payable to F. Sigrist.

Privileges: *Commentarii Mathematici Helvetici* (reduced price); information concerning activities of SMS.

Officers: U. Stammbach(President); H. Holmann (Vice-President); F. Sigrist (Treasurer-Secretary).

•Société de Mathématiques Appliquées et Industrielles*

Apply to: Société de Mathématiques Appliquées et Industrielles, Centre de Mathématiques Appliquées, École Polytechnique, 91128 Palaiseau, France.

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Nominations and applications are invited for the F. Burton Jones Chair in Topology. The University seeks a distinguished scholar recognized for outstanding research in topology. The selected individual is expected to encourage and sustain research and scholarly studies in Topology and have a strong commitment to excellence in teaching. It is hoped to have the position filled by July 1, 1992. It is expected that the appointment will be with tenure at the rank of full professor and that the appointee will perform all the duties thereof. Established criteria of the University of California determine rank and salary. Applications and nominations will be accepted until the position is filled.

Please send nominations, applications and supporting materials to:

Professor Gerhard Gierz
Chair Selection Committee - F. Burton Jones Chair
Department of Mathematics
University of California
Riverside, CA 92521

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Department of Mathematics
Centenary College
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Department of Mathematics
WELLESLEY, MA 02181

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Department of Mathematics

Applications are invited for at most two tenure-track Assistant Professor positions effective 8/15/92. Candidates should have a Ph.D. in Mathematics and be committed to teaching. Those who also desire to continue their research (in any area) or to make significant service contributions (to the Department and College) are particularly encouraged to apply. The Department has ten full-time faculty. The usual teaching load is four courses per semester with $\approx$ 25 students per lower-level course and $\approx$ 14 students per upper-level. Mary Washington College is a small ($\approx$ 3500) undergraduate liberal arts college, and the Department has 70+ majors. Areas of faculty (research) activity include semigroups, graph theory, topology,

number theory, and differential geometry. Send vita to:

Marie Sheckels
Department Search Committee
Dept. of Mathematics
Mary Washington College
Fredericksburg, VA 22401

The review of applicants will begin in November 1991, and will continue until the positions are filled. Mary Washington College is an Equal Opportunity/Affirmative Action Employer.

CANADA

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OTTAWA
Department of Mathematics and Statistics

The Department of Mathematics and Statistics invites applications for a tenure-track position (subject to budgetary approval), at a rank commensurate with the applicant's qualifications, to commence July 1, 1992. Applications are invited from outstanding candidates, both female and male, whose research interests are in the area of Modern Applied Mathematics, namely: combinatorics, optimization, operations research. The successful candidate will be expected to be active in research, supervise graduate students, and support the Department's tradition of excellence in teaching. In accordance with Canadian immigration requirements, this advertisement is directed first to Canadian citizens and permanent residents. Applications including curriculum vitae should be addressed to:

Dr. John D. Dixon, Chairman
Department of Mathematics and Statistics
Carleton University
Ottawa, Ontario K1S 5B6

Candidates should also arrange for three letters of reference to be sent to the same address. Information concerning the department, including research interests of the faculty, may be obtained upon request. The closing date for receipt of applications is January 7, 1992.

CARLETON UNIVERSITY
OTTAWA, CANADA
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The Department of Mathematics and Statistics invites applications for a six month term appointment at the level of Assistant Professor, to commence January 1, 1992. Applications are invited from outstanding candidates, both female and male, with a Ph.D. degree in the area of Modern Applied Mathematics, with an emphasis in linear programming, optimization, combinatorics. There is a possibility of this position becoming a tenure-track appointment. The successful candidate will be expected to be active in research, supervise graduate students, and support the Department's tradition of excellence in teaching. In accordance with Canadian immigration requirements, this advertisement is directed first to Canadian citizens and permanent residents. Applications including curriculum vitae should be addressed to:

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Candidates should also arrange for three letters of reference to be sent to the same address. Information concerning the department, including research interests of the faculty, may be obtained upon request. The closing date for receipt of applications is October 1, 1991.

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Department of Mathematics

Applicants are invited for a tenure-track Position at the Assistant or Associate professor level in Mathematics beginning spring 1992. Primary area of research interest is analysis, but exceptional candidates in applied mathematics or probability theory will be considered. Candidate must have a Ph.D., demonstrated excellence in research, and be able to teach in Korean. For the required documents applicants should contact: the Chairman, Department of Mathematics, Yonsei University, Seoul 120-749, Korea (Fax: 82-2-392-6634, Office Tel: 82-2-392-0131 (ext. 2244), Home Tel: 82-2-324-5374). The deadline for the receipt of applications is September 15, 1991.

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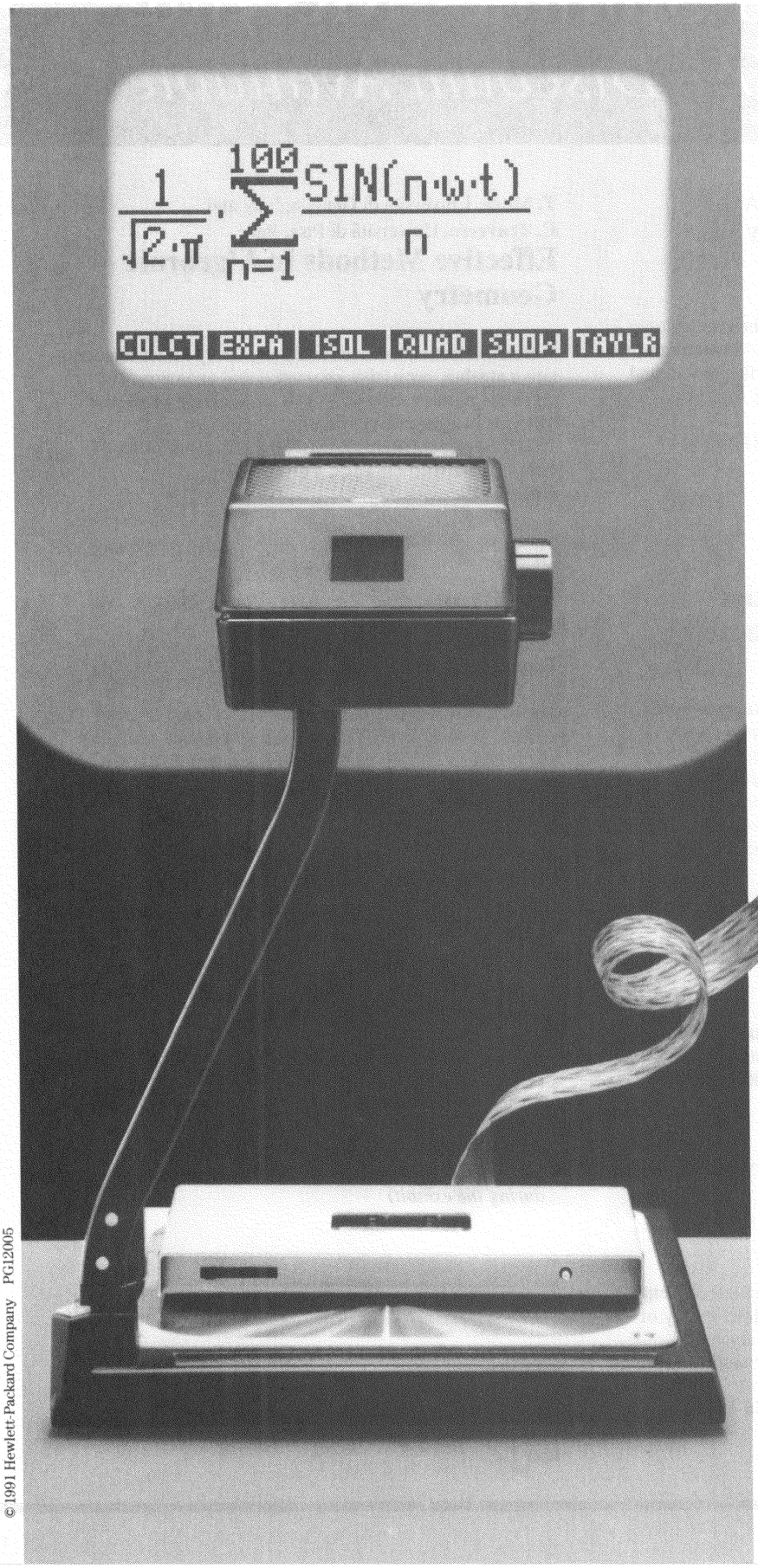

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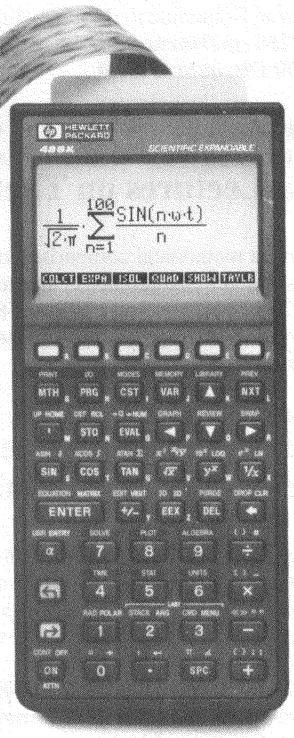

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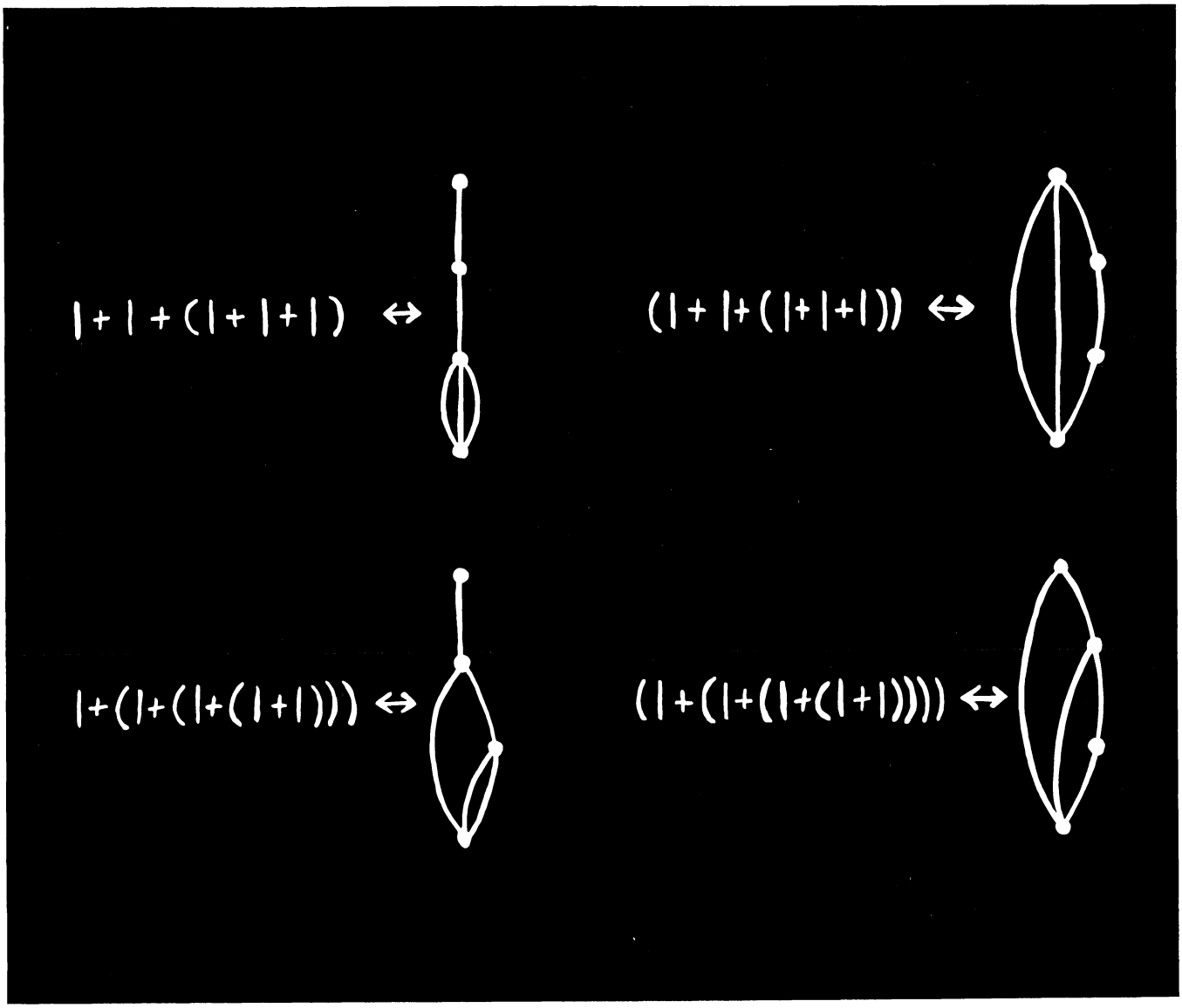

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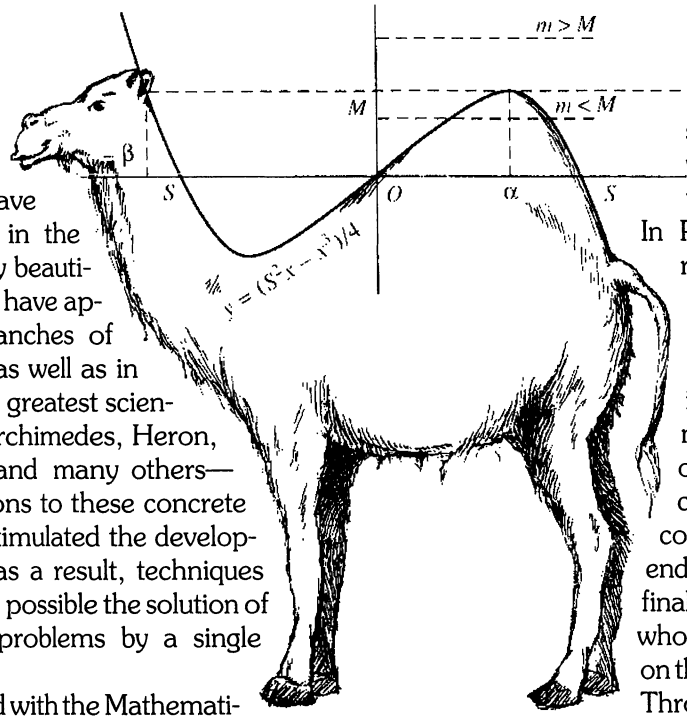
Volume 1

Stories about Maxima and Minima

V. M. Tikhomirov

translated by Abe Shenitzer



Throughout the history of mathematics, maximum and minimum problems have played an important role in the evolution of the field. Many beautiful and important problems have appeared in a variety of branches of mathematics and physics, as well as in other fields of science. The greatest scientists of the past—Euclid, Archimedes, Heron, the Bernoullis, Newton, and many others—took part in seeking solutions to these concrete problems. The solutions stimulated the development of the theory, and, as a result, techniques were elaborated that made possible the solution of a tremendous variety of problems by a single method.

This book, copublished with the Mathematical Association of America (MAA), presents fifteen "stories" designed to acquaint readers with the central concepts of the theory of maxima and minima, as well as with its illustrious history. Unlike most AMS publications, the book is accessible to high school students and would likely be of interest to a wide variety of readers.

In Part One, the author familiarizes readers with many concrete problems that lead to discussion of the work of some of the greatest mathematicians of all time. Part Two introduces a method for solving maximum and minimum problems that originated with Lagrange. While the content of this method has varied constantly, its basic conception has endured for over two centuries. The final story is addressed primarily to those who teach mathematics, for it impinges on the question of how and why to teach. Throughout the book, the author strives to show how the analysis of diverse facts gives rise to a general idea, how this idea is transformed, how it is enriched by new content, and how it remains the same in spite of these changes.

1980 *Mathematics Subject Classifications*: 00, 01, 46, 49
ISBN 0-8218-0165-1, LC 90-21246, ISSN 1055-9426
187 pages (softcover), March 1991
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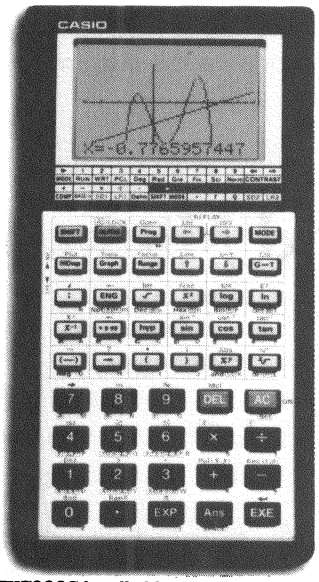

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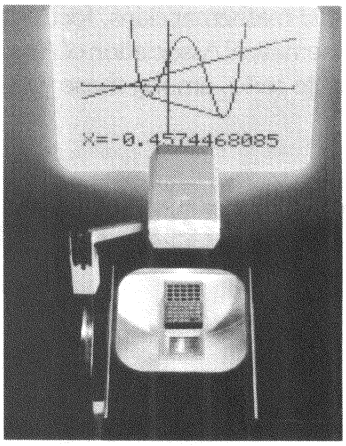

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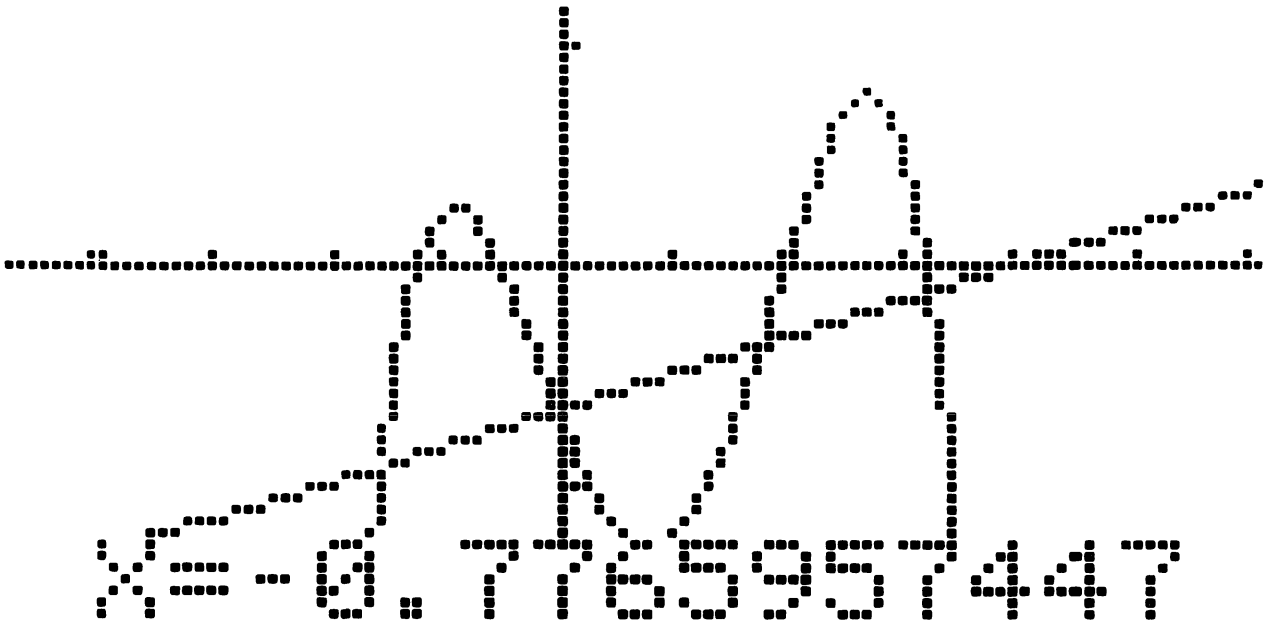

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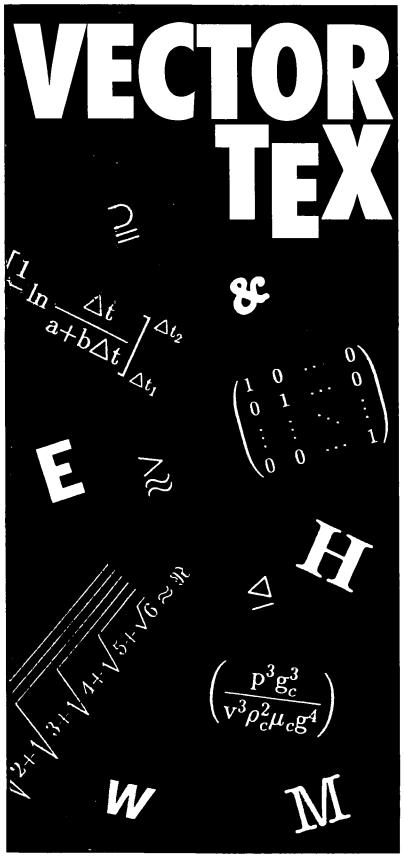
Dean of the School of Technical Sciences
Prof. Dr. Heinz Falk
Johannes Kepler University
A-4040 Linz, Austria
Telephone Austria (732) 2468-312)

Further information can also be obtained from the Chairman of RISC-LINZ, Prof. Dr. Bruno Buchberger, Johannes Kepler University, A-4040 Linz. (Tel: Austria (7236) 3231-41. Electronic mail: K313370AEARN.bitnet.)



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52 Convex and discrete geometry
53 Differential geometry
54 General topology
55 Algebraic topology
57 Manifolds and cell complexes
58 Global analysis, analysis on manifolds
60 Probability theory and stochastic processes
62 Statistics
65 Numerical analysis
68 Computer science
70 Mechanics of particles and systems
73 Mechanics of solids
76 Fluid mechanics
78 Optics, electromagnetic theory
80 Classical thermodynamics, heat transfer
81 Quantum theory
82 Statistical mechanics, structure of matter
83 Relativity and gravitational theory
85 Astronomy and astrophysics
86 Geophysics
90 Economics, operations research, programming, games
92 Biology and other natural sciences, behavioral sciences
93 Systems theory; control
94 Information and communication, circuits

M1NO

Membership Categories

Please read the following to determine what membership category you are eligible for, and then indicate below the category for which you are applying.

*For **ordinary members** whose annual professional income is below $45,000, the dues are $75, for those whose annual professional income is $45,000 or more, the dues are $100.*

*The **CMS Cooperative Rate** applies to ordinary members of the AMS who are also members of the Canadian Mathematical Society and reside outside of the U.S. For members whose annual professional income is $45,000 or less, the dues are $64 and for those whose annual professional income is above $45,000, the dues are $85.*

*For a **joint family membership,** one pays ordinary dues, based on his or her income, and the other pays ordinary dues based on his or her income, less $20. (Only the member paying full dues will receive the* Notices *and the* Bulletin *as a privilege of membership, but both members will be accorded all other privileges of membership.)*

*Minimum dues for **contributing members** are $150.*

*For either **students** or **unemployed individuals,** dues are $25, and annual verification is required.*

*The annual dues for **reciprocity members** who reside outside the U.S. and Canada are $50. To be eligible for this classification, members must belong to one of those foreign societies with which the AMS has established a reciprocity agreement, and annual verification is required. Reciprocity members who reside in the U.S. or Canada must pay ordinary member dues ($75 or $100).*

*The annual dues for **external members,** those who reside in developing countries which do not have any mathematical society, are $53.*

*Members can purchase a **multi-year membership** by prepaying their current dues rate for either two, three, four or five years. This option is not available to either unemployed or student members.*

1991 Dues Schedule (January through December)

For any category of membership where more than one dues level is given, see the above for descriptions of Members' Categories.

Ordinary member ..... ☐ $75 ☐ $100

CMS Cooperative rate ..... ☐ $64 ☐ $85

Joint family member (full rate) ..... ☐ $75 ☐ $100

Joint family member (reduced rate) ..... ☐ $55 ☐ $80

Contributing member (minimum $150) ..... ☐

Student member (please verify)[1] ..... ☐ $25

Unemployed member (please verify)[2] ..... ☐ $25

Reciprocity member (please verify)[3] ..... ☐ $50 ☐ $75 ☐ $100

External member ..... ☐ $53

Multi-year membership ..... $ ..... for ..... years

1 Student Verification (sign below)

I am a full-time student at .....

..... *currently working toward a degree.*

2 Unemployed Verification (sign below) *I am currently unemployed and actively seeking employment. My unemployment status is not a result of voluntary resignation or of retirement from my last position.*

3 Reciprocity Membership Verification (sign below) *I am currently a member of the society indicated on the right and am therefore eligible for reciprocity membership.*

Reciprocating Societies

- ☐ Allahabad Mathematical Society
- ☐ Asociación Matemática Española
- ☐ Australian Mathematical Society
- ☐ Berliner Mathematische Gessellschaft e.V.
- ☐ Calcutta Mathematical Society
- ☐ Dansk Matematisk Forening
- ☐ 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
- ☐ Íslenzka Staerðfraeðafélagið
- ☐ Israel Mathematical Union
- ☐ János Bolyai Mathematical Society
- ☐ 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
- ☐ New Zealand Mathematical Society
- ☐ Nigerian Mathematical Society
- ☐ Norsk Matematisk Forening
- ☐ Österreichische Mathematische Gesellschaft
- ☐ Polskie Towarzystwo Matematyczne
- ☐ Punjab Mathematical Society
- ☐ Ramanujan Mathematical Society
- ☐ Real Sociedad Matemática Española
- ☐ Sociedad Colombiana de Matemática
- ☐ Sociedad de Matemática de Chile
- ☐ Sociedad Matemática de la Republica Dominicana
- ☐ Sociedad Matemática Mexicana
- ☐ Sociedade Brasileira Matemática
- ☐ Sociedade Brasileira de Matemática Aplicada e Computacional
- ☐ Sociedade Paranaense de Matemática
- ☐ Sociedade Portuguesa de Matemática
- ☐ Societat Catalana de Matemàtiques
- ☐ Société de Mathématiques Appliquées et Industrielles
- ☐ Société Mathématique de Belgique
- ☐ Société Mathématique de France
- ☐ Société Mathématique Suisse
- ☐ Southeast Asian Mathematical Society
- ☐ Suomen Matemaattinen Yhdistys
- ☐ Svenska Matematikersamfundet
- ☐ Union Mathemática Argentina
- ☐ Unione Matematica Italiana
- ☐ Vijnana Parishad of India
- ☐ Wiskundig Genootschap

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Signature

EMPLOYMENT INFORMATION IN THE MATHEMATICAL SCIENCES

The American Mathematical Society, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics publish *Employment Information in the Mathematical Sciences* six times a year. The following resolution was passed on October 25, 1974, by the Council of the American Mathematical Society: "The Council of the AMS adopts principles that all positions in the mathematical sciences shall insofar as practicable be advertised, and that the standard place for the advertisements to appear is the publication *Employment Information*." A similar resolution was subsequently approved by the Board of Governors of the Mathematical Association of America.

The November, January, March, May, and August issues contain listings of open positions, information for which has been provided by heads of mathematics departments of colleges and universities in the United States, Canada, and overseas. In addition, these issues contain descriptions of open positions within government, industry, and other nonacademic areas. The December issue contains résumés of job applicants who will be participating in the Employment Register at the January Annual Meeting.

Subscription rates include first-class delivery in North America and airmail delivery elsewhere. The 1992 subscription starts with the November 1991 issue and ends with the August 1992 issue. All subscribers receive all six issues regardless of when the order is received.

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by **V. Boicescu, A. Filipoiu, G. Georgescu** *and* **S. Rudeanu**

Annals of Discrete Mathematics Volume 49

1991 xvi + 584 pages
Price: US $ 143.00 / Dfl. 250.00
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The Lukasiewicz-Moisil algebras were created by Moisil as an algebraic counterpart for the many-valued logics of Lukasiewicz. The theory of LM-algebras has developed to a considerable extent both as an algebraic theory of intrinsic interest and in view of its applications to logic and switching theory. This book gives an overview of the theory, comprising both classical results and recent contributions, including those of the authors. N-valued and θ-valued algebras are presented, as well as θ-algebras with negation. Mathematicians interested in lattice theory or symbolic logic, and computer scientists, will find in this monograph stimulating material for further research.

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Combinatorics

edited by **A. Hajnal, L. Lovász** *and*

Colloquia Mathematica Societatis Ja
Volume 52

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Besides mailing addresses for members, the Society's records contain information about members' positions and their employers (for publication in the *Combined Membership List*). In addition, the AMS maintains records of members' honors, awards, and information on Society service. Information of the latter kind appears regularly in *Notices*.

When changing their addresses, members are urged to cooperate by supplying the information requested below. The Society's records are of value only to the extent that they are current and accurate.

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