NOTICES OF THE AMERICAN MATHEMATICAL SOCIETY

MAY/JUNE 1992, VOLUME 39, NUMBER 5

Providence, Rhode Island, USA

ISSN 0002-9920

Calendar of AMS Meetings and Conferences

This calendar lists all meetings and conferences 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
875		June 29–July 1, 1992 (Joint Meeting with the London Mathematical Society)	Cambridge, England	Expired	May-June
876	*	October 30–November 1, 1992	Dayton, Ohio	August 3	October
877	*	November 7–November 8, 1992	Los Angeles,California	August 3	October
878	*	January 13–16, 1993 (99th Annual Meeting)	San Antonio, Texas	October 8	December
879	*	March 26–27, 1993	Knoxville, Tennessee	January 5	March
880	*	April 9–10, 1993	Salt Lake City, Utah	January 29	April
881	*	April 17–18, 1993	Washington, D.C.	January 29	April
882	*	May 21–22, 1993	DeKalb, Illinois	February 26	May-June
883	*	August 15–19, 1993 (96th Summer Meeting) (Joint Meeting with the Canadian Mathematical Society)	Vancouver, British Columbia	May 18	July-August
		October 22-23, 1993	College Station, Texas		
		January 12–15, 1994 (100th Annual Meeting)	Cincinnati, Ohio		
		March 18–19, 1994	Lexington, Kentucky		
		March 25–26, 1994	Manhattan, Kansas		
		October 28-29, 1994	Stillwater, Oklahoma		
		January 25–28, 1995 (101st Annual Meeting)	Denver, Colorado		
		March 24–25, 1995	Chicago, Illinois		
		January 10–13, 1996 (102nd Annual Meeting)	Orlando, Florida		

* Please refer to page 476 for listing of Special Sessions.

Conferences

July 6–24, 1992: AMS Summer Research Institute on Quadratic forms and division algebras: Connections with algebraic K-theory and algebraic geometry, University of California, Santa Barbara.

July 26–August 1, 1992: AMS-SIAM Summer Seminar in Applied Mathematics, Exploiting symmetry in applied and numerical analysis, Colorado State University, Fort Collins, Colorado.

January 11–12, 1993: AMS Short Course on Wavelets and Applications, San Antonio, Texas.

Deadlines

	September Issue	October Issue	November Issue	December Issue
Classified Ads*	July 30, 1992	August 27, 1992	October 1, 1992	November 13, 1992
News Items	July 16, 1992	August 13, 1992	September 21, 1992	October 29, 1992
Meeting Announcements**	July 16, 1992	August 17, 1992	September 21, 1992	October 29, 1992

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

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

NOTICES OF THE AMERICAN MATHEMATICAL SOCIETY

ARTICLES

FEATURE COLUMNS

DEPARTMENTS

NOTICES
OF THE
AMERICAN MATHEMATICAL SOCIETY

SUBSCRIPTION INFORMATION
Subscription prices for Volume 39 (1992) are $131 list; $105 institutional member; $79 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—$28; expedited delivery to destinations in North America—$32; 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.

[*Notices of the American Mathematical Society* is published monthly except bimonthly in May, June, July, and August by the American Mathematical Society at 201 Charles Street, Providence, RI 02904-2213. Second class postage paid at Providence, RI and additional mailing offices. POSTMASTER: Send address change notices to *Notices of the American Mathematical Society*, Customer Service Department, American Mathematical Society, P. O. Box 6248, Providence, RI 02940-6248.] Publication here of the Society's street address, and the other information in brackets above, is a technical requirement of the U. S. Postal Service. All correspondence should be mailed to the Post Office Box, NOT the street address. Tel: 401-455-4000.

From the Executive Director ...

MATHEMATICS INFRASTRUCTURE: POSTDOCS

This column (November 1989 *Notices*) addressed postdoctoral programs in the mathematical sciences with particular attention on the need to have a strong component of mentorship in any such program and asked the question should postdoctoral positions in mathematics be less-the-exception and more-the-rule. Discussions taking place at that time in the AMS Committee on Science Policy were a major impetus for the National Research Council (NRC) study on doctoral and postdoctoral experiences in the mathematical sciences reported on in this issue of the *Notices*. The NRC report and a related report on a workshop "Graduate Education in Transition" published by the Conference Board on Mathematical Sciences (1992) has heightened discussion of the mathematics postdoctoral experience. Should a postdoc position in mathematics be a logical next-step after the doctorate? Is it an important step in continuing lifelong professional development?

There is statistical information available that provides some perspective. For the year 1988 (last year of complete figures), there were 752 new Ph.D.s in mathematics from U.S. doctoral granting institutions, 280 individuals being counted as postdocs, and 188 postdocs receiving some federal support. During the same period, physics had 1093 and chemistry had 1990 new Ph.D.s, 1578 physicists and 3429 chemists were counted as postdocs, and 1280 physics postdocs and 2587 chemistry postdocs were receiving some federal support. It is often pointed out that the differences are easily explained because both physics and chemistry can be viewed as laboratory sciences. It is also true that one must be careful in using such comparisons—if for no other reason than parity is not going to be a successful argument for increasing the availability of postdoctoral experiences in mathematics. The issue, however, is on the importance of a postdoctoral experience in the professional development of a mathematician and whether it is an element of the mathematics infrastructure that has been greatly neglected and under-supported.

The prevalent model for a postdoctoral experience in the mathematical sciences is one in which an individual has exhibited outstanding research potential while a graduate student and has successfully competed for a limited number of prestigious postdoctoral positions. What happens to the large number of individuals who have shown great promise, who have made their first important independent discovery, which becomes a dissertation, and spend the latter part of their graduate program polishing this dissertation and applying for a position? Many of these individuals end up in environments that not only do not provide continuing professional development but have duties and expectations for which the recent Ph.D. was never prepared. Many survive; but are we risking the loss of valuable talent? Are we risking stagnation of careers and the loss of the investment made toward attainment of the doctoral degree?

These issues are currently being debated within the Society concerning a proposal for a broad, national, postdoctoral program, one that introduces new elements into the community's view of a postdoctoral experience. Such a program would have the goal of increasing the number of academic postdoctoral research opportunities available and increasing the number of nonacademic postdoctoral positions available in mathematics institutes, government facilities, and in business and industry; it would introduce postdoctoral experiences for mathematics Ph.D.s interested in mathematics education, including experiences in 4-year colleges and nondoctoral programs; and it would introduce interdisciplinary postdoctoral positions for new Ph.D.s in mathematics. Important components that are seen as necessary to such a program are nurturing, group building, deepening understanding of mathematics and expanding knowledge beyond the doctoral dissertation, providing a broad spectrum of career path opportunities, and instilling the desire for continued scholarship and learning. Such a program will need the commitment and support of the federal agencies, the academic community, and business and industry.

The responsibilities and expectations on the mathematics community and the academic departments of mathematical sciences are quite demanding. The infrastructure of the profession needs attention. An important component of this infrastructure is the postdoctoral experience for mathematicians and preparation for lifelong scholarship and professional development.

William Jaco

Letters to the Editor

Open Letter to Shafarevich

The March 1992 issue of the *Notices of the American Mathematical Society* contained the Open Letter to Shafarevich which was signed by over three hundred mathematicians. The Open Letter was published as an advertisement. A statement that this "advertisement" was paid for by the Society and not by the signatories was, unfortunately, omitted.

In the interest of openness and accuracy in journalism, a note to this effect should have appeared. I would like to think that the Council's decision to ensure that this letter appear in the *Notices* reflects the Society's commitment to combating anti-semitism.

Irwin Kra
SUNY at Stony Brook
(Received March 23, 1992)

Editor's Note: The omission of any indication that the advertisement referred to in the above letter was not paid for by the individuals involved was an editorial oversight and was not done with the intention of misleading anyone. The editors regret any misunderstanding that was caused by this oversight.

Pilot Assessment of the Mathematical Sciences

The "Pilot Assessment of the Mathematical Sciences," prepared for the House Committee on Science, Space, and Technology (*Notices*, February 1992, Vol. 39, No. 2), is certainly impressive, to-the-point, and true. It is an admirable response to the questionnaire.

However, truth is not enough! I wish they had included some of the religious fervor of the mathematician. We could have used Fourier's statement on the "Austere Beauty of Mathematics" or the Pythagorean Doctrine that mathematics satisfies the soul, or even said it makes mathematicians happy.

After all, if you watch television you can't help noticing that politicians are impressed by dramatic and eloquent statements.

Maurice Machover
St. John's University
(Received March 18, 1992)

Unrecognized Talent

A recent issue of *The New Yorker* (2 Mar 92) contains an interesting and lengthy (approximately 20 pages) popular article which I highly recommend as reading for AMS members. It deals mostly with the plight of two well-known Ukrainian-born American mathematicians who are brothers. In spite of their obvious talent (I have reviewed some of their papers for *MR*), they can't find serious academic employment. The content of the article is a microcosm of a very old problem of mathematical culture embedded in research on mathematical objects which are not entirely elusive or eccentric. I believe the content of the article is mostly correct and only occasionally exaggerated (surely Abel, e.g., who, in addition, had problems of getting adequate food, was far worse off). This area of mathematical culture needs more attention, but not the kind of focus that prevents people from engaging in mathematical research, itself. In any case, the article should be carefully reviewed in *MR* for its historical and cultural value.

Albert A. Mullin
Huntsville, AL
(Received March 3, 1992)

Who is Teaching Precollege Mathematics?

A recent report suggests that high school students in Canada and the U.S.A. are deficient in Mathematics as compared to their peers in, for example, Czechoslovakia and Hungary. This should not be surprising. Outside of North America, people who teach Mathematics in high schools are required to have learned a substantial amount of mathematics in Universities. In North America, teacher training is controlled by pedagogical institutes having philosophies of the sort that prompted Mark Twain to deduce that "teaching is the fine art of imparting knowledge without possessing it."

John A. Baker
University of Waterloo
(Received February 18, 1992)

Calculus Reform

In Murray Protter's article "Calculus Reform II," the recommendation that each faculty member take on an additional section of calculus is no doubt sufficient to ensure that his proposals will not be adopted wholesale. However, since the essence of the method of instruction he calls for—small sections taught by faculty and graduate students alike—is the structure currently in place at Yale, we feel compelled to address some of the assumptions that underlie his argument.

Explicitly driving the article is an emphasis on small class sizes. While we believe that lecture courses of 500 or more students represent a serious abdication of duty on the part of educators, who under such conditions could probably be replaced by a series of videotapes, we see nothing canonical about the number 30. In short, size is important, but only to the extent that the professor knows his or her students and that they feel comfortable asking questions in class. Our experience shows that this is possible in courses of 50–60 students.

Letters to the Editor

Letters submitted for publication in the *Notices* are reviewed by the Editorial Committee.

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

Letters should be typed and in legible form or they will be returned to the sender, possibly resulting in a delay of publication. All published letters must include the name of the author. Letters which have been, or may be, published elsewhere will be considered, but the Managing Editor of the *Notices* should be informed of this fact when the letter is submitted.

The committee reserves the right to edit letters.

Letters should be mailed to the Editor of the *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.

At Yale we have a system very much like the one Protter advocates. Courses are taught in numerous small sections, whose sizes are targeted at 30–35, but which have recently ranged from 3 to 67. Our experience is that within this range, the putative benefits of small class size are of minor significance in comparison to other issues affecting the quality of instruction. We have several instructors whose sections routinely swell beyond capacity on the strength of good word-of-mouth. These instructors and their students generally do not find the size of their classes to be detrimental, and exam scores seem to corroborate this feeling.

On the other hand, our less successful sections suffer from exactly those conditions more likely to prevail under Protter's proposal. Since the teaching of calculus consumes an enormous amount of our resources, it requires the participation of graduate students, temporary and visiting faculty, as well as tenured professors. As a consequence, the overall level of institutional experience with the curriculum at any time is low. This system requires the participation of instructors who may actively dislike teaching calculus, who aren't very good at teaching calculus, or who simply teach calculus too often to keep the subject fresh. We hasten to point out, however, that these individuals make invaluable educational contributions to our department as advisors to graduate students, as instructors of graduate courses, and in many cases as instructors of upper-level undergraduate courses. Any mathematics department at a research university will always and indeed should always have some number of faculty members and graduate students who for one reason or another will not be effective calculus instructors, and hence research departments must be organized with this in mind. Just as importantly, this broad participation in calculus instruction comes at the cost of variety in the upper-level undergraduate curriculum, a consideration absent from Protter's supply-side scheme. In contrast, a system that includes teaching assistants would allow for extra class time (something we as instructors have felt a need for) that could be put to use in a number of creative ways; their absence robs calculus students of a valuable resource and graduate students of a gentle introduction to teaching in an American university.

We are unsure with what degree of sarcasm to interpret Protter's vignettes of the popular and unpopular calculus teachers. If he means to suggest that speaking clearly, working illustrative examples, and developing a rapport with the students are irrelevant to teaching well, then we strongly object. If the students seem to prefer not to learn how to write proofs, it is because the curriculum is not sufficiently rigorous. We guarantee that if they are expected to understand proofs when examined, the instructor who proves theorems will enjoy a surge in popularity. Protter concedes that some faculty members would prefer not to teach calculus at Berkeley, despite the reduced teaching load. This seems to indicate some combination of antipathies for large classes and for calculus. To the extent that the latter plays a role, we suggest that those who, despite incentives to do so, would prefer not to teach calculus, should perhaps have that preference respected. Conversely, those who for whatever reason enjoy teaching calculus and who are successful at it, should be encouraged to continue. The argument that calculus students would be thrilled at the prospect of interacting with a tenured faculty member rings hollow to us. In our experience, they care little whether they're being taught by a Fields medalist or a struggling graduate student, but more about the clarity of presentation and the accessibility of the instructor.

There remains the issue of how to measure successful teaching. Exam scores and student popularity cannot tell the whole tale, but neither must they be entirely misleading: if an instructor is focusing narrowly on routine examples that will result in high exam scores, the fault lies not only with him or her, but also in the curriculum and in the design of exams. Moreover, in a multiple-section system as advocated in the article, calls for "fairness" will lead to common exams, which in turn can lead to homogenization of the product and again a narrow focus (now sharpened by competition among sections) on the exams. A least-common-denominator approach is not therefore strictly a result of large class size.

In conclusion, we fail to see how Protter's suggestions will improve calculus instruction at research universities. In fact, many of the problems we experience at Yale occur precisely because our system so closely resembles the one he proposes.

William Cherry
John Fischer
Yale University
(Received March 3, 1992)

Thank you for Murray Protter's candid article on calculus teaching in the January *Notices*. Obviously, he's been around. However, I find another problem with his proposal. In my opinion, at least one-half of all mathematics professors haven't the slightest clue as to how to teach undergraduates. In fact, some of them aren't competent to teach at all, and only the timidity of docile graduate students, upon whom they propel their inscrutable wares, accounts for their continuing sustenance within the collegiate entity.

Having completed four years as a TA, I have a much more radical proposal. I believe that all universities, from the large state schools to the Princetons, should split their faculties into teaching and research faculties, thereby creating colleges within universities to handle 90% of the instruction of freshmen and sophomores. Whatever else you may think of this proposal, the addition of tenured, professional calculus teachers to our universities could be the answer to a calamitous national crisis.

I have heard the argument that asking a world authority in projective planes to teach Calc I max-min problems "is of mutual benefit to teacher and student." That is simply bogus public relations, in my opinion. In truth, most research mathematicians are bored to tears teaching undergraduate courses, whether in a small class or a large lecture. How can it benefit a student to be taught by a bored teacher? So let's

change the system so they won't have to.

Ronald A. Wiener
Sarasota, Florida
(Received January 23, 1992)

With respect to Calculus teaching, none of the learned AMS members understands the main issues. It matters not whether we teach a lean and lively or a fat and lazy calculus. Either way, students will fail because they can't perform the basic algebraic manipulations required in such a course.

E.g., I recently asked the ten students in my first semester calculus class (at a Texas college) to write the expansion of $(a+b)^2$—and received not a single satisfactory answer. Seven students wrote what was anticipated—a^2+b^2—while three others, although knowing about cross-terms, were unaware of commutativity, and so wrote them as $ab+ba$. Now, this particular college was (literally and figuratively) on the wrong side of the tracks, so a poor score might be blamed on the ghetto schools these kids attended. But at another Texas college, attended by middle and upper class students, another basic algebraic question—simplify the expression $(a^{-1}+b^{-1})^{-1}$—produced similar bad results: only 4 out of 25 calculus students performed the needed conversion, addition, and inversion.

So high school math preparation is bad, anywhere you go.

Again, the failure isn't hard to trace: high school graduates know nothing about algebra for the same reason they know nothing about history, art, literature, or anything else. To state it in the most primitive terms: the kids think that $a/b+c/d=(a+c)/(b+d)$ for the same reason that they think Karl Marx was one of the Marx Brothers or that Renoir is the name of a planet.

So the generalization is: students know nothing about algebra because they know nothing about anything.

The general cause also seems clear. High schools no longer function as educational institutions but as what one writer calls minimum security institutions. If a set of warm bodies can be herded into the 10th grade and kept alive for three years, with none of the students being knifed (and none of the teachers mugged) then the mission is a success and all students graduate. Various exceptions are scattered about the country—e.g., the Boston Latin School, Pierce High School (in Richardson, Texas), or Beverly Hills High—but these are just isolated singularities.

Parents, of course, blame all this on teachers who, they say, fail to enforce discipline. But such criticism is better directed at father and mother; if children don't respect their parents, they'll not respect other authority figures, like teachers.

So bad math results from bad high schools, which in turn result from bad parents. I'll let the AMS take it from there.

Leland Sapiro
McNeese State University
(Received January 27, 1992)

Educating Mathematical Scientists: Doctoral Study and the Postdoctoral Experience in the United States

In July 1990, the Board on Mathematical Sciences (BMS) of the National Research Council (NRC) convened the Committee on Doctoral and Postdoctoral Study in the United States to conduct a study and make recommendations for improvement and change in doctoral and postdoctoral education in the mathematical sciences. The Committee's report, "Educating Mathematical Scientists: Doctoral Study and the Postdoctoral Experience in the United States," was released in March 1992. Presented here are the report's Executive Summary and Introduction, in addition to critiques of the report written by five members of the mathematical sciences community.

Reprinted with permission from "Educating Mathematical Scientists: Doctoral Study and the Postdoctoral Experience in the United States," 1992. Published by National Academy Press, Washington, D.C. To order the complete book, sixty-four pages, $19, call 1-800-624-6242, or send a check plus $3 for shipping and handling to National Academy Press, 2101 Constitution Avenue, N.W., P.O. Box 285, Washington, D.C. 20055.

Committee on Doctoral and Postdoctoral Study in the United States: Ronald Douglas, State University of New York at Stony Brook, *Chair*; Hyman Bass, Columbia University; Avner Friedman, University of Minnesota; Peter Glynn, Stanford University; Ronald Graham, AT&T Bell Laboratories; Rhonda Hughes, Bryn Mawr College; Richard Jacob, Arizona State University; Patricia Langenberg, University of Maryland; D. J. Lewis, University of Michigan; J. Scott Long, Indiana University at Bloomington; John Rice, University of California at San Diego; Donald Richards, University of Virginia; Karen Uhlenbeck, University of Texas at Austin; Mary Wheeler, Rice University.

Executive Summary

Although the United States is considered a world leader in mathematical sciences research and in doctoral and postdoctoral education, concern is growing about whether the needs of the profession and of an increasingly technological society are being met. Many doctoral students are not prepared to meet undergraduate teaching needs, establish productive research careers, or apply what they have learned in business and industry. This inadequate preparation, continuing high attrition, and the declining interest of domestic students, the inadequate interest of women students, and the near-absent interest of students from underrepresented minorities in doctoral study are problems that transcend the current difficult job market.

The charge to the Committee on Doctoral and Postdoctoral Study in the United States was to determine what makes certain programs successful in producing large numbers of domestic Ph.D.s, including women and underrepresented minorities, with sufficient professional experience and versatility to meet the research, teaching, and industrial needs of our technology-based society. The committee based its findings on site visits to a diverse set of programs in 10 universities carried out in late 1990 and early 1991. These programs were in both small and large, and in both public and private, universities. They were also geographically diverse. They were all in the "top 100" and included four departments in the "top 20."

The audience to which the report speaks is all U.S. doctoral and postdoctoral programs in the mathematical sciences, and, in particular, those programs that have limited human and financial resources. The report suggests that even with limited resources success can be achieved if, among other things, a program focuses its energies rather than trying to implement a "standard" or traditional program that covers too many areas of the mathematical sciences. It also notes that departments with the best faculty do not necessarily have the most successful doctoral and postdoctoral programs. A quality faculty is necessary for a good program, but of equal importance are students and researchers that can benefit from the program.

In this report, a "successful" program is understood to be one that accomplishes the following two objectives.

- All students, including the majority who will spend their careers in teaching, government laboratories, business, and industry rather than in academic research, should be well prepared by their doctoral and postdoctoral experience for their careers.
- Larger percentages of domestic students, and, in particular, women and underrepresented minorities, should be attracted to the study of and careers in the mathematical sciences.

In its site visits, the Committee on Doctoral and Postdoctoral Study in the United States looked for features that were present in successful programs as well as for elements that were detrimental to quality education. The committee noted that successful programs possessed, in addition to the *sine qua non* of a quality faculty, the following three characteristics:

1. A focused, realistic mission,
2. A positive learning environment,
3. Relevant professional development.

A positive learning environment is an environment that provides the assistance, encouragement, nurturing, and feedback necessary to attract and retain students and to give them an education appropriate for their future careers.

The findings of the committee are as follows:

- There are several different models (missions) for programs, including
  - * the standard model, which supports research in a broad range of areas, offers depth in each one, and has as its goal preparation for careers at research universities, and
  - * specialized models, such as the subdisciplinary model, the interdisciplinary model, the problem-based model, and the college-teachers model, which were seen to alleviate two large human resource problems, recruitment and placement, and to be conducive to clustering of faculty, postdoctoral associates, and students, a practice that helps create a positive learning environment and promote relevant professional development.
- Both standard and specialized programs can be successful. However, programs that do not have the human or financial resources to run a successful standard program should consider whether a specialized model might better fit their needs.
- New Ph.D.s with a broad academic background and communication skills appropriate for their future careers are better able to find jobs.
- Active recruiting increases the pool of quality students. It does not just reapportion the pool. It also increases the number of women and underrepresented minorities. Students with strong mathematical backgrounds have a choice of studying mathematical sciences, physical sciences, engineering, law, medicine, and other areas. More of them can be attracted to the mathematical sciences.
- Clustering faculty, postdoctoral associates, and doctoral students together in research areas is a major factor in creating a positive learning environment.
- A positive learning environment is important to all doctoral students but is crucial for women and underrepresented minorities.
- All departments, including those characterized as elite and selective, need to provide a supportive learning environment.
- Doctoral students and postdoctoral fellows should receive broad academic preparation appropriate for their future careers in research universities, teaching universities, government laboratories, business, and industry.
- Doctoral students and postdoctoral fellows should learn teaching skills and other communication skills appropriate for their future careers.
- The number of postdoctoral fellowships in the mathematical sciences should be greatly increased so that such positions can be viewed as the logical next step after completion of the doctorate for the good student, not as a highly competitive prize for a select few. More postdoctoral fellowships should have applied, interdisciplinary, or pedagogical components.

Changing the American doctoral and postdoctoral system in the mathematical sciences so that it responds better to the needs of the profession, students, and the society is a task that requires the cooperative efforts of faculty, departments, professional societies, and federal agencies. The departments at research universities have a special responsibility to raise the level and increase the knowledge of talented but underprepared entering American doctoral students. Federal agencies should continue their programs and also increase their awareness of the impact of their programs on the doctoral and postdoctoral system. Professional societies should be involved in monitoring change in the universities, the agencies, and the community. But action, if it starts at all, will start from the faculty. The faculty should be aware that creating and maintaining a successful doctoral/postdoctoral program will require additional effort and time. The long-term benefits to the department, the students, and the society are clearly worth the effort.

1. Introduction

In the period since World War II, research in the mathematical sciences has flourished in the United States. Large numbers of graduate students and researchers from around the world have come to this country to study and to work in pure and applied mathematics, in well-established and new fields. The American system of doctoral and postdoctoral study and research in the mathematical sciences is considered by many to be an unqualified success, in contrast to the system of pre-college and undergraduate education.

The current scarcity of highly qualified domestic graduate students, often attributed to mediocre pre-college education and to related problems in undergraduate education, is seen by many as an unfortunate circumstance but not as a major problem. In the 1990–1991 academic year, only 43% (461 out of the adjusted total of 1061 reported in McClure, 1991, p. 1093) of the recipients of Ph.D.s in the mathematical sciences from institutions in the United States were U.S. citizens (McClure, 1991), whereas during the 1960s, 82% of the recipients of such Ph.D.s from U.S. institutions were U.S. citizens (NSF [National Science Foundation], 1988). Among the U.S. citizen recipients of Ph.D.s in the 1990–1991 academic year, less than a quarter were women and less than a twentieth were from underrepresented minorities. American mathematical sciences departments, research laboratories, and industry are relying increasingly on students, faculty,

and professional researchers from abroad because fewer and fewer American students are being attracted to study in the mathematical sciences and because the education that many of those students receive leaves them ill equipped to compete with their foreign counterparts.

Noting the scarcity of highly qualified domestic students and the current tight employment market, some maintain that the chief problem in the doctoral and postdoctoral system is overproduction of Ph.D.s, a problem that should be solved by encouraging students to choose other disciplines and by reducing the number of doctoral students. Our overreliance on academia for jobs for new Ph.D.s is often not considered to be a problem, nor is the matching of doctoral education with the positions that graduates take considered to be a priority. Increasing production of Ph.D.s since 1987, international events that have increased immigration of students and professional mathematicians to the United States, and a recession in the economy have indeed combined to produce what is now the most difficult employment market for Ph.D. mathematicians since the 1970s. Further complicating the current picture are the indications that the demand for mathematical scientists will rise as the many mathematical scientists hired in the 1960s start to retire over the next decade (NRC [National Research Council], 1990b). The long-term growth in demand for mathematical scientists in academia, government, business, and industry and the expectation that the wave of immigration of mathematical talent to the United States will eventually taper off suggest that the country will be best served by a positive outlook that emphasizes attracting more domestic students into the mathematical sciences and giving those students proper foundations for their future careers.

A positive outlook that serves the interests of the profession and the country can be translated into actions intended to achieve the following two broad objectives:

- All students, including the majority who will spend their careers in teaching, government laboratories, business, and industry rather than in academic research, should be well prepared by their doctoral and postdoctoral experience for their careers.
- Larger percentages of domestic students, and, in particular, women and underrepresented minorities, should be attracted to the study of and careers in the mathematical sciences.

In this report, a "successful" program is understood to be one that accomplishes these two objectives. The needed renewal of the profession, as pointed out in the "David I" report (NRC, 1984), *A Challenge of Numbers* (NRC, 1990b), and the "David II" report (NRC, 1990c), requires larger percentages of domestic students. Although statistics invariably oversimplify the situation, the following two "completion rate" statistics concerning percentages of domestic students are useful in judging a program's success: (1) the percentage of students who entered the program five years earlier and who have received their doctorates, and (2) the percentage of students who completed their second year of graduate study four years earlier and who have received their doctorates. The first of these two types of completion rate is an appropriate measure of the success of highly selective programs, while the second is appropriate for less selective programs. The committee observed a number of programs for which both rates were well above 50 percent.

Purpose and Scope of This Report

The charge to the committee was to determine what makes certain doctoral and postdoctoral programs in the mathematical sciences successful in producing large numbers of domestic Ph.D.s, including women and underrepresented minorities, with sufficient professional experience and versatility to meet the research, teaching, business, and industrial needs of our technology-based society. The mathematical sciences are considered to be pure mathematics, applied mathematics, statistics and probability, operations research, and scientific computing. Computer science, a separate discipline, is not included among the mathematical sciences.

The doctoral period considered in this report extends from the first year of graduate study through completion of the thesis, regardless of whether or not the student obtains a master's degree. The postdoctoral period is the first five years after receipt of the Ph.D. A postdoctoral associate, postdoctoral fellow, or, in common parlance, "postdoc," is a recent Ph.D. who has a fully funded position to do research. Since such a small number of new Ph.D.s in the mathematical sciences enjoy postdoctoral fellowships, this report concerns not only postdoctoral fellows but also junior faculty working during the postdoctoral period.

The purpose of this report is to present and disseminate information about types of mathematical sciences doctoral and postdoctoral programs that succeed in attracting large numbers of domestic students, including women and underrepresented minorities, and succeed in giving their students academic and professional experience that is relevant to their future careers. There are U.S. programs that provide high-quality doctoral education to student bodies that are 80% American, have nearly 50% women, or have 30% underrepresented minorities. This report, based on the committee's insights gained in site visits to 10 universities, describes characteristics of these programs. What these programs do differently and what they and others consider to be their successes and their frustrations is information that this report seeks to make available to the community so as to encourage doctoral/postdoctoral program models that are relevant to the needs not only of academic research but also of teaching, government, business, and industry, and to increase the quality and number of domestic Ph.D.s, especially women and underrepresented minorities.

This report follows on and is complementary to a number of studies by the National Research Council that examine the health of U.S. mathematical sciences research and education, including *Renewing U.S. Mathematics: Critical Resource for the Future* (NRC, 1984), *Everybody Counts* (NRC, 1989), *A Challenge of Numbers* (NRC, 1990b), *Moving Beyond Myths* (NRC, 1991b), *Renewing U.S. Mathematics: A Plan for the* 1990s (NRC, 1990c), and *Actions for Renewing U.S.*

Mathematical Sciences Departments (NRC, 1990a). One includes the following pertinent summary.

> Graduate and postdoctoral training programs offered by mathematical sciences departments are key to the successful renewal of the profession and reform of mathematics education. Successful programs can attract individuals to a career in the mathematical sciences and can develop highly qualified teachers and researchers to stimulate, nurture, and train future generations. Is our present graduate and postdoctoral educational system in mathematics working well? The answer seems clearly to be that it could be much better. The community could attract more students to the study of the mathematical sciences, and more students entering graduate programs could succeed in obtaining doctorates. With nurturing and continued attention through good postdoctoral programs, more of these young people could develop into good mathematicians—some as teachers, some as researchers, and many as both. (NRC, 1990a, p. 13)

Contents of This Report

Chapter 2 gives a brief historical perspective of the mathematical sciences in America, with emphasis on doctoral and postdoctoral training.

Chapter 3 describes how some programs in the present system achieve success. Three characteristics of successful programs—a focused and realistic mission, a positive learning environment, and relevant professional development—are introduced in this chapter. The issue of having a high-quality faculty—a *sine qua non* of a successful program—is acknowledged but not discussed in detail in this report.

The heart of the report is Chapters 4–7, which treat the three characteristics of successful programs and human resource issues that must be taken into account. Chapter 4 discusses human resource issues; in particular, those related to domestic students, women, and underrepresented minorities are examined. A number of specialized missions for doctoral/postdoctoral programs are described in Chapter 5. Chapter 6 discusses a positive learning environment. Relevant professional development is described in Chapter 7.

Chapter 8 describes how faculty, departments, professional societies, and federal agencies can work together to create more successful programs.

A guide for self-evaluation by departments forms Appendix A. Appendix B includes advice to prospective doctoral students on how they can best choose a doctoral program. Appendix C is a brief discussion of master's degree programs in the mathematical sciences, a feature that may form a part of a well-rounded graduate program in the future as doctoral programs become more oriented toward wider job markets, including business and industry.

References

McClure, D.E., 1991, "1991 Annual AMS-MAA Survey (First Report)" in *Notices of the American Mathematical Society*, **38**, 1086–1102.

National Research Council (NRC), 1984, *Renewing U.S. Mathematics: Critical Resource for the Future* ("David I" report), National Academy Press, Washington, D.C.

National Research Council (NRC), 1989, *Everybody Counts: A Report to the Nation on the Future of Mathematics Education*, National Academy Press, Washington, D.C.

National Research Council (NRC), 1990a, *Actions for Renewing U.S. Mathematical Sciences Departments*, National Academy Press, Washington, D.C.

National Research Council (NRC), 1990b, *A Challenge of Numbers: People in the Mathematical Sciences*, National Academy Press, Washington, D.C.

National Research Council (NRC), 1990c, *Renewing U.S. Mathematics: A Plan for the 1990s*, ("David II" report), National Academy Press, Washington, D.C.

National Research Council (NRC), 1991b, *Moving Beyond Myths: Revitalizing Undergraduate Mathematics*, National Academy Press, Washington, D.C.

National Science Foundation (NSF), 1988, *Science and Engineering Doctorates*: 1960–86, National Science Foundation, Washington, D.C.

In order to stimulate discussion of the report, "Educating Mathematical Scientists: Doctoral Study and the Postdoctoral Experience in the United States," the *Notices* solicited the following critiques of the report from five members of the mathematical sciences community.

Solomon Garfunkel

Garfunkel is Executive Director of the Consortium for Mathematics and its Applications in Lexington, MA.

First, let me begin by saying that I am pleased that this study was done and this report written. It is well past time that we take a serious look at doctoral and postdoctoral programs and how they could and should be improved. The fact that this study was undertaken under the aegis of the National Research Council (NRC) is admittedly a good news/bad news situation. The good news is that the prestige of the NRC may help increase the awareness of the community and encourage more people to read and take its contents seriously. The bad news is that, as with other NRC reports, the review process has a "smoothing" effect and tends to take out strong and controversial positions. This is not a strong report. With one notable exception, it says nothing wrong and may in fact do some good. However, it manages to miss the central point and is therefore largely irrelevant to serious debate.

That central point is the reward system (for both faculty and students). Nowhere in the report is there any mention of reward. If faculty are only promoted or granted tenure on the basis of research, the real message to graduate students is loud and clear. Moreover, what about the graduate students themselves? If they are "trained" to teach through courses, seminars, evaluations, etc., what are their rewards? What if they fail to demonstrate adequate teaching ability or

communication skills, but can write strong theses? Do we go ahead and certify them as college faculty, or do we tell prospective employers of their deficiencies? In short, (how) do we put our money where our mouths are? While I realize that these are extremely hard questions requiring a great deal of community debate, to completely ignore them here is a dramatic failure.

If this were the only flaw in an otherwise well-intentioned report, I probably wouldn't have written this critique. Unfortunately, there is another more serious problem, and, to be honest, one I found quite disturbing.

This study's treatment of the subject of foreign students is very poorly done. The report correctly speaks to the issues involved in increasing enrollment and graduation rates of American students in general and women and underrepresented minorities in particular. However, in the half page devoted to foreign students, the entire tone is about the problems they present to their fellow graduate students and undergraduates they may teach. Thus, we are told that "foreign students often have a higher level of mathematical experience" and therefore "when placed in the same introductory courses... often perform better than the American students." Moreover, "the committee believes that such a disparity can contribute to an increase in the dropout rate among domestic students, especially among women and underrepresented minorities." The analysis of foreign students concludes with

> "Colleges and universities have of necessity had to rely increasingly on foreign nationals to teach undergraduate mathematics. The long-term ramifications and impact of this practice need careful study."

This discussion is at best disingenuous. Foreign graduate students now make up about 45% of all graduate enrollments. They *are* our students. Moreover, most of those who get Ph.D.s stay in this country, teach our undergraduates, and work in government labs and in industry. They may very well have different problems than domestic students, but they need "a positive learning environment" just as much as any other student group. Foreign students cannot be seen as a problem for American students or, worse, be pitted against women and underrepresented minorities. This is dangerous ground.

I am sure that the authors of this study were well intentioned. However, to advance the discussion of graduate programs we must seriously address the university reward structure and take a much deeper look at the participation of foreign-born students throughout the system. It is my sincere hope that the AMS or the Joint Policy Board for Mathematics (JPBM) will undertake such a project in the near future spurred by this report and our reactions to it.

***Editor's Note:** JPBM recently convened a Committee on Professional Recognition and Rewards. Information about this Committee appears in the Inside the AMS column in this issue of the *Notices*.

Fern Y. Hunt

Hunt is associate professor of mathematics at Howard University. On leave from Howard this year, she is currently a research mathematician at the Computing and Applied Mathematics Laboratory at the National Institute of Standards and Technology.

In April, the *Washington Post* reported that an influential study of the National Science Foundation forecasting serious shortages of scientists and engineers beginning in the 1990s was based on faulty extrapolations and that the predicted need may in fact be overstated. This is disappointing news indeed, as it comes in the midst of one of the most unfavorable job markets for mathematicians in more than a decade. Yet, there are many in the mathematical community who believe that the gravest risk to the future of mathematics in the U.S. is not the oversupply of mathematicians but the undersupply of future American mathematicians. This is one of an array of what might be termed "boundary value problems" arising from our failure to communicate the value and meaning of our mathematical work to certain groups at the boundary of the mathematics world. In this case, the group is prospective mathematicians, but one could add other groups, such as students and scientists working in other fields and, beyond these, the general public.

In recognition of the problem of declining percentages of domestic students in mathematics Ph.D. programs, the Board on Mathematical Sciences charged the Committee on Doctoral and Postdoctoral Study in the United States to produce a report that surveyed a variety of programs throughout the country. The Committee has successfully carried out this task, defining and describing successful graduate programs that produce large numbers of domestic Ph.D.s and, more generally, Ph.D.s that are adequately prepared to fill our research and educational needs in universities, government, and industry. The Committee's most significant and admirable achievement was to make attracting and retaining larger percentages of domestic students—and, in particular, women and minorities—a crucial part of the definition of a successful program. Further, in a section entitled "The Key to Action," the Committee stated that "the departments at research universities have a special responsibility to raise the level and increase the knowledge of talented but underprepared entering American doctoral students."

Fortunately, the Committee found that there are programs around the country that are successful by this definition and achieve this success with many techniques that do not seem to require a lot of money. What is required is a commitment on the part of individual faculty and departments to seek out students and provide sustained support. In a national atmosphere of growing racial and ethnic animosity, the call for active nurturing of minority students will not be an easy one for us to hear. It will be tempting for the community to simply build on the recent modest increases in the number of female Ph.D.s mainly coming from ethnic groups already well represented in the profession. The techniques described

in this report will work for many minority students, and I am convinced that continuing efforts to increase both women and minorities will enrich the community not only socially but scientifically as well.

In nonacademic settings, mathematicians are far likelier to encounter nonmathematicians ranging from scientists who use a lot of mathematics to administrative types with very little scientific background. The report urges departments to prepare students to operate successfully in such environments. Mathematicians need to be able to talk about mathematics to nonmathematicians in a way that doesn't trigger unpleasant memories from their student days. The training graduate students (should) receive in teaching can also be used to sharpen communication skills. In addition, I would recommend that graduate faculty who aren't already collaborating with nonmathematicians go out of their way to talk with researchers in other departments at their universities and to researchers in government laboratories or local companies so that she or he can gain first-hand knowledge of some of the barriers to communication and collaboration, many of which are not well understood by the mathematics community.

To insure the health of the mathematical enterprise in the twenty-first century, how must doctoral programs change if they must at all? The Committee has succeeded admirably in addressing this question and making the case for change, and they have pointed to the characteristics of programs that are successfully meeting this challenge. The report is a worthy contribution, and I hope its recommendations are implemented.

Andrew J. Lazarus

Lazarus received his Ph.D. from the University of California at Berkeley in 1989. Since then, he has been a visiting assistant professor at U.C. Riverside and U.C. Davis.

The Committee on Doctoral and Postdoctoral Study in the United States has produced a report whose suggestions fall into two categories. The first set discusses improvement of doctoral programs within the framework of their current mission, the production of research mathematicians. Most of these proposals are meritorious and all are reasonable. I commend two of them specifically: research atmosphere and recruitment.

I believe that the training of graduate students is a fundamental obligation of senior faculty. Many world-famous mathematicians find ways to integrate supervision of graduate students into their own research program, leaving examples, subcases, and analogues to the apprentices. Faculty and students work together in a way similar to programs in laboratory science. In a successful program, everyone roots for everyone else. Although I do not agree with every assertion in the report's chapter "Positive Learning Environment," I was impressed with its suggested models for a productive research environment and the implicit repudiation of the lamentably common competitive paradigm in which the adviser orchestrates a trial-by-ordeal for his (or her) inexperienced rival.

My own observations about recruitment of talented undergraduates agree with the report's: most departments, shockingly, just don't. We seem to be content to let dozens of students who enjoy mathematics go on to careers in physics, computer science, or even law, without mentioning mathematics graduate school. The number of students pursuing bachelor's theses or other independent work is ridiculously small.

Hit-or-miss recruitment methods overlook students capable of doing mathematics, but, unfortunately, they find more than enough to fill the small number of research positions available today. The sad truth is that with the collapse of the academic job market last year and the even worse market this year, there are already many talented research mathematicians at liberty, and there will soon be more. The committee attempted to address this issue by revising the mission of doctoral programs to include better preparation for "college teaching" and industry. Unfortunately, this second set of suggestions is vague and incoherent. To quote the report:

> "The college-teachers model is designed to prepare teachers at two- and four-year colleges. A college teachers program is to be distinguished from a program that confers doctor of arts or doctor of education degrees. Breadth of course work and an emphasis on professional development in pedagogy are, in addition to a research apprenticeship, parts of such a program."

The attempt to combine course breadth and research depth is a recipe for mediocrity—as the committee realized when dealing with *faculty* specialization, where it suggested that departments, except the very best, concentrate their efforts. The same *should* hold true for graduate students. Since the research component of the college-teachers model will be diluted—it is intended for the students who will be *furthest* from the research frontier in any one field—the difference between the new Ph.D. and the D.A. and Ed.D. is that the latter two have poor reputations already while the first will need time to develop one. The committee seems to have assumed without proof that training in pedagogy is more important for college teachers than university professors, who still teach, albeit less. Except perhaps for faculty closely involved in precollegiate teacher training, I don't see why this is so.

The report also fails to articulate why graduates of this program will be more attractive to colleges. Colleges are now choosing from literally hundreds of applicants. Some colleges want demonstrated teaching excellence; others see the job crisis as an opportunity to hire first-rate scholars who just miss a position at a major university. None are complaining about a lack of qualified applicants, quite the contrary. The positions for graduates of the college-teachers model are chimerical. Even the report avers only that need

for them "could increase" by the end of the '90s. One wonders where this idea came from, since the committee contained only one member from a four-year college, an elite institution with teaching load and publication expectations similar to research universities', and no members from two-year colleges.

The suggestions about involving mathematics with industry do not appear to be any better informed. (The committee contained one member from industry, but he is from an atypical quasi-academic think tank which has, moreover, had a hiring slowdown for years.) Only a handful of nonacademic jobs are being advertised in the *Notices* and *Employment Information in the Mathematical Sciences*. If there truly are plentiful industrial positions for mathematicians, active solicitation of ads for them would be a great service the Society could perform for recent graduates. But if not, and we are driving taxicabs, let us at least have earned a quality degree.

Jim Lewis

Lewis is chair of the department of mathematics and statistics at the University of Nebraska at Lincoln. A member of the AMS Committee on Science Policy, he chairs the Committee's task force on academic support for mathematics and connections between mathematics research and education.

Almost any department chair in the mathematical sciences will find *Educating Mathematical Scientists: Doctoral Study and the Postdoctoral Experience in the United States* to be a useful document in connection with a careful look at their own department. The current job market for Ph.D.s has caused most people in doctoral granting institutions to reassess the job they are doing and to look for ways to improve the employment possibilities of their students.

The report offers what appears to be sound advice built around the major themes that a successful department must have a quality faculty, a focused mission, a positive learning environment, and relevant professional development. Of particular use will be the list of questions in the appendix on "Doctoral and Postdoctoral Program Self-Evaluation." Indeed, the report will have a positive impact on graduate programs in mathematics if enough faculty use this list to analyze their own departments.

The goal of the report was to determine what makes certain programs successful. The approach was to conduct site visits to ten programs that had been identified as successful and report on the characteristics that made those programs successful. The committee that produced this report made the fundamental decision that in order to receive the cooperation of the departments visited, no program identification would be made. As readers of the report, we are assured that the ten programs visited were both successful and diverse (small and large, public and private, top twenty and top one hundred, geographically diverse, etc.).

Unfortunately, this approach makes it impossible for readers to decide for themselves whether they agree with the conclusions of the report. Built into the definition of a "successful" program is the idea that "larger percentages of domestic students, and, in particular, women and underrepresented minorities should be attracted to the study of and careers in the mathematical sciences." Given that this is a part of the definition of successful, one longs for information as to how successful these programs are in order to compare their success with one's own department. Providing such information, or offering what the committee viewed as appropriate goals for a department, would have strengthened the report.

Whether our institutions are producing enough domestic students, especially women and underrepresented minorities, was one of the concerns that led to this report, and success with domestic students was built into the definition of a "successful" program. We are told that, "departments at research universities have a special responsibility to raise the level and increase the knowledge of talented but underprepared entering American doctoral students."

How shall we fulfill that responsibility? Each department makes decisions as to which graduate students receive financial support. Even though active recruiting can increase the pool of quality students, most departments will still be faced with choosing between a domestic student and a foreign student who appears to have better qualifications for graduate work. Should department chairs reserve a certain percentage of their resources for American students? If so, how much?

Another part of the definition of a "successful" program also concerns me: "All students, including the majority who will spend their careers in teaching, government laboratories, business, and industry rather than academic research, should be well prepared by their doctoral and postdoctoral experience for their careers." This theme is repeated so often that one who did not know better might conclude that the five areas described above are five separate but relatively equal career paths for Ph.D.s in the mathematical sciences.

Are there jobs for mathematics Ph.D.s in government laboratories, business, and industry that are going unfilled? A careful look at the 1991 AMS-MAA Survey in the November 1991 issue of the *Notices* reveals that, if one considers only the graduates of Group I, II, and III departments and takes out the statistics students, only thirty-three individuals went into government, business, and industry jobs. Let us all wish it were not so. Let us attempt as a profession to open markets for our graduates in government, business, and industry. At the same time, let us realize that currently only about 6% of new Ph.D.s outside of statistics and the Group V departments obtain jobs in the U.S. and outside of academia.

Finally, I take issue with the implied distinctions between careers in teaching and careers in academic research. Even while trying to stress that we should pay greater attention to

developing the abilities of our students to teach, the report's repeated references to careers in teaching and careers in academic research as if they were separate perpetuates an unfortunate separation. A colleague of mine likes to say that he considers himself a teacher-scholar. I think this is the correct perspective. As institutions vary, so will the distribution of effort between research and teaching. Perhaps the real point is that about two-thirds of all academic positions at or above the assistant professor level are in institutions that do not offer a Ph.D. This fact, together with the need to open nonacademic markets for our graduates, should influence how we prepare Ph.D.s in mathematics.

Carol S. Wood

Wood is chair of the department of mathematics at Wesleyan University and president of the Association for Women in Mathematics.

For mathematicians, a graduate program is highly desirable, particularly a doctoral program; it is one measure of seriousness of purpose, and it allows teaching at a very rewarding level. When administering a graduate program, most of us build on our own graduate experiences, incorporating a few modificiations which we would have liked. Novel programs have come into existence mostly in response to external pressures. It would be surprising if a report from within the community called for extreme upheaval, although the current document does put in a strong plug for professional masters programs. Since this report has gone through NRC's editing and stringent approval measures, it may be argued that the result is radical indeed, calling for significant changes in how the U.S. mathematics doctoral community is to be renewed in future years, and stressing the importance of a "positive learning environment." The existence of such an environment cannot be left to chance, but happens by design and by intervention on the part of forceful, respected members of the program. Nonetheless, some believe that only a few schools matter, and that their students are well served by the sheer excellence of the faculty and the resultant opportunities to sit at the feet of these masters. It is unfortunate that the best schools are the least likely to heed this report; some will point proudly to the achievements of their successful students, thereby dismissing any notion that a more "positive learning environment" is needed. Part of me wants to agree that nothing but the pursuit of mathematics should matter... until I see the results. We're not talking about ogres here, or even administrators; we're talking about our fellow (sic) mathematicians, who rightly demand enormous respect. Why then do American students leave graduate school disenchanted? Who do some of the best never apply? Why so few women and minority students? I believe graduate schools have failed the rest of the mathematics community when their completion rates are low and when they promote a definition of future mathematician whose narrowness excludes most talented young people growing up in the U.S. Perhaps even those programs that are doing a good job along the recommended lines will deny the importance of such issues. My own colleagues may have my head on a platter when this appears. I shudder at the thought of a senior mathematician's saying sarcastically to a young woman student, "I'm told you need a supportive environment. What does *that* mean?" But the current generation of students takes careful note of the graduate environment, regarding atmosphere and attrition rates as crucial factors in considering graduate study. This is the impression I gain from listening to the students I meet across the country, undergraduate and graduate. There is a generational/cultural gap deepening over time. Many of us over-forty mathematicians are experienced know-it-alls, fiercely competitive and eager to stand out as the best. My mother loved games and hated to lose; by the time I entered a classroom I was happy to compete under "boys' rules." This played a greater role in my choice of career than I usually want to admit. In time I found an intellectual excitement in mathematics much deeper and more satisfying than simply beating the next guy to a theorem (although sometimes I wonder... after all, my middle name *is* Saunders). But our craft is still presented to students as much more a competition for stardom than is healthy or even accurate. We invite a reaction of disgust or discouragement: "I love mathematics but just don't belong with these people." Surely we have more imagination than to believe that every talented student who exits in this manner "just doesn't have what it takes to be a mathematician!" A recent NSF report from a conference of Presidential Young Investigators indicates that throughout the sciences the over-forty set is out of step with the ambitions and views of the next leaders. A highly competitive setting has very limited appeal to today's brightest students, and is in fact a downright turn-off to many women and minorities. Their interest in hard work is hardly increased by the threat of having their weaker peers weeded out. The NRC report suggests that we take a careful look at how we recruit and educate our successors and make some adjustments in our culture. We dismiss it at risk.

Graduate Education in Transition

The Report of a Conference
Sponsored by
The Conference Board of the Mathematical Sciences

This report of the Conference Board of the Mathematical Sciences (CBMS) is based on a workshop held in June 1991 in Washington, D.C. The report first appeared in February 1992.

Introduction

Background

In the last few years, both activity and urgency of reform efforts in mathematics education have increased dramatically. There is widespread agreement that the mathematics education system, from elementary school through graduate school, needs to be greatly improved, and that the changes required to bring about this improvement will not come easily or quickly, but will require a continuing commitment of time and effort. At the school and collegiate levels, the mathematical sciences community has refocused its attention on teaching and the needs of today's students. The Mathematical Sciences Education Board and the CBMS member societies are now working to implement the vision of school mathematics presented in the National Council of Teachers of Mathematics (NCTM) *Standards*. Undergraduate mathematics education is the focus of major programs in the National Science Foundation and in many of the mathematics professional societies. At both the school and collegiate levels, there is increasing emphasis on changing the culture and priorities of the mathematical community to promote the importance of teaching.

In contrast to this, no comparable national effort or leadership has emerged as yet in the mathematics graduate education enterprise. Despite an apparent mismatch between the needs of the nation and much of the current practice in graduate programs, relatively little attention has been given to postbaccalaureate education in the mathematical sciences.

The CBMS Conference

In order to promote serious discussion of the issues of graduate education and to move the mathematical sciences community to action, the Conference Board of the Mathematical Sciences organized a three-day conference on "Graduate Education in Transition," held in Washington, DC, May 4–6, 1991. At this meeting, leaders of various segments of the mathematical sciences community were asked two key questions: what are the nation's needs and how can the community best respond?

Twenty-four individuals participated in the conference. Among them were seven current presidents and six former presidents of CBMS member societies. A complete listing of the participants is given at the end of this report.

The conference began with keynote remarks by Luther Williams, Assistant Director of the National Science Foundation, Directorate for Education and Human Resources, and by Calvin Moore, Vice-President for Academic Affairs at the University of California at Berkeley, followed by the charge to the participants given by Ivar Stakgold, Chair of CBMS. The participants were formed into three working groups—the Doctoral Group, the Master's Group, and the Professional Development Group—corresponding roughly to the three types of postbaccalaureate education in mathematics. Throughout the working sessions and general discussions, the participants were asked to identify the national needs in postbaccalaureate education in the mathematical sciences and to recommend what actions should be taken, and by whom, to make the graduate education enterprise more responsive to those needs.

This report is based on the written summaries of the working groups and of the discussions which took place at the plenary sessions. It is organized into two main sections: Discussion of the Issues and Recommendations.

The Conference Board of the Mathematical Sciences would like to express our gratitude to the Exxon Education Foundation for their support of this conference.

Discussion of the Issues

Introduction

The amount of national attention now given to educational reform in mathematics is staggering. Can anyone recall an American president addressing a meeting of mathematics educators, as George Bush did recently at the National Summit on Mathematics Assessment?

The report of the Federal Coordinating Council for Science, Education, and Technology (FCCSET) accompanying the President's 1992 budget both deplores the present

state of science and mathematics education and proposes objectives and priorities to guide future federal activities. Recommended budget increases run 28% at the precollege level, 14% at the undergraduate level, but only 2% at the graduate level.

Unlike the post-Sputnik reform, which was driven by military needs, the present effort is driven by economic concerns. The government sees leadership in science and mathematics as a critical element to regain American competitiveness in the international arena.

Many reports have analyzed aspects of mathematics education and have proposed remedies (see, for example, [1], [2]). Member societies of CBMS have played important parts in writing these reports and translating them into action. The two Boards of the National Research Council (the Mathematical Sciences Education Board and the Board on Mathematical Sciences) have provided both stimulus and coordination for many of these projects. The mathematical community has generally participated with energy and enthusiasm in these studies and plans for action. Indeed, in a speech delivered at the International Congress of Industrial and Applied Mathematics in July 1991, D. Allan Bromley, Assistant to the President for Science and Technology, praised the mathematical community for its leadership in educational reform.

It is not surprising that relatively little is said concerning graduate study in most of these reports since the most pressing needs are clearly in school education and in undergraduate education (see, however, [3], [4], [5]). Now that a concerted effort is being made at these levels, we submit that *without reform in graduate education no lasting change in school or undergraduate education is likely.* Short-term intervention programs in the schools will yield some temporary benefits, but the attitudes and skills of school teachers are, in the long run, molded in colleges and universities, where these teachers are instructed by the products of our graduate schools. One does not have to subscribe to a domino theory to see that all parts of our educational system are interdependent.

There is also a more direct reason for suggesting changes in graduate education in the mathematical sciences. Although our graduate programs have brought U.S. mathematics to world leadership in research, they have been less successful in preparing students for college teaching and for positions in industry.

What are the features of graduate education in the mathematical sciences that need attention? *The main problem is the mismatch between graduate programs and the existing job market.* The gap is even wider if we take into account potential, unexploited markets. The Ph.D. program in mathematics (the use of the singular is appropriate in view of the considerable similarities among programs), culminating as it does in a research dissertation, is intended principally to prepare students for careers on the faculty of research universities. This narrow focus has led to a very strong community of research mathematicians in the U.S., despite the fact that nearly 80% of Ph.D.'s publish little after receiving their degrees. Most mathematics Ph.D.'s spend their careers in comprehensive universities and colleges, where the mission of the institution and the role of the faculty is much broader than simply producing research. The importance of all the roles of the faculty—research and graduate education, undergraduate education, service to a broad set of client disciplines, community outreach, service to the department, the university, the local community, and the profession—must be recognized, and some preparation for these roles should begin in graduate school.

The success of the Ph.D. program in producing a cadre of strong researchers must be balanced against weaknesses in the preparation for college teaching and other careers. There is the cost of unfulfilled obligations and missed opportunities. Programs in mathematics (unlike those in other mathematical sciences such as statistics and operations research) often are held in splendid isolation without stressing, or sometimes even mentioning, connecting strands to other sciences. The emphasis on individual, independent research is often exaggerated; whether in the real world or even in academic research, there is considerable need for teamwork either within or across disciplines.

One unfortunate consequence of the parochialism in graduate mathematics education is that much of industry and business still regards mathematicians with some suspicion. Few industries have career paths for mathematicians; contributions of a mathematical nature are often not recognized as such because they are made by physicists, engineers, and computer scientists.

An interesting case in point is given by the list of the ten greatest engineering achievements of the past quarter century as compiled by the National Academy of Engineering: the moon landing, application satellites, microprocessors, computer-aided design and manufacturing, the CAT scan, advanced composite materials, jumbo jets, lasers, fiber-optic communications, and genetically engineered products. Each of these spectacular engineering achievements has a strong mathematical component identifiable (and acknowledged) by engineers but not by the general public.

We also believe that industry does not take full advantage of the potential of mathematics. Although part of the reason lies with the attitude and training of some mathematicians, equally important factors are some shortsighted business practices that have become prevalent in recent years. Policy makers and corporate managers are often so concerned with short-term profit that they do not sufficiently invest in technological development and industrial innovation (see [6]).

In this report, we shall make a number of recommendations to departments, scientific organizations, and funding agencies to help bring graduate education in the mathematical sciences closer to the needs of American society. For the past several years, departments of mathematical sciences have faced increasing and more varied responsibilities, often without adequate resources. On some campuses, a favorable climate has made it possible for the faculty to meet the challenges of research, educational reform, and service to

the institution and community. The time has come for other university administrations, in conjunction with the federal agencies that support mathematics and science, to correct the chronic underfunding of mathematical sciences departments in order that they may achieve the goals and expectations of our society as we move into the twenty-first century.

National Needs

The present demand for Ph.D.'s in the mathematical sciences is generated by several different market segments: university faculty, college faculty, industry and commerce, and government organizations and laboratories. In the five year period 1986–1990, 80% of the new Ph.D.'s in the mathematical sciences employed in the U.S. took academic positions. If the field of statistics is factored out, the percentage climbs to nearly 90% (see [7]). In the existing market, new mathematics Ph.D.'s are employed principally by academic institutions. Although some mathematical scientists move into industry or government after a postdoctoral appointment or junior faculty position, little data are available on this subject. Demographic projections show more faculty retirements in the period 1995–2000 than can be filled by prospective Ph.D.'s at the present rate of production. Although economic strains in many states have caused retrenchment in hiring in 1990 and 1991, many observers expect this to be temporary.

At the Master's level, the market is more difficult to pinpoint. It is clear that the industrial, business, and government share of the market is much more significant here than at the Ph.D. level (see [8], [9]). Two-year colleges and secondary schools are major employers, and there is also evidence that much of precalculus teaching at colleges and universities is provided by Master's degree faculty.

Recent reports have considered the preparation of prospective teachers in schools [10], [11], in two-year colleges [12], and in four-year colleges [13]. This workshop strongly supports the recommendations in these reports. In particular, we endorse the key principles of the Mathematical Association of America Committee on Preparation for College Teaching [13], namely that doctoral programs should prepare students to meet a wide range of professional responsibilities, should not be limited to specialization in narrow areas, and should give systematic attention to promoting excellence in the teaching of mathematics.

The mathematical sciences have yet to find their proper place in industry. We consider the mathematical sciences as an important, if partially untapped, industrial resource. A recent National Research Council report, "Mathematical Sciences, Technology, and Economic Competitiveness" [14], points out some of the vital contributions that have been made by the mathematical sciences to technology, but also challenges the U.S. mathematical community to speed the transfer of new technologies to the production line.

Mathematics as an industrial resource needs both greater acceptance and further development. Graduate programs with an industrially oriented point of view are relatively rare. To paraphrase J.R. Ockendon [15], such programs should instill a professional attitude toward real-world problems. This means that mathematicians must be fully prepared to accept the responsibility of familiarizing themselves with the methodology for analyzing practical problems, whether expounded by chemists, engineers, biologists, or economists. There are a few excellent applied mathematics programs in the U.S. and elsewhere that provide this orientation; they deserve to be publicized and could serve as models (with local variations) for the education of industrial mathematicians. Goals and standards for such programs should be promulgated by professional societies as they have been for teacher preparation.

At the same time, many small and medium size industries have been slow in adopting mathematical modeling and computational mathematics. One reason is the lack of properly trained applied mathematicians with an interest in industrial problems. Another is industrial inertia and perhaps even some residual distaste for mathematics in management. The pressure on near-term corporate profits and the lack of a government industrial policy also have serious consequences for American economic competitiveness. Michael Schrage has pointed out how "mathematics remains a crucial—and misapplied—key to economic edge" [6]. Believing as we do in the potential effectiveness of the mathematical sciences in industry, we must make a concerted effort to demonstrate this to industry. A possible approach is to organize academic-industrial centers on the model of the European Consortium for Mathematics in Industry.

The continued technological and economic health of the U.S. depends on maintaining at least the present supply of graduate-level mathematical scientists. In recent years, half of our Ph.D.'s have been foreign, and most have entered the American job market. This ratio does not seem appropriate for the steady state. American women and minorities, who will be a large fraction of the new entrants in the work force by the year 2000, have traditionally not been attracted in sufficient numbers to careers in the mathematical sciences. No doubt some are merely expressing their free choice, but others may have been kept away for lack of encouragement. We propose a number of remedies: active recruitment, a supportive environment, and a better balance between competitive and collaborative activities in graduate programs. A supportive and nurturing atmosphere, which is helpful to all students, is essential for recruiting and retaining students from underrepresented groups.

In examining present postbaccalaureate education, one cannot help but observe the lack of postdoctoral opportunities in the mathematical sciences as compared to physics or chemistry, for instance. Opportunities for later career development also seem to be minimal. As mathematics expands, so often does its circle of applications. There is a need to respond to individual demand for specific courses and to present advances in mathematics that can be expected to be important in applications. School and college teachers will also profit from "updating" their education, both to keep them intellectually active and to enable them to incorporate new ideas into their teaching.

Design of Graduate Programs

We strongly advocate greater diversity among graduate programs to take advantage of existing and potential career opportunities as described in the previous sections. As pointed out in the Board on Mathematical Sciences report [4], graduate and postdoctoral programs offered by mathematical sciences departments are the key to successful renewal of the profession and reform of mathematics education. There is a need for programs that are sensitive to the needs of individual students and that recognize broad options for different career paths, i.e., the personal mix of research, teaching, outreach, service, and other professional activities that each student chooses.

The first step in designing or reforming a graduate program is a realistic assessment of resources. What are the talents and interests of the faculty? Are there prospects for regional cooperation with industry, business, government, and colleges? Does the university possess strengths in other areas that could lead to interdisciplinary or joint programs? What is the department's track record in recruiting and placing students? What financial support is available for prospective students through teaching assistantships, research assistantships, or internships?

Answering these questions, exploring opportunities, forging links, and enlisting administration support will take faculty energy and dedication, but it is the best way to create a viable program. Even established institutions with a strong record of sending graduates to the faculties of research universities also place other of their graduates at comprehensive universities, four-year colleges, and in industry. We hope to influence them to reexamine their programs and become more aware of the diversity of their mission. For universities whose niche is less secure and for others contemplating new programs, we urge them to strive for individuality and to try to meet some well-defined market needs. After a department has selected its goals, it must design a program that will realistically take into account the potential careers of the students.

For a master's program in industrial mathematics, for example, one would include in addition to some core mathematics, courses in modeling, in probability and statistics, in computational mathematics, and in optimization. Clinics, seminars in industrial mathematics, case studies, and internships are all possible "practical experiences" that could be part of the program. Such a program could perhaps share some offerings with operations research or statistics programs based in other departments.

A Ph.D. program to prepare for college teaching would stress broadly based scholarship rather than narrowly focused research and would pay careful attention to curricular issues and to the goals of undergraduate education. The relations between the branches of mathematics and between mathematics and other disciplines would be emphasized to enable prospective college teachers to meet a wide range of professional responsibilities.

Values and Attitudes

We must convey to students (and to the public at large) that mathematics is a lively, dynamic, and varied profession that has attracted inquisitive minds since the birth of civilization. It is important that both principal aspects of mathematics be appreciated: its useful, indispensable role in science and technology, and its continuing intellectual fascination over the ages.

Students entering graduate school in the mathematical sciences are presumably already interested in the subject and exhibit some talent for it. The graduate experience should build on these advantages by further stimulating the students' enthusiasm, and by both widening and deepening their mathematical knowledge.

One important issue that always surfaces in reports such as ours is the balance between research and teaching. Some years ago, the scales may have tipped towards research, but they have begun to swing back to a proper appreciation of both aspects of the profession. Advocates of better balance urge that research be interpreted more broadly to include other types of scholarship as well as specialized research [16]. The need for educational reform has also given more importance to collaborative activities, to more stimulating presentation of undergraduate courses, to the inclusion of computation (symbolic, numerical, and graphical), and to emphasis on communication skills. These latter skills are equally important in industry. In [17], Fan Chung of Bellcore makes that point forcefully:

> 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 nonexperts. 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 when planning a career in this country.

Graduate students, both domestic and foreign, are supported in large measure by teaching assistantships. Universities have the clear responsibility to carefully train and supervise all teaching assistants, and, for foreign students, to also make sure that they speak English well and are sufficiently familiar with the sociology of the American classroom. Many of our universities already have such

programs in place. But, beyond this—to paraphrase the Mathematical Association of America report [11]— universities should reward teaching assistants and junior faculty who are performing well and should help those who are teaching inadequately. Although university teaching is done largely by the lecture method, alternative approaches encouraging student initiative and collaborative learning are being adopted successfully in many different settings. Such approaches can also be introduced on a limited scale in the graduate curriculum. Graduate students, being more mature and motivated than the average undergraduate, do respond to well organized lectures presented in a challenging manner. Room can be made, however, for some problem-oriented seminars in which students participate actively and give oral presentations of projects. Working in small groups also has benefits: it develops comradeship among students and prepares them for the team approach encountered in most research groups in industry, government, and even universities.

Recommendations

Mathematical Sciences Departments

- Review existing and prospective graduate programs, taking into account the potential job market, faculty skills within and outside the department, and available resources (including possible connections with local industry, school districts, and other academic institutions).
- Expose graduate students to some collaborative projects with oral presentations; prepare all students to become effective teachers or communicators of mathematics.
- Elevate Master's programs to professional status with well-defined goals related to specific market needs. Examples include preparation for teaching in two-year colleges and for industrial employment.
- Establish a climate in which the spectrum of contributions by the faculty is recognized and valued. Consider adopting guidelines such as those described in Boyer's "Scholarship Reconsidered."
- Provide a supportive learning environment for all potentially successful students, with the particular goal of encouraging and retaining underrepresented groups.
- Include computational mathematics as a component in all graduate programs.

Universities

- Provide adequate resources to chronically underfunded mathematical sciences departments.
- Establish a climate in which the spectrum of contributions by the faculty is recognized and valued. Consider adopting guidelines such as those described in Boyer's "Scholarship Reconsidered."

Government

- Provide stable funding for Ph.D. students by balancing teaching, fellowship, and research support.
- Expand postdoctoral programs at government laboratories and help to fund postdoctoral programs in industry and academic institutions. Establish postdoctoral programs that combine research with preparation for teaching.

Industry

- Establish internships similar to those available in statistics. Expand summer employment programs. Provide appropriate postdoctoral opportunities.
- Cooperate with professional societies and universities to communicate the mathematical needs of the workplace and to develop suitable programs in industrial mathematics.
- Recognize the industrial role of computational and applied mathematics and help to establish industrial career paths for mathematical scientists.
- Change managerial attitudes and financial practices to take into account the long-term advantage of industrial innovation and technological development in achieving economic competitiveness.
- Cooperate with academic institutions and professional societies in the continuing professional development of employees.

Professional Societies

- Jointly develop and disseminate career information for graduate students. Provide an information service for currently available jobs and potential jobs. Investigate the possibility of a placement office.
- Establish standards and goals for graduate programs. Develop a list of existing programs with their special features.
- Provide a wide range of opportunities for continuing professional development, occasionally in cooperation with societies in other fields, including programs for in-service teachers and programs relating to new technologies, to new fields of application, and to recent mathematical developments. Involve regional chapters of professional societies in these efforts.
- Develop and publicize a list of mathematical contributions in industry and government. Promote the industrial use of mathematics, mathematical models, and computational mathematics. Develop an industrial liaison group to help industry find appropriate specialists for particular problems.
- Organize workshops and conferences which bring together prospective industrial employers and university faculty to discuss industry needs.

References

1. National Research Council, *Everybody Counts: A Report to the Nation on the Future of Mathematics Education*, Washington, DC, National Academy Press, 1989.

2. National Research Council, *Moving Beyond Myths: Revitalizing Undergraduate Mathematics*, Washington, DC, National Academy Press, 1991.

3. National Research Council, *Educating Mathematical Scientists: Doctoral Study and the Post-Doctoral Experience in the United States*, Washington, DC, National Academy Press, 1992.

4. Board on Mathematical Sciences, *Actions for Renewing U.S. Mathematical Sciences Departments*, Washington, DC, National Research Council, 1990.

5. Board on Mathematical Sciences, *Renewing U.S. Mathematics: A Plan for the 1990s*, National Research Council, Washington, DC, National Academy Press, 1990.

6. Schrage, Michael, "Mathematics Remains a Crucial—and Misapplied—Key to Economic Edge," *The Washington Post*, 13 September 1991, page D2.

7. McClure, Donald E., "1991 Annual AMS-MAA Survey (First Report)," *Notices of the American Mathematical Society*, **38**:9 (November 1991) 1086–1122

8. Madison, Bernard L. and Hart, Therese A., *A Challenge of Numbers: People in the Mathematical Sciences*, Committee on Mathematical Sciences in the year 2000, National Research Council, Washington, DC, National Academy Press, 1990.

9. Seitelman, Lee, "The Old Economic Rules No Longer Apply," *SIAM News*, **24**:5 (September 1991) 6.

10. National Council of Teachers of Mathematics, *Professional Standards for Teaching Mathematics*, Reston, VA, National Council of Teachers of Mathematics, 1991.

11. Mathematical Association of America Committee on the Mathematical Education of Teachers, *A Call for Change: Recommendations for the Mathematical Preparation of Teachers of Mathematics,* Washington, DC, Mathematical Association of America, 1991.

12. American Mathematical Association of Two-Year Colleges Committee on Education, *Guidelines for the Academic Preparation of Mathematics Faculty at Two-Year Colleges*, (To appear 1992).

13. Mathematical Association of America Committee on the Preparation for College Teaching, First Report: "How Should Mathematicians Prepare for College Teaching," *Notices of the American Mathematical Society*, **36**:10 (December 1989) 1344–1346.

14. Glimm, James (Ed.), *Mathematical Sciences, Technology, and Economic Competitiveness*, Board on Mathematical Sciences, National Research Council, Washington, DC, National Academy Press, 1991.

15. Ockendon, J. R., *ECMI Newsletter*, (March 1991).

16. Boyer, Ernest L., *Scholarship Reconsidered: Priorities of the Professoriate*, Princeton, NJ, The Carnegie Foundation for the Advancement of Teaching, 1990.

17. Chung, Fan R. K., "Should You Prepare Differently for a Non-Academic Career," *Notices of the American Mathematical Society*, **38**:6 (June/July 1991) 560–561.

Scientific Issues in Manufacturing

Army Research Office Holds Workshop to Define Research Directions

Is manufacturing a fundamentally messy endeavor, with dies forcing metal into a crude approximation of the ideal shape, "house of cards" scheduling that collapses when delivery of the right bolts is delayed, and cost considerations dictating quick and dirty solutions instead of careful planning? Or is manufacturing a futuristic marvel, with visual sensors that examine products for defects, robots transporting materials quickly and efficiently, engineers quickly and cheaply cycling through numerous prototypes before hitting on the optimal design? At a recent workshop on Scientific Issues in Intelligent Manufacturing, the answer seemed to be, a little of both.

The workshop, organized by the Mathematics and Computer Science Division of the Army Research Office (ARO), was held March 7–8, 1992 at ARO headquarters in Research Triangle Park, North Carolina. A cargo train rumbled past the skinny pines just outside the window of the ARO conference room, providing a real-world counterpoint to much of the high-tech talk at the workshop: there are a lot of great ideas for making the world more efficient, but old technology dies hard, sometimes for good reason, and sometimes for no reason at all.

Why is the Army interested in manufacturing? Isn't there a whole defense industry set up to cater to its needs, from Patriot missiles to $1000 toilet seats? Not for much longer, says Jagdish Chandra, director of ARO's Mathematics and Computer Science Division and organizer of the workshop. In addition to responding to a government-wide initiative in manufacturing, Chandra explains that, in the future, it won't be economically feasible for the Department of Defense (DoD) to rely on an industry that's dedicated to DoD needs and shielded from competition. As a result, he says, the DoD must support a research base that will contribute to efficient, flexible manufacturing so that other companies will be able to manufacture the products the DoD needs. In addition, the ARO has a mission to support the science and technology research base. He notes that mathematics and computer science provide the fundamental tools in such areas as simulation, prototyping, and control, so his division has an interest in supporting this kind of research. The purpose of the workshop, he says, is to identify scientific issues in mathematics and computer science that will help to solve manufacturing problems, and especially to pinpoint "gaps" in knowledge that need to be filled before successful knowledge transfer can be made.

The workshop brought together about thirty-five participants, mostly from departments of industrial or electrical engineering or statistics, though several were from mathematics or applied mathematics departments and a few from industry. Emerging from the presentations were a variety of intriguing problems that tax scientific and technical abilities, and a degree of disagreement on how to get at the underlying scientific problems that manufacturing poses, on whether those problems can be solved in a cost-efficient way, and on whether the scientific knowledge and the right mechanisms are in place to get the problems solved.

U.S. Industry Lagging

Forming the backdrop for the workshop was the declining ability of the U.S. to compete in global markets. Part of the problem is that other countries can manufacture better products at lower cost and can introduce improvements more rapidly. In addition, points out Anil Nerode of the Mathematical Sciences Institute at Cornell University, many companies, such as General Electric, Honeywell, and Boeing, are cutting back on their long-term research staffs. Industry and government do not recognize the importance of both basic and applied research to manufacturing, he says.

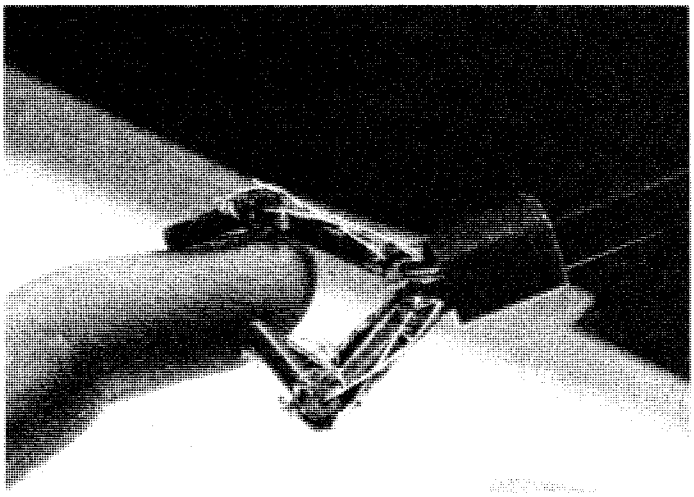
Other problems haunt U.S. industry as well. Ideas for new industrial processes sometimes never get put into practice because of uncertainty over whether the Environmental Protection Agency (EPA) would approve them, says Nerode. Countries like Taiwan, Malaysia, and the Philippines can do things that American industries cannot because those countries have fewer environmental restrictions. Nerode doesn't advocate neglecting environmental concerns, but he raised questions about whether some EPA regulations really make sense. One famous example occurred when New York City was forbidden by the EPA to put its waste into the land, the water, or the air, so it put its trash on barges that floated out at sea for a number of years. In the future, he noted, it will be crucial for industry to not just model its products and processes, but its waste as well.

Another problem is that academia—which is where much of the nation's basic and applied research is done—often doesn't understand the needs of industry. James Solberg is

in the school of industrial engineering at Purdue University and is director of Purdue's Engineering Research Center for Intelligent Manufacturing Systems, funded by the National Science Foundation. Solberg says that, for example, many people in academia make careers out of applying operations research ideas to scheduling problems, but this research is "laughed at" in the manufacturing world because it simply does not apply to the problems industry is trying to solve.

As another example, he pointed to some research he had done in the early 1970s on flexible manufacturing systems—that is, systems that can be easily adapted to manufacture a variety of products. Since then, many other papers have been written that cite his initial work. He made some simplifications in his research, and the later papers became increasingly abstract and farther removed from the original problem. At a recent conference on research in flexible manufacturing, he says, very few of the participants had actually seen a flexible manufacturing system in action. Because of this tendency toward abstraction and distance from real-world problems, flexible manufacturing has become a "dirty word" in the real world of manufacturing, says Solberg, and some important opportunities have been missed.

On the other hand, Solberg points out that industry is not always as open-minded as it could be. He says he's been working on the development of low-cost mobile robots that could move materials around in factories, which he said would save money in some situations. But industry just isn't biting, because they don't see the handling of materials as a problem. Jokingly, Solberg described the reaction this way: "We can buy K-Mart wagons and hire people to move materials, what do we need robots for?"



Prototype of cable driven robotic hand for endoscopic surgery. Photo courtesy of B. Smallridge, D. C. Deno, S. Sastry, J. Wendlandt, Robotics Laboratory, University of California at Berkeley.

Some Success Stories

Despite these problems, there have been some clear success stories in which theoretical research has helped to solve some important industrial problems. Donald McClure of the division of applied mathematics at Brown University described some applications of machine vision to manufacturing problems. Although the power of machine vision was initially oversold, it has become an important tool in many industries. A tough problem for visual inspection of products is the recognition and classification of defects. Defects aren't always easy to identify: is it a dust particle, or is it a scratch? Development of machine vision has not reached a point where it is easily applicable to a wide range of problems, McClure says.

Cheeseborough-Ponds, which manufactures vaseline, has successfully used machine vision in a controlled situation. At the end of the production cycle, jars of vaseline are run by a machine vision system which examines each jar for misalignment of the label and lids that aren't screwed on properly. If a jar is defective, an air jet blows it off the conveyor belt. Because the vision requirements were very specific, this system was not difficult to set up, and it turns out to be far more efficient than having people inspect the jars.

Another example McClure discussed is optical character recognition which, being a two-dimensional problem, is easier to handle than three-dimensional machine vision. Optical scanners that can convert a printed document into a computer text file are nowadays available for personal computers. However, McClure says this problem is fairly easy to solve, since it involves standardized characters printed in black on a white sheet of paper. A more difficult problem is posed by silicon wafer manufacturing, in which an eighteen-character identification code is etched in a standardized font onto each wafer. Various steps in the processing of the wafers can deface this code so that its characters no longer conform to the standardized font. McClure says the aim here is to develop algorithms for processing the visual information that are insensitive to the variation in appearance.

This approach—finding methods that are insensitive to variation—is credited to Genichi Taguchi, a Japanese industrial consultant. Ramón León of the statistics department of the University of Tennessee at Knoxville described another example of the "Taguchi method." A Japanese tile manufacturer would stack tiles onto a conveyor that would pass through the oven. Because the oven heat was not uniform, and because of the way the tiles were stacked, some tiles would come out thicker than others. Two obvious—and costly—solutions are to install fans to even out the oven heat and send through fewer tiles at a time. Instead, Taguchi proposed raising the lime content from 1% to 5% in the tile clay, which makes the clay less suceptible to variations in temperature. Because lime is cheap, this turned out to be a cost-effective solution. In a number of situations described during the workshop, this idea of finding and adjusting the right control parameters turned out to be an important method in solving a range of manufacturing problems.

Medicine is another area that poses intriguing problems for the development of intelligent systems. Although this was not a focus of the workshop, Shankar Sastry of the

electrical engineering and computer science department at the University of California at Berkeley described some work he had done on a robotic device to remove polyps from the stomach or intestine. In endoscopic surgery, the physician inserts, either through the mouth or the anus, a device that feeds visual information to a television screen. Watching the screen, the physician can then use the device to grasp the polyp, cauterize its base, and remove it. Sastry and his coworkers have built a prototype device with a "glove" that gives the physician, in addition to visual information, a sense of feel—an important factor, partly because the polyps move around and are not easy to grasp and partly because whether a polyp feels hard or soft can give an indication of malignancy. To test this device, the physicians Sastry works with set for him a "grape-plucking" test, in which the device had to grasp a particular grape on a bunch of grapes, cauterize its base, and remove the grape without breaking it. The device cleared that hurtle, and Sastry says he expects it to be available within the year.

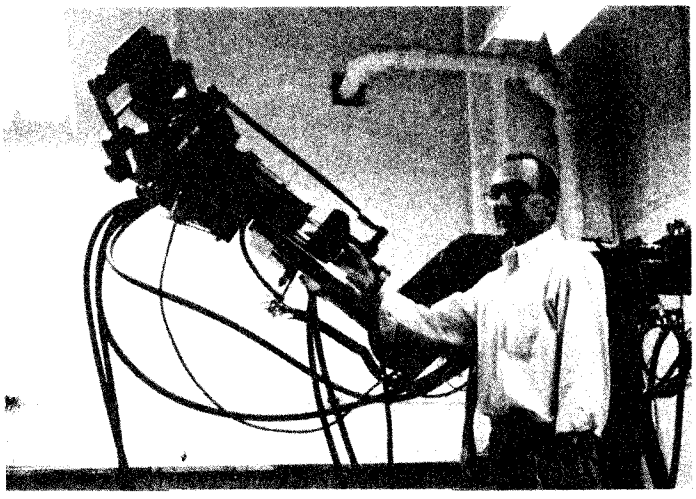
Ambitious Research Agendas

Some of the participants laid out fairly ambitious research agendas. Sastry presented a position paper on "rapid prototyping," which he believes is the key to developing high quality products quickly and easily. He directed his remarks toward what he called "mechatronic" devices, though his ideas extend to other products as well. Mechatronic is shorthand for eletromechanical—that is, electronic systems that control mechanical devices. One example is the antilock brake mechanism option available on new cars. Even though the mechantronic gadget used in antilock brakes only costs about $150 to manufacture, Sastry says that the antilock brake option typically costs the consumer between $1200 and $1500. It took the automobile companies so long to develop and create prototypes for the mechanism that they must amortize their investment over several years of sales.

Sastry's research agenda aims at a "rapid prototyping environment," a neglected area of manufacturing that falls between basic research and production. The main idea is to provide an interface between a graphics package and a three-dimensional "printer." In this scenario, a designer could use a CAD graphics package to generate a visual design of a mechatronic device. Information about various parts of the device are then fed to a three-dimensional output device that creates a prototype out of machinable wax, and the parts are assembled by robots. At each stage, the designer can examine the parts and and see how they fit together, not just by looking at a representation on a computer screen, but by actually handling the prototype. As Sastry points out, having a three-dimensional object to examine provides immediate intuitive information that a picture on a computer screen simply cannot communicate. All of this must be done quickly and cheaply, so that the designer can modify the design and cycle through a number of prototypes.

Nerode also had some ambitious ideas for manufacturing, though his ideas were of quite a different type. He believes that many of the theoretical structures in computer science could inspire development of analogous structures in manufacturing. For example, a computer manipulates symbols while a manufacturing system manipulates parts; machine language in computer science is analogous to controller language in manufacturing; the output of a computer program is like the product and waste from manufacturing, and so on. Nerode put up a list of perhaps twenty such parallels between the two areas. What is needed, he says, is a manufacturing "Turing machine"—a generic system that could serve as a foundation for modeling manufacturing systems. Of course, manufacturing runs into messy problems in physics, while computer science stays in the neater realm of symbols, but Nerode made a persuasive case for an intellectual basis for the parallels between the two areas.

Roger W. Brockett of the division of applied science at Harvard University brought up some similar issues in the area of motion control. Is there a way to describe motion in terms of motion "primitives"? Can a computer language be developed that would manipulate geometric data in the way that computer languages can now manipulate symbolic data? Agreeing on a generic representation is crucial, he says, because if representations of motion control are not device-independent, then the engineering costs for using them are prohibitive. He pointed to Postscript as an analogy for what could be developed in motion control. In wide use for typesetting and publishing, Postscript is page descriptor language that can be used on any output device, be it a printer or a terminal, that has a Postscript interpreter. Before Postscript, the way a printed document looked depended on what kind of printer was used. Although Postscript is not perfect, Brockett notes, it is simple, portable, and in wide usage. He hopes that something similar can be developed for computer representation of motion.



H. Kazerooni with a prototype for his robotic "extender" that allows humans to lift heavy objects. Photo courtesy of H. Kazerooni, Department of Mechanical Engineering, University of California at Berkeley.

Such problems are difficult because of their generality, which makes the lack of theoretical results a major obstacle. Sometimes if one's aims are more specific, more sophisticated results are possible. This approach is seen in the work of H. Kazerooni of the department of mechanical engineer-

ing at the University of California at Berkeley. Among a number of robotics projects he described, one was particularly intriguing: a robotic "extender" that assists people in lifting objects so that, for example, a 500 pound object might feel like ten or fifteen pounds. Kazerooni showed drawings depicting various designs of this device that could be used for different kinds of lifting—one showed a man using the device to load baggage into the cargo hold of an airplane. Kazerooni says he was motivated in part by the large number of back injuries in various professions because of too much heavy lifting, and he has found enthusiastic interest in industry. Having a human control the extender avoids the complication of programming a computer to control the device.

"Universal" Problems, or Usable Solutions?

A late addition to the workshop program, Kazerooni brought up some uncomfortable points that the organizers probably hadn't bargained for. His aim is to build robotic devices to perform a specific task, and he decried the trend toward trying to solve "universal" problems to the exclusion of getting the job done. He says he constantly has to redirect his students to the task at hand, for they automatically drift toward the larger, more theoretical problems. Because his work is practical, task-specific, and easy to understand, he asserts, program officers pass it over in order to fund "sexy" research on universal problems, despite the uncertainty of the return on investment in such theoretical areas. There is value in trying to tackle universal problems, he believes, but too much money is going in that direction, especially given today's tough economic times. As Kazerooni hammered away at his point, uneasy laughter spread around the room, for most of the workshop participants were of a theoretical bent.

Although many seemed to find Kazerooni's views extreme, everyone agreed that there are major cultural obstacles that need to be overcome if theoretical research is going to have an impact on manufacturing. For academics, solving nitty-gritty problems in industry is too often a thankless job: it's not the kind of thing that impresses a tenure committee. For its part, industry often neglects the development of the theoretical research that could insure its future strength. In the end, it appears that these kinds of sociological problems are almost as daunting as the scientific ones.

Allyn Jackson
Staff Writer

The Agency That Came in from the Cold

Richard J. Shaker

Richard J. Shaker is Chief of the Office of Mathematical Research at the National Security Agency (NSA). Following are excerpts from his address at the Joint Mathematics Meetings in Baltimore on January 8, 1992.

I work for a wonderful agency that does marvelous things we cannot tell you about. Our public affairs office is paid for the number of column inches that do not appear rather than the number that do. They were pleased when the program listed my affiliation as the National Security Administration, although they would have preferred Social Security Administration (or our most common mistranslation, the National Aeronautical and Space Administration). Throughout this Baltimore area, thousands of individuals tell store clerks or Department of Motor Vehicle officials that they work for the Defense Department—the *cogniscenti* among those clerks say, "Oh, you mean NSA." Our Director, a charming, wonderfully people-oriented leader, makes but two or three public appearances a year. Yet, one of Admiral Studeman's rare appearances in 1989 was to address these societies, then convened at Phoenix. Mathematicians are now instructed to display the National Security Agency, rather than the Defense Department, on their name tags when attending professional meetings. This exception from anonymity for mathematicians and mathematics by an agency that craves anonymity was not given lightly—only after we realized that mathematics, a vital resource for the United States—a resource essential not only for our industry and science but also for our security and defense—was not receiving support commensurate with its national importance.

Even more than in the forties, when the great mathematicians played vital roles in the dramatic successes of cryptanalysis during World War II, mathematics is the fundamental science supporting the creation and analysis of the complex algorithms that protect vital communications. Not surprisingly, the NSA has a constant requirement for mathematicians in our work. We need well-trained mathematicians not simply because they are well trained in the deductive thinking needed in cryptanalysis—we need them because graduate-level mathematical concepts, ideas, and theorems are needed to solve our problems...

When pressed to describe mathematical subjects especially useful to us, we list algebra, number theory, combinatorics, probability and statistics, but, in fact, every important subject area in core mathematics has proved valuable. Our mathematicians have used both the mathematics they have known well—their area of specialization—or the mathematics with which they were merely familiar—areas in which they had a single graduate course, or studied for the first time after coming to NSA—to solve our problems. When selecting mathematicians for hire, we are not overly influenced by their area of specialization: we look for a solid record of accomplishment in core mathematics and evidence of strong problem solving ability. Besides using mathematics to solve our current problems, after solving them, we use mathematics to understand what we have done. The abilities of mathematicians to abstract, to generalize, to characterize, to prove theorems, are all important to us. We have several examples where an idea or a technique used to solve one problem has been developed into a major internal NSA subject matter, a local paradigm, used for over a decade to solve a number of other problems more important than the original problem...

It is well known that we do a great deal of computing on a number of state-of-the-art computers; less well known that our top programmers are pure mathematicians who can, at a moments notice, turn off their programming skill and work in the rarified atmosphere of pure mathematics, though their most typical mode is to do both simultaneously. The relationship between empirical and theoretical is synergistic, with neither driving the other out. No matter how powerful our computers, we need them to be more powerful. Our best cryptomathematicians make them more powerful with subtle coding and aggressive use of leading-edge architectures. When needed, our mathematicians have taken the lead in designing special purpose computers for especially effective cryptanalytic applications. To do this, they have had to learn new concepts and subject matter, but their understanding of the cryptanalytic problem and the underlying mathematics has been indispensable. Although they have worked closely with engineers and computer scientists, they could not be replaced by them.

Clearly, we need a healthy U.S. mathematical community as a source for technical staff. More subtly, we need a

healthy U.S. mathematical community because no matter how skilled our staff are, and how well they are able to apply mathematical technology to cryptologic problems, there are always important new developments in mathematics that seem very abstract, that seem unrelated to what we are doing, but through some miracle (sometimes referred to as the "unreasonable effectiveness of mathematics") are exactly what we need to solve the important problems of the present. For our access to the cutting edge of the "new mathematics" to be most effective, we require a strong U.S. mathematical community to help keep us informed, and we can best learn from you if you can take the time to learn what we do. We have benefitted greatly from visiting academic mathematicians who have worked directly on our problems, in a succession of summer conferences, or on their sabbaticals, or as consultants. They have solved important problems and enhanced our old technology, but, more importantly, they have played a vital role in exposing us to new ideas and new mathematics, some of which we have continued to use for many years...

I am going to describe 1987 as the beginning of a time period when, because of concern for the health of mathematics in the United States, we began to overcome our introspection and circumspection and "came out of the cold" to become more active citizens in the mathematical community, but we have had important interactions with mathematics throughout our four decades...

In 1987, we opened up the NSA twice, for two days each, to 100 leaders of the U.S. mathematical community, letting them into the "Puzzle Palace" without requiring them to fill out extensive forms, be fingerprinted, or take a polygraph examination. Some thought that the reason for these conclaves was a dramatic announcement: that we intended from our limited technology budget to provide $2–$3 million annually in grant funding for undirected (by us) mathematical research. I was pleased to have been correct in my prediction that our 100 visitors in 1987 would be more interested in us than in our money. Several of the visitors commented to me that the most important thing they learned about NSA was that it was populated by the same kind of people they worked with in their universities, which they meant neither as praise nor criticism...

In a two hour discussion period during the first of the two 1987 meetings, you gave us guidance on how we should administer our new grants program. Many of our visitors had a lot to say. Everyone seemed to have a pet project, an area, an initiative, or a niche where funding was needed, funding which would have great benefit to the research community and thus to the health of American mathematics; yet funding that for some reason was not being provided by anyone else. We listened intently and constructed our program accordingly. We have continued to listen. Under the leadership of Brent Morris, Marv Wunderlich, and Charlie Osgood, we have, for four years, been running a program that the David II report praised, not only for helping in dollar terms reverse the severe downward trend of government funding of mathematics in real dollars, but for providing the funding in innovative and worthwhile new programs...

NSA has undertaken a number of new initiatives following the 1987 meetings, in addition to our grants program and increasing participation in open research and national meetings. We have established a formal sabbatical program so that you can visit us, work with us for a year or two, and continue to remain affiliated with your university and participate in your university's retirement program... We have also constructed a program for NSA mathematicians to return to academe... We committed, early on, to provide core funding for the Mathematical Sciences Education Board (MSEB), and, better than money, sent them one of our best and most energetic mathematicians, Kevin Colligan, on a one-year, non-reimbursable detail. With mixed feelings, we said goodbye to Joan Donahue, a fine mathematician, technical manager, and leader of our educational reformists, who left us to become a full-time member of the MSEB staff. We built on our MSEB connection by meeting through them and becoming involved with the National Council of Teachers of Mathematics, the Alliance to Involve Minorities in Mathematics, the [Mathematical Association of America's] SUMMA committee, and other national-level efforts. We have been active in outreach programs to historical black colleges and universities and other minority institutions; this year, many of our mathematicians will be involved in HBCU/MI (Historically Black Colleges and Universities/Minority Institutions) support efforts. We participate in a wonderful program, the National Physical Science Consortium, where we support a number of new women and minority mathematicians each year for up to six years through their Ph.D. studies—more important than merely sending checks, we meet the fellows, expose them to the excitement of NSA problems, and mentor them. At the state level, we have been a key player in the early efforts to establish the Maryland Mathematics Coalition, a broadly representative group of government, industry, and education leaders promoting mathematics education reform throughout the state.

I want to discuss in more detail two NSA programs that contribute to the health of American mathematics, that play to our strength and that are new since 1987. The first is a cherry-picker program. It hopes that despite all that is wrong with our educational system, we can discover some gems near the end of the pipeline and provide that last little push to get them through. It is a program where it is easy to see accomplishments. The second is harder. It is like throwing a pebble in the ocean. It is more controversial.

The first intervention program [the Director's Summer Program (DSP)] I want to tell you about belies the notion that we have problems with our educational system...

We began in late 1989 to aggressively seek out top young undergraduates who showed great promise and interest in mathematics and expose them to our exciting problems. Many thought we were doing this as a long-term recruiting program. Indeed, we were recruiting, but for mathematics, not for NSA. Our interest and intent was to use a summer experience with us, preferably between the junior and senior

year, to provide direct evidence that mathematics provides both subject matter and training for challenging careers... We had hoped for a few more, but we were still pleased that eight were able to stick it out through the processing and come, because they were eight very special young people.

We were hoping that we could put these eight in a room by themselves, working on our best problems, so that the experience would be strongly peer-interactive, but such an aggressively structured experience could only be pulled off if our top mathematicians took on technical director responsibilities. The demands on our top mathematicians are incredible. They have too much to do, they have earned the right to do what they want, they most enjoy solving our hardest problems, they are most rewarded for the work they do in solving our problems. Yet, the first two of our top mathematicians that we asked to lead the 12-week DSP not only said yes, they worked hard during the spring to prepare for the students, identifying and developing the best problems to present them. When one of them was asked how he had the time to nursemaid eight students, he responded, "Did you see their resumés?"

The first two weeks of the workshop were extremely difficult, for the technical directors and the students. The students had to learn decades of NSA-developed technology in two weeks, as well as a myriad of details about the four problems presented them. During these two weeks, some learned to program for the first time. All were proficient programmers by the end of the summer. One, who had no computer science courses on his transcript, taught everyone C in half a day. Another, who also had no computer science courses on his transcript, didn't like our setup and so wrote a special operating system for the group. By the third week, the students knew everything there was to know about the problems, had developed their own suite of programs, had broken into overlapping groups, and knew NSA slang and jargon so well they sounded as if they had worked for us for ten years. We had five Sun terminals connected to the CRAY in the room for the eight students and two technical directors, but we had to add three more. Optimists like me expected the students would make substantial contributions to all the problems they worked on. They did. We expected them to come up with innovative, new ways of looking at our problems. They did. We did not expect them to obtain significant bottom-line results. That's where we were wrong. On the fifth and tenth weeks, they obtained very important results substantially solving two of the problems, convincing the last of the skeptics that this program was very worthwhile. Clearly, we were rewarded for trying to do a good thing. But the real payoff was not the contributions to our product, impressive as those contributions were. The real payoff was to the pipeline.

Incredibly, before they met us, two of our DSPers, juniors, had not been planning to go on to graduate school following their senior year. They had outstanding academic credentials. Some of the others had been off to faster starts, taking an incredible assortment of undergraduate and even graduate level courses while in high school. But these two were performing exceptionally well in their current, demanding academic program, and, ironically, made the most direct contributions to the most significant bottom-line results of the workshop. One, according to her father, might have gone on after taking a year off or might not have. But she came home from the DSP with a surge of confidence, applied to all the top graduate schools, and is now in a Ph.D. program on a National Science Foundation (NSF) fellowship. The other had no intention of going on. After two weeks, she wanted to become an NSA employee. She would have been a fine one, and still may well be one, but we talked her out of joining us right away. A joint math, computer science major through her junior year, she took all pure math courses her senior year and is now in graduate school in a Ph.D. program on a fellowship.

The 1991 DSP was also very successful. We had more time to canvass the nation systematically, which we did through the good auspisces of the MAA. With the 1990 success, it was easy to recruit top technical directors. They led a larger group of participants, including some 1990 returnees, to complete solutions to three problems and significant results on four others...

The second, broader NSA initiative we now call the NSA Mathematics Education Partnership Program (MEPP). Inspired by the 1987 meetings, our mathematicians, some of whom had been active in educational support projects earlier, initiated, doubled, or redoubled their efforts. NSA volunteers went to high schools to talk on mathematics, cryptology, and other exciting applications of mathematics. As they built up their courage, they dared to venture into the middle and elementary schools, where it was scarier to talk to the students, because they were so young and so small, but where the potential impact was greater. In response to numerous requests from the schools that we visited for a list of talks we were able to give, one mathematician volunteered to produce a brochure listing all the talks all NSA mathematicians were willing to give. He discovered through a nightmare year how difficult it was to prepare such a brochure. But his effort led to a well-defined speakers' bureau with a fixed set of offerings, along with an expressed willingness to prepare customized talks at teacher's requests. The popularity of this program built over the years—in 1991, NSA speakers made 230 forays into the three local counties, often presenting multiple talks. NSA was approached to find volunteers for coaching mathematics teams in high schools, to lead science enrichment programs in elementary and middle schools, and to provide faculty at summer mathematics camps for gifted and talented students. For each program, volunteers were identified and NSA management supported these efforts. At our initiative, our mathematicians presented two three-day workshops to middle and high school teachers on the application of mathematics to real world problems...

After four years of active volunteer activities, a thousand points of light, we have decided that our support of K–12 is important enough to institutionalize it. Last month, Admiral Studeman formally established the MEPP after fifteen senior mathematicians representing all the NSA mathematical

elements prepared a hard-hitting, enthusiastic report urging creation of the office. We will continue to depend on the spirit and enthusiasm of our hundreds of volunteers, but we believe there are benefits to establishing a single contact point and employing a small staff of mathematicians in full-time planning and coordination. At a time of austerity, when we do not have enough mathematicians to tackle the expanding number of problems we face, it takes a sense that educational support is very important to dedicate even three mathematicians to the program. We are also proud of who they are—one senior and two mid-career mathematicians taking two years out from successful careers breaking codes, then to be replaced by other working mathematicians...

Just as in the greater mathematics community, these activities began in controversy at NSA, not the result of concerns of lawyers or agency managers, but concerns of working mathematicians that we should not get involved, that we're not the right people to help solve the problem, that the problems are too hard, that they're beyond our scope, that they're societal problems, that we have a job to do, that we're being paid to break codes, that "real mathematicians don't do K–12." But as we have convinced ourselves that our long-term health is our concern and that we do have something to offer, we have ignored those voices rather than argued with them, and we have really had a wonderful time. The excitement of contributing to the long-term health of our profession and the satisfaction that comes from sharing our excitement about doing mathematics is a real reward that more than makes up for time "away from the job." In the same way that presenting twelve talks in Baltimore is perhaps more important for us than it is for you, these outreach activities that I've described help us understand the importance of belonging to a larger community and continuing to contribute to our profession.

Now that you know we're good guys, you'll be pleased to hear that we're not going out of business. Cryptology remains a vital mission. The world is still a dangerous place, a volatile place. The need for our decision-makers to be as well-informed as possible has not diminished. But I would be less than candid if I did not admit that we are facing more then a little bit of austerity. It has not yet gotten to the point where we have to conduct a bake sale or collect grocery receipts to buy our computers (we do collect grocery receipts for the local schools), but although NSA is a national agency with a national mission, a large part of our mission supports Defense, so we cannot expect to be immune from the draw down taking place in Defense. But the consistent ability of mathematicians to understand and solve the difficult problems we face has encouraged our management, very few of whom are mathematicians, to prioritize the hiring of mathematicians first and foremost...

As an insular NSA cryptologic mathematician, I believe cryptography is a unique subject perfectly suited for the science and art of the mathematician. But can it be all that unique?... [O]ur mathematicians do more than classical cryptology. They have proved indispensable in project areas they might never have been exposed to had we not been bringing on mathematicians for cryptography and cryptanalysis. They provided big breakthroughs needed for our work in communications, engineering, speech research, signals processing, and the design and implementation of powerful, specialized computers. In doing this, they worked closely with engineers, computer scientists, physicists, and linguists. Although at times distinctions in background blurred as scientists worked on common problems, the ability of mathematicians to understand mathematical foundations and employ mathematical analysis has been vital. Appreciation and respect for mathematicians among NSA managers who do not have hands-on experience in cryptanalysis and cryptography comes in part from respect for the cult of the codebreaker but, also, and significantly, in part from the demonstrated usefulness of mathematicians on projects that managers understood quite well but had not realized mathematicians would be so useful on; perhaps did not realize they would be useful at all.

Just as the David committee understood it was naive to expect that the government would discover on its own the need to fund research in mathematics, it is naive to believe we can sit back and have industry discover mathematics. NSA can help a little by sharing the message it has brought here with the captains of industry—it does try to do this, whenever it can, but perhaps it needs to do this more systematically, more deliberately. Perhaps your "power structure" can lobby industry or, further up the pipeline, the business schools, educating them on the value of mathematicians in yet another outreach program. Mathematicians in industry need to convince their management, when they do a fine piece of work, that they have been able to do it not just because they are brilliant but because they are mathematicians. National and state consortiums of employers of mathematicians to support education can add "employment" to their agendas, as I understand the Maryland state coalition has. But without waiting for others, there is much you can begin to do at a "grass roots" level. At a minimum, we need enhanced awareness on the part of research mathematicians of how mathematics is used in industry. We need top research mathematicians to take occasional sabbaticals in industry so that, if for no other reason, they can develop perspectives and contacts that help them be broader in their ability to counsel their students on employment opportunities. We need Ph.D. advisers to keep in touch with their graduates in industry, as well as their graduates in academia, to learn what they're doing as well as how they're doing. We need mathematics departments to be involved in helping undergraduates find summer jobs working with mathematicians in industry that will encourage them to remain mathematicians. We need Ph.D. advisers to care about what permanent jobs in industry their graduates are taking as much as they care about what faculty positions they're taking. We need our mathematicians in industry to be employed in jobs where they can make a difference, well-mentored to maximize the probability that they will.

The Graduate Student Cohort, Doctoral Department Expectations, and Teaching Preparation

Bettye Anne Case and M. Annette Blackwelder

The following reports on a survey conducted by the Committee on Preparation for College Teaching, a joint committee of the AMS, the Mathematical Association of America (MAA), and the Society for Industrial and Applied Mathematics (SIAM), chaired by Bettye Anne Case. Both authors are members of the Department of Mathematics, Florida State University.

Introduction

As requested in 1987 by the presidents of the AMS, MAA, and SIAM, the joint Committee on Preparation for College Teaching was established with the following charge:

> To make recommendations concerning the appropriate preparation of college teachers of mathematics, taking into account the varieties of institutions of higher education, the diversity of the mathematical sciences, the backgrounds and career interests of college students, the impact of computers, and insights from research on student learning.

A description of the committee's early work and recommendations is found in its 1989 First Report [CT]. Finding no existing models that embodied their recommendations, the Committee secured funding from the Fund for the Improvement of Postsecondary Education, U.S. Department of Education, to conduct a survey and to promote adoption of its recommendations. The project currently involves development of programs in eight doctoral departments.* as well as the survey. This article presents findings from the first stage of the survey.

The wider scientific community is concerned that future faculty members be representative of the various U.S. citizen population groups. It is well known that women, and Blacks and Hispanics of both sexes, are underrepresented in the mathematical community relative to their proportion in the population. Annual data continues to show the same pattern of underrepresentation among new doctorates [D]. Further, anecdotal information suggests that persistence through graduate school is lower for underrepresented groups than for white males, and for U.S. citizens than for noncitizens. Because graduate students will supply most of the new entrants to the professoriate, efforts toward change must address underrepresentation within the graduate student population.

*University of Cincinnati, Clemson University, Dartmouth College, University of Delaware, Harvard University, Oregon State University, University of Tennessee, and Washington University.

Description of the Survey and Responses

The Committee's survey was designed to provide information about the race, sex, and citizenship characteristics of the graduate student cohort and about the preparation for future teaching and attitudes about teaching in graduate departments. The survey, formulated with the assistance of the AMS-MAA Data Committee, has two stages. First, a questionnaire was sent to doctoral departments in May 1991 with the Data Committee's Annual Survey of New Doctorates; the results of that survey are presented here. The second stage is a follow-up survey, to be conducted during Spring 1992, to collect information about retention in doctoral programs of the entering 1990-1991 graduate student cohort.

Doctoral departments are divided into six groups [G]. Groups I, II, III, and Va fall within the purview of the Committee's charge and hence were included in the survey. The excellent response rates, shown in Table 1, lend confidence to the data.

TABLE 1
Departmental response rates

Group I	36 of 39
Group II	41 of 43
Group III	65 of 86
Group Va	11 of 16
Total	153 of 184

The data about New Doctorates presented in this report is derived from the Annual AMS-MAA Survey [D] and is presented for comparison purposes.

Sex, Race, and Citizenship Data

The survey sought to classify students into six racial categories: Asian, Pacific Islander; Black; American In-

dian, Eskimo, Aleut; Mexican American, Puerto Rican or other Hispanic; None of the Above; Unknown. There were four classifications for citizenship: U.S.; Canada; Other; Unknown. Each department was asked to provide this information for women students and for men students who first entered the department's program between June 1, 1990 and May 31, 1991, and whose highest degree was a bachelor's. The departments also provided race and citizenship information for students entering in that time interval with a master's degree, and for all full-time graduate students enrolled. Findings about graduate students will provide a baseline for retention data to be collected in the second stage of the survey.

Academic Expectations and the Teaching Climate

The survey included questions about the expected preparation of incoming graduate students and about preliminary and qualifying examinations. Information was also collected about teaching duties assigned to graduate students in the department, preparation for those duties, and any additional activities in preparation for a future professorial role. Questions about teaching awards and the importance of teaching qualifications in hiring decisions were included as indicators of the importance attached to teaching and the teaching climate in departments.

U.S. Citizen and Underrepresented Population Groups among Graduate Students and New Doctorates

Education Level of Doctoral Department Entrants

Most entrants—74% of the 2,805 reported by surveyed departments—into doctoral programs hold only the equivalent of a U.S. bachelor's degree. Of the U.S. citizens entering doctoral programs, 83% (of 1,693 reported) hold only a bachelor's degree. For Group I departments, this percentage is higher still, 88%. The remainder of reported entrants hold the equivalent of a U.S. master's degree.

TABLE 2
Percentages of doctoral department entrants holding only a bachelor's degree

	U.S. Citizens	Non-U.S. Citizens	All Entrants
Group I	88%	67%	79%
Group II	81%	53%	70%
Group III	81%	55%	73%
Group Va	74%	58%	68%
All Dept. Groups	83%	59%	74%

U.S. Citizens

The percentage of U.S. citizens among new doctorates has been stable for several years around 45% [D], but nearly 70% of entrants to doctoral departments with only a bachelor's degree are U.S. citizens. Table 3 shows that 62% of the Doctoral Department Entrants are U.S. citizens—a fairly high percentage compared to the 56% among All Graduate Students and the 45% among New Doctorates. Although these numbers may appear to promise a larger proportion of U.S. citizens among future crops of doctorates, the situation is not so simple. For example, anecdotal reports from some departments indicate that the proportion of U.S. citizens who persist to the doctorate is significantly lower than that of non-citizens. Retention will be investigated in the second stage of the survey.

(It should be noted that the numbers for All Graduate Students include, for the reporting departments, their 1991 doctoral recipients. The cohorts of lines 1 and 2 do not overlap and are combined for line 3; also, cohorts of lines 3 and 5 are included in that of line 4.)

TABLE 3
Percentage of U.S. citizens in Groups I, II, III, and Va among:

1. 1990–1991, Doctoral Department Entrants with Bachelor's Degree	69%
2. 1990–1991, Doctoral Department Entrants with Master's Degree	41%
3. 1990–1991, Doctoral Department Entrants with either a Bachelor's Degree or a Master's Degree	62%
4. 1990–1991, All Graduate Students	56%
5. 1991 New Doctorates	45%

Women among U.S. Citizens

With respect to their proportion in the workforce, women are underrepresented among mathematical scientists of all types. Statistical and anecdotal information about this underrepresentation is well known and is collected in several papers and their references in the *Notices*, September 1991 [B, Ha, He, J, L, S], as well as in the previously cited statistical reports [D].

This underrepresentation is strongly exhibited among faculty and students in the mathematics doctoral departments comprising the population of this survey—Groups I, II, III, and Va. The Annual AMS-MAA Surveys report for Groups I-V that 24% of the U.S. citizen new doctorates are women. However, within Group IV, the analogous figure is 38%, and within Group Vb it is 44%. Removing these department groups from the data results in a drop to 20%, as seen in line 4 of Table 4 (see next page). (Note that there is no overlap between lines 1 and 2, and that lines 1, 2, and 4 are included in line 3.)

TABLE 4
Percentage of women among U.S. citizens Groups I, II, II, and Va

1. 1990–1991, Doctoral Department Entrants with Bachelor's Degree	35%
2. 1990–1991, Doctoral Department Entrants with Master's Degree	31%
3. 1990–1991, All Graduate Students	31%
4. 1991 New Doctorates	20%

As with the citizenship data, the numbers in Table 4 might be taken to predict eventual increases in the percentages of women among U.S. citizen doctorates and faculty. But, again, anecdotal information—combined with the stability of the percentage of women U.S. citizens among new doctorates for a number of years—invites caution. For whatever reason, the proportion of women who persist to the doctorate is significantly lower than that of men. The second stage of the survey will address the question: "What percentage of the entering 1990-1991 students persisted to a third year of graduate study or have received a master's degree?" For those who obtained a master's degree and then left a doctoral department, the more subtle questions about "intent" (to complete only a master's or to go on for the doctorate) versus leaving with the master's degree as a "consolation prize" will not be answered.

Underrepresented Minority Groups

Some ethnic minority groups comprise a smaller proportion among mathematicians and mathematics graduate students than in the general population; this pattern remains even when one looks at women only or men only. Table 5 combines the data from departmental Groups I, II, III, and Va and gives both reported numbers and percentages for three such U.S. citizen minority groups. Table 6 reports Groups I and II data. Even allowing for nonreporting departments, the numbers are very small: out of a total of 4677 doctoral students in 143 departments, only 344 are members of these minority groups.

Because the numbers are so small, one must be wary of generalizations, but a few comments can be made. The significantly higher proportion of Hispanics among "all" graduate students than among "entering" graduate students stands out. (The weight of the Hispanic data in the combined data for these minorities causes the same effect in the Totals.) This pattern—which is also found when the data is examined by departmental Group and is especially marked in Group III—does not have favorable implications about the number of Hispanics receiving doctorates in the future. Another unexpected note: For the applied departments of Group Va, the percentage of "entering" Black graduate students is significantly higher than for "all" Black graduate students; perhaps good recruiting will lead eventually to more doctorates awarded to Blacks.

TABLE 5
Numbers and percentages from underrepresented minorities among U.S. citizen graduate students

	Entering Graduate Students with Bachelor's Degree Only	Entering Graduate Students with Master's Degree	All Entering and Continuing Graduate Students	New Doctorates
Black				
Number	49	14	134	8
Column %	3.5%	4.7%	2.9%	2.3%
American Indian, Eskimo, Aleut				
Number	3	2	11	2
Column %	0.2%	0.7%	0.2%	0.6%
Mexican American, Puerto Rican or Other Hispanic				
Number	24	6	199	4
Column %	1.7%	2.0%	4.3%	1.2%
Total of Above				
Number	76	22	344	14
Column %	5.5%	7.4%	7.4%	4.1%
Usable Responses	146 of 184	146 of 184	143 of 184	173 of 184
Reported U.S. Citizens of Known Race	1384	296	4677	343

It is interesting to determine whether the proportions of men and women for the minority groups follows that in each of the graduate student cohorts. For Blacks, the breakdown of men and women is very close to that for the entire U.S. citizen cohorts, although in departmental Groups I and II a larger percentage of black graduate students entering with a bachelor's degree are women—50%. Also, Eskimos-Indians have a higher percentage of women in each of the cohorts; six men and five women were reported among All Graduate Students and three women and two men among Entering Graduate Students. For Hispanics, the proportion of women entrants holding only bachelor's degrees follows that predicted by the population, but otherwise there are proportionately fewer women among Hispanics than generally. There were two Hispanics reported among new doctorates, one man and one woman.

TABLE 6
Underrepresented minorities among U.S. citizen graduate students in Groups I and II

	Entering Graduate Students with Bachelor's Degree Only		All Entering and Continuing Graduate Students	
	Group I	Group II	Group I	Group II
Black				
Number	8	17	31	42
Column %	2.0%	4.2%	1.9%	3.2%
American Indian, Eskimo, Aleut				
Number	0	2	1	6
Column %	0.0%	0.5%	0.1%	0.5%
Mexican American, Puerto Rican or Other Hispanic				
Number	7	7	56	30
Column %	1.8%	1.7%	3.5%	2.3%
Total of Above				
Number	15	26	88	78
Column %	3.8%	6.4%	5.4%	5.9%
Usable Responses	33 of 39	41 of 43	34 of 39	39 of 43
Reported U.S. Citizens of Known Race	398	404	1616	1319

Entrance and Continuation Expectations and Characteristics Related to Teaching

One portion of the survey was devoted to questions about the preparation expected of entering graduate students, continuation requirements for students, preparation for teaching, and the teaching climate in departments.

Entrance Requirements

Entrance requirements or recommendations for upper division undergraduate courses are far from universal. The survey asked departments whether or not certain courses were "strongly recommended" as background for entering graduate students, and whether these courses could be made up in graduate school. In some cases, the "strongly recommended" courses were actually required for entrance. Several departments indicated that graduate students are accepted only as master's candidates until deficiencies in background are made up. Results about the categories of courses surveyed are indicated below.

Real Analysis. Real Analysis I (Advanced Calculus I) is "strongly recommended" in 96% of doctoral mathematics departments overall, with 80% reporting they will admit students and let them make up the course after enrolling. (The corresponding percentages for Real Analysis II are 91% and 86%.) It is interesting that *all* of the Group Va (applied) departments responded that Real Analysis I is "strongly recommended," and only 70% will allow makeup after entrance to graduate school.

Modern Algebra. Predictably, few Group Va departments "strongly recommend" Modern Algebra I, but 93% of Group I, II, and III departments do. This percentage drops to 73% when it comes to Modern Algebra II; makeup is allowed in 90% of Group I, II, and III departments combined, but by only 81% of Group I departments.

Probability and Statistics. For Groups I, II, and III only 21% list Probability and Statistics as "strongly recommended," and in Group I only one department does so. However, in Group Va there is stronger positive response: 64% of the departments indicate "strongly recommended." Probability and Statistics have been included repeatedly for many years in professional society curriculum recommendations [CU] as essential in undergraduate major programs. The Committee on Preparation for College Teaching feels that some study of Probability and Statistics at the upper division undergraduate level is necessary for the broad foundation in mathematical topics important to undergraduate teachers [CT, p. 1346].

Additional Courses. Answers reflect differences between "pure" and "applied" programs. Under the category *Applied Mathematics*, 75% of Group Va departments indicate "strongly recommended courses"; only 23% of the other departments mark this category. The *Applied Mathematics* courses most often listed are Numerical Analysis and Partial Differential Equations. These courses and other courses in the general area of applied mathematics were sometimes listed under *Other*.

The courses listed in the *Other* category most frequently as "strongly recommended" are Topology and Complex Variables (Complex Variables was also sometimes listed under *Applied Mathematics*). Linear Algebra and Ordinary Differential Equations were reported by a number of departments, and this confusion led to a change in the second stage of the survey, in which the ambiguous term "upper division courses" will be replaced by "courses coming after single and multivariable calculus." There will also be provision for a separate listing when two programs within a department have different entrance expectations.

The Preliminary Examination

As with entrance expectations, the areas examined may differ by choice of program within a department; on the examinations, there may or may not be a choice of topics within a program. Again, responses found in this first stage of the survey will help to clarify the questions for the second

stage. Respondents were asked to say whether the format was oral or written, indicate when the examination needs to be completed, and describe the content of the examination.

The usable responses on this item were high. Here are some interesting highlights.

- Only two departments did not report a preliminary examination. (One said there was none while one did not answer the item.)
- A "written only" examination is more common in Groups I and III but in Groups II and Va both a written *and* an oral examination are the more common testing requirement.
- The examination is typically taken in the second or third graduate year.
- Generally, on the written portion of the examination, at least two areas are included, with three or four areas most typical.
- In about 60% of the departments, some choice of testing area is available to the students.

Content of preliminary examinations vary, because they appropriately reflect the research interests of the faculty. Therefore, it is not possible to list a set of nonoverlapping areas, topics, or concentrations from which departmental testing areas are taken. Samples of responses indicate in some cases student choice of topic:

- all of complex analysis, real analysis, topology, analysis on manifolds, linear algebra, and abstract algebra;
- three from algebra, applied mathematics, complex analysis, real analysis, or topology;
- from a department with two doctoral programs: Pure Mathematics: algebra, real and complex analysis, topology; Applied Mathematics: analysis, numerical analysis, PDE and numerical PDE, fluid dynamics, and another topic chosen from research area;
- two from analysis, algebra, linear algebra, combinatorics, or probability.

Mathematical Breadth

As indicated earlier in the discussion about undergraduate mathematical preparation, the Committee on Preparation for College Teaching considers it desirable that graduate students become familiar with a wide range of mathematical topics at the advanced undergraduate level:

> Graduate education should not be limited to specialization... Breadth of knowledge forms the background for teaching a variety of courses, for advising students, and for recognizing different kinds of talent in mathematics. Further, the increasing interrelation of ideas at advanced levels of research makes it imprudent to be ignorant concerning major branches of mathematics. [CT, p. 1344]

Accomplishing this goal is a joint responsibility of undergraduate and graduate departments [CU, Case 1991, pp. 4, 18, 20] and may not be specifically reflected in doctoral requirements. To provide a basis for later Committee recommendations, the survey attempted to ascertain the extent to which doctoral programs appear to encourage mathematical breadth. Answers indicate that:

- a number of departments consider that their preliminary or qualifying examinations, over several areas, accomplish this goal;
- few departments require a minor outside of the department—even in applied mathematics only 42% do so; and
- 80% believe "breadth" is reflected through their areas of required courses.

Preparation and Duties of Teaching Assistants

The Committee does not consider "TA training" sufficient preparation for college teaching, and such training is, in fact, the primary concern of another committee. Nevertheless, the Committee does see TA training as an important part of the total preparation. In 42% of Group Va (applied) departments, graduate students are not involved in teaching at all, or else have responsibility only for assisting professorial faculty and grading in upper division courses. Various TA training mechanisms were listed, and the most interesting findings concern orientation programs (Table 7), English language training (Table 8), and faculty observations of TAs (Table 9). Data from a previously published survey [C] about departments in Groups I, II, and III indicates an increase in all three activities since the mid-1980s.

Table 7
Percentage of departments reporting teaching assistant orientation programs

	Group I	Group II	Group III
1991	94%	95%	85%
1987 [C, p. 37]	79%	86%	76%
1985 [C, p. 37]	66%	88%	64%

Table 8
Percentage of departments reporting English language training

	Group I	Group II	Group III
1991	94%	90%	75%
1987 [C, p. 36]	72%	70%	71%
1985 [C, p. 36]	60%	71%	68%

Table 9
Percentage of departments reporting faculty observations of teaching assistants

	Group I	Group II	Group III
1991	81%	83%	72%
1987 [C, p. 38]	62%	67%	67%

Student evaluations are common, but other components of TA training and supervision are less frequently used. Although peer observations by other graduate students have been used and considered effective for a number of years [C, p. 36], the reported incidence is small. Overall, 28% of programs reported videotaping of classes with incidence in Groups I and II at 40%. Videotaping of mock classroom sessions is thought to be much higher. (For example, non-specific "Uses videotape" queries in 1985 and 1987 were answered positively in Groups I, II, and III by over half the reporting departments.)

Teaching Activities of Graduate Students

Individuals typically teach their own classes, with varying levels of supervision, in departments other than the Group Va (applied) departments. Duties of graduate students almost universally include grading and student contact in recitation or tutorial sections, if not in classes with full responsibility. Over half of the departments indicated that graduate students occasionally act as substitute teachers for regular faculty. Although graduate students often teach courses in which department-wide examinations are used, 73% (excluding Group Va) nevertheless report that their graduate students gain experience in the designing of examinations.

Additional Items Regarding Teaching

The Committee recommends that all third- and fourth-year graduate students be involved in "systematic attention to issues and excellence in the teaching of mathematics" [CT, p. 1345]. The grant to the Committee through the Fund for the Improvement of Postsecondary Education provides for pilot programs to design "professional seminars" and other such mechanisms. These activities would target advanced graduate students and are in addition to TA training, which focuses primarily on an immediate concern for competent teaching in the department.

The survey asked departments to list additional aspects of their program that prepare advanced graduate students for undergraduate teaching, and there were few responses: 92% of departments listed nothing. Of the few responses, involvement in seminars in their mathematical specialty was mentioned most frequently. Several others mentioned the opportunity to teach sections of classes beyond single-variable calculus with full classroom responsibility. One department responded that students are encouraged to take a course in the Science Teaching Department.

Table 10
Departments making teaching awards

	Group I	Group II	Group III	Group Va
TA awards	50%	66%	31%	none
Faculty awards	17%	36%	17%	13%

The last two items of the survey were included to provide some indication of the departmental climate regarding teaching or attitude toward the importance of teaching (Table 10). One item concerned departmental teaching awards; since there are university- or college-wide awards programs that may not have been reported in these responses, the second stage of the survey will ask about such awards.

The last item on the survey was intended to provide some indication about the importance the departments attached to teaching activities. The departments were asked: "In the view of your department chair, how important was evidence of teaching preparation and experience during graduate school in the decisions which led to appointment of entry-level assistant professors during the last three years?"

A scale from 1 (Not important) through 5 (Very important) was provided. The weighted mean answer was 3.5 with the responses by Groups I, II, III, and Va, respectively, 3.1, 3.4, 3.8, and 2.9.

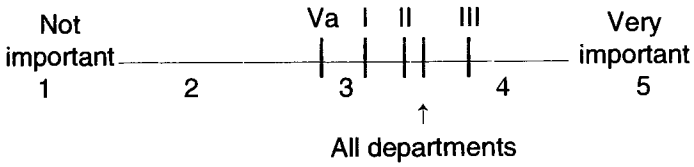


Figure 1. Importance of teaching in hiring, by department groups

References

[B] Lynne Billard, "The Past, Present, and Future of Academic Women in the Mathematical Sciences," *Notices of the AMS* **38**:7 (September 1991) pp. 707–714.

[BR] William G. Bowen and Neil L. Rudenstine, *In Pursuit of the PhD*, Princeton University Press, 1992.

[C] Bettye Anne Case, Editor, *Keys to Improved Instruction by Teaching Assistants and Part-Time Instructors*, MAA Notes 11, 1989, Mathematical Association of America.

[CT] "How Should Mathematicians Prepare for College Teaching?" *Notices of the AMS* **36**:10 (December 1989) pp. 1344–1346.

[CU] CUPM 1991: The Undergraduate Major in the Mathematical Sciences (Bettye Anne Case, Chair, CUPM Subcommittee). To be included in *Heeding the Call for Change*, MAA, to appear 1992. CUPM 1981: Recommendations for a General Mathematical Sciences Program (Alan Tucker, Chair, CUPM Panel). Washington, DC: MAA.

[D] All of the following Annual AMS-MAA Survey reports appear in *Notices of the AMS*. Donald E. McClure: 1991 First Report, **38**:9, (November 1991) pp. 1086–1122; 1990 Second Report, **38**:5 (May/June 1991) pp. 411–419; 1990 First Report, **37**:9 (November 1990) pp. 1217–1250. Edward A. Connors: 1989 Second Report, **37**:6 July/August 1990) pp. 658–665; 1989 First Report, **36**:9 (November 1989) pp. 1155–1188.

[G] **Groups I and II** include the leading departments of mathematics in the U.S. according to the 1982 Assessment of Research-Doctorate Programs conducted by the Conference Board of Associated Research Councils in which departments were rated according to the quality of their graduate faculty. **Group I** is composed of 39 U.S. departments with scores in the 3.0–5.0 range. **Group II** is composed of 43 U.S. departments with scores in the 2.0–2.9 range. **Group III** contains the remaining U.S. departments of mathematics reporting a doctoral program. **Group IV** contains U.S. departments (or programs) of statistics, biostatistics, and biometrics reporting a doctoral program. **Group V** contains U.S. departments (or programs) in applied mathematics/applied science, operations research and management science which report a

doctoral program. **Group Va** is applied mathematics/applied science; **Group Vb** is operations research and management science. [These findings were published in *An Assessment of Research-Doctorate Programs in the United States: Mathematical and Physical Sciences*, edited by Lyle V. Jones, Gardner Lindzey, and Porter E. Coggeshall, National Academy Press, Washington, D.C., 1982. The information on mathematics, statistics, and computer science was presented in digest form, *Notices of the AMS* **30**:3 (April 1983) pp. 257–267, and an analysis of the above classifications was given in *Notices* **30**:4 (June 1983) pp. 392–393. Also see *Notices* **35**:4 (April 1988) pp. 532–533.

[Ha] Jenny Harrison, "The Escher Staircase," *Notices of the AMS* **38**:7 (September 1991) pp. 730–734.

[He] Claudia Henrion, "Merging and Emerging Lives: Women in Mathematics," *Notices of the AMS* **38**:7 (September 1991) pp. 724–729.

[J] Allyn Jackson, "Top Producers of Women Mathematics Doctorates," *Notices of the AMS* **38**:7 (September 1991) pp. 715–719.

[L] D.J. Lewis, "Mathematics and Women: The Undergraduate School and Pipeline," *Notices of the AMS* **38**:7 (September 1991) pp. 721–723.

[S] Alice T. Schafer, "Mathematics and Women: Perspectives and Pro- gress," *Notices of the AMS* **38**:7 (September 1991) pp. 735–737.

Data Analysis and Presentation: In addition to the AMS-MAA Data Committee assistance, the survey forms were prepared, distributed, and collection coordinated by Monica Foulkes and the AMS staff. Allyn Jackson of the AMS staff provided helpful editorial assistance. Technical support and other assistance was provided by the Department of Mathematics, Florida State University, and special thanks go to Melissa E Smith, the department's Senior Art/Publication Production Specialist. The research was partially supported by P116B00184, Comprehensive Fund, FIPSE.

Support for Mathematics Departments and Federal Funding

AMS Committee on Science Policy Examines Issues Confronting the Community

Picture this scenario: A large state university faces deep budget cuts. Looking around for ways to save money, the university administration concludes that the mathematics department's main role is to teach undergraduates. So the administration tells the department to discontinue its graduate program, double the teaching load of the faculty, and hire part-timers to take up any slack. Where could the department turn for help? Are there any standards for the average teaching load of mathematics faculty? Is there a position statement on using part-time faculty? Does there exist a broad "mission" for mathematics departments that makes the case for the importance of research and scholarship to the vitality of the department?

Although this is an extreme example, many departments are already facing these kinds of problems on a smaller scale. The AMS may seem to be the likeliest place to seek assistance, but, as William James Lewis of the University of Nebraska notes, the Society is entirely unprepared to help with these kinds of problems. Lewis made his points during a meeting of the AMS Committee on Science Policy (CSP), held April 4, 1992 in Chicago. The Committee's discussions for the most part were motivated by declining resources for mathematics, be they from academic institutions or from the federal government. Adding an urgent tone to the discussion were such problems as the poor job market in mathematics, flat funding in the National Science Foundation (NSF) budget request for undirected research in mathematics, and widespread budget crises in academia.

Departmental Woes

During the discussion about academic support for mathematics, Lewis said that the 1990s will be a time for reduced resources for higher education. Even Yale University has had to consolidate its departments because of budget cuts, and, Lewis remarked, "If Yale is cutting programs, then everyone is." In this climate, mathematics departments could be hit hard with reductions in numbers of faculty, increased teaching loads, and cutbacks in graduate programs. In addition, mathematics departments are often seen very differently by nonmathematicians on campus than they are by mathematicians. For example, the size of mathematics departments tends to be driven by the number of students taught, while the size of, say, chemistry departments tends to be driven by research needs. Mathematics research is merely "tolerated" on many campuses, he said.

Bolstering this point, Committee member Michael C. Reed of Duke University noted that mathematicians like to talk about how valuable mathematics is to other areas of science, but, if such claims were true, "why aren't chemistry and physics beating on the dean's door to get more faculty positions in mathematics?" The fact is, he said, on most campuses there are few intellectual connections between mathematics and other sciences. In addition, "mathematics is not perceived to be on the cutting edge of the most interesting research opportunities in the universities," Reed asserted. Provosts and deans see the most important science with the best funding opportunities coming out of interdisciplinary research, which has not been the strong suit of many mathematics departments. "So I think our political position in the universities is actually worse than we think," he remarked, and, were it not for teaching, mathematics departments would be much smaller than they are today. He suggested the CSP recommend that departments devote 10% of their resources to technology transfer.

Such a recommendation would represent a fairly radical shift in how the AMS has traditionally operated. Should the AMS play a leadership role in stimulating change in departments? Should it promulgate standards for department teaching loads, class size, faculty size, resources, equipment, and so on? (For example, the Mathematical Association of America has a committee that has produced a draft report on "guidelines" for undergraduate programs in mathematics.) Such questions lead to the idea of accreditation, often a powerful bargaining chip in negotiations with university administrations. One Committee member noted that when the chemistry department at his university told the administration that the American Chemical Society required them to offer certain courses, the administration forked over the money for the courses without a peep of protest. On the other hand, many react negatively to the prospect of the AMS telling departments what to do, how to teach, or what courses to offer. Some on the CSP foresaw the AMS turning into "Big Brother," watching over departments to make sure they complied with a generic set of standards.

As Lewis pointed out, a "one size fits all" approach wouldn't work, given the diversity of educational institu-

tions and departments. But perhaps general agreement could be reached on broad outlines for departmental standards and responsibilities in teaching, research, outreach to other disciplines, curriculum development, and so on. However, Lewis pointed out that before such matters could be addressed, there needs to be discussion about and consensus on just who the AMS is trying to serve. Is it trying to serve its current membership, or is it trying to serve the profession more broadly?

These issues will be examined in the coming months by a CSP task force, chaired by Lewis, on academic support of mathematics and connections of mathematics research to education. This is one of four task forces recently convened by the CSP to provide more focused attention to specific issues growing out of the AMS strategic plan and previous CSP discussions.

The Washington Presence

One of the other task forces, chaired by Eric M. Friedlander of Northwestern University, will look at federal support and public awareness of mathematics. The CSP discussed a number of ideas for strengthening what's come to be known as the "Washington presence" for mathematics. One idea was to establish mechanisms by which the Society could, on short notice, get advice on policy matters in which a quick response is needed. The need for such a group has arisen a number of times in recent years, most recently this fall, when the staff of a Congressional subcommittee asked the AMS for input on a discussion of priority setting in science funding. (The Society's response was a report, which appeared in the *Notices*, February 1992, pages 101–110). The CSP also discussed the possibility of having an energetic person of high mathematical stature with good political connections serve as a representative for mathematics in the federal policy scene.

A perennial problem with the Washington presence is getting mathematicians of high stature to work in Washington. Would the "mathematics advocate" position be paid, or volunteer? If it's volunteer, then there's a limit to what can be expected. And if it's paid, then it's unlikely any mathematician of the proper caliber would leave research to take the job. It hasn't been easy to get top mathematicians to take positions in Washington, either in the research funding agencies or in advocacy positions.

Another difficulty with the Washington presence is that several different groups are involved—the CSP, the Joint Policy Board for Mathematics (JPBM), the NSF's Advisory Committee for the Mathematical Sciences, the Board on Mathematical Sciences (BMS), the Conference Board of the Mathematical Sciences (CBMS), among others. These groups don't always communicate as effectively as they might, so the suggestion was made that they all meet and exchange information about what they're doing. But would yet another meeting be effective? Reed thinks not. "Talk is not cheap," he said, pointing to the nontrivial expense of such a large meeting. "We all think that if we could meet and decide what's good, it will happen," he said, but it doesn't work that way. In addition, he disagreed that there's a lack of communication among these groups—last year, he was simultaneously chair of the CSP and of the Advisory Committee, and also served on JPBM. He made a point of insuring that the various groups knew what the others were doing. So what's wrong? "We have to face the fact that those who are funded are happy," he said, so it's hard to get the community seriously discussing science policy.

Another area that Friedlander would like his task force to look at is support for mathematics. He would like to see various levels of fixed-rate grants, perhaps senior, junior, and travel awards. Such dollar-stretching tactics are especially appealing in light of the news that next year's budget request for the NSF contains no increase for undirected research in mathematics (see the Washington Outlook column in this issue of the *Notices* and also "The National Science Foundation Budget Request for Fiscal Year 1993," the *Notices*, April 1992, pages 286–297). However, they also raise the question of whether mathematicians are selling themselves cheap by volunteering for a pay cut. Friedlander said he believes that mathematics is sufficiently different from other sciences to warrant a different mode of funding that allows for expanding the base of researchers supported. The pros and cons of such grant mechanisms have been debated for years, but there has been no change, partly because agencies like NSF are not wild about the idea and partly because no one has seriously made a persuasive case for it. This last matter was raised as the CSP discussed how a position paper on this issue might be produced. Again, such a document would represent a new way of operating for the AMS—typically the Society has taken a passive attitude toward such thorny issues.

A National Postdoc Program

Another topic that generated interest at the CSP meeting was a proposal for the AMS to take the lead in developing an expanded program of postdoctoral appointments. The idea would be to provide a variety of paths by which new doctorates could continue their education and professional development, whether their primary interest is mathematics research, education, technology transfer, interdisciplinary research, or other directions. The proposal suggests a fifty-fifty cost-sharing arrangement between federal agencies and academic institutions, as well as aggressive development of postdoctoral research opportunities in government laboratories and industry. The role of the AMS would be primarily as an advocate for getting the program established.

The proposal grew out of dicsussions of the CSP over the last few years and the development reports "Educating Mathematical Scientists" from the BMS and "Graduate Education in Transition" by the CBMS (both reports are covered in articles in this issue of the *Notices*). There is a strong feeling that more structured postdoctoral training is needed to allow new doctorates to make the crucial transition from graduate student to professional mathematician. A number of concerns were raised about the proposal during the CSP meeting—some feared it would strain already

limited federal funds for research, some wondered if such a large number of postdoctorates is necessary, and some were wary of departments using these positions to replace tenure-track lines. In addition, some worried about the proposal's suggestion that departments shift funds for teaching assistants to these kinds of postdoctoral appointments, a strategy that could bode ill for graduate student support in some departments.

These criticisms notwithstanding, the CSP on the whole felt that the basic philosophy behind the proposal—providing a variety of paths by which new doctorates can pursue further education and training—was commendable. There appeared to be a clear consensus that the proposal be rewritten to take into account the concerns of the Committee. A revised version of the proposal is to be circulated at the next CSP meeting in Washington in September.

In addition to the task forces chaired by Lewis and Friedlander, the CSP has appointed two others. One, chaired by Reed, will focus on corporate support of mathematics and the connections of mathematics research to the uses of mathematics. The other, chaired by Linda Preiss Rothschild of the University of California at San Diego, will look at the science policy aspects of core AMS activities, such as meetings and publications, and at the Society's international role. The focal areas for the task forces grew out of the AMS operational plan and will form the basis for a comprehensive "science policy strategy" that the CSP will be developing during the coming months.

The CSP welcomes comments and suggestions from the mathematical sciences community. They may be sent to the chair of the Committee, Frank W. Warner III, Department of Mathematics, University of Pennsylvania, Philadelphia, PA 19104-6395.

Allyn Jackson
Staff Writer

Doctoral Degrees Conferred 1990–1991

Supplementary List

The following list supplements the list of thesis titles published in the November 1991 issue of the *Notices*. Each entry contains the name of the recipient and the thesis title. The number in parentheses following the name of the university is the number of degrees granted by the department.

CALIFORNIA

University of California, Berkeley (13)

STATISTICS

Chang, Yu-Lin, *Local behavior of mixtures of normal distributions.*

Chow, Edmond Dean, *Stochastic minimum distance tests for censored data.*

Jin, Kun, *Empirical smoothing parameter selection in adaptive estimation.*

Kooperberg, Charles Louis, *Smoothing images, curves, and densities.*

Lee, Sang Ho, *Some statistical aspects of gradient gel electrophoresis.*

Lorentziadis, Paragotis Loudovikou, *Forecasts in oil exploration and prospect evaluation for financial decisions: a semiparametric approach.*

Meester, Ludolf Erwin, *Contributions to the theory and applications of statistics.*

Perman, Mihail, *Random discrete distributions derived from subordinators.*

Pfannes, Othimar, *Edgeworth expansions for T-statistics based on expected and observed information.*

Sugahara, Clyde Nobuo, *Some bootstrap methods for finite state Markov chains.*

Wang, Xiaobao, *On the estimation of trigonometric and related signals.*

Wang, Yonghua, *On efficient estimation under equation constraints.*

Wu, Colin Ou, *Asymptotic efficient robust estimates in some semiparametric models.*

University of California, Santa Cruz (1)

MATHEMATICS

Libby, Richard, *Asymptotics of determinants and eigenvalue distributions for Toeplitz matrices associated with certain discontinuous symbols.*

COLORADO

University of Colorado, Boulder (10)

MATHEMATICS

Barnett, Janet, *Effect of Cohen and random reals on certain combinatorial consequences of Martin's Axiom.*

Bekkalt, Mohammed, *On superatomic Boolean algebras.*

Bricher, Stephen, *Blow up patterns for semilinear heat equations via center manifold theory.*

Caveny, Deanna, *Independence results for certain classes of U-numbers.*

Darby, Carl, *Countable Ramsey games and partition relations.*

Limber, Mark, *Quasi interiors of convex sets and applications to optimization.*

Martin, John, *A formulation of the limitation of size theory using ideals and representing small collections as individuals.*

Shulman, Bonnie Jean, *Wave propagation through inhomogeneous media with applications to solar coronal loops.*

Sobh, Nahil, *Preconditional conjugate gradient and finite element methods for massively data—parallel architectures.*

Wyshinski, Nancy, *Asymptotic properties of polynomials satisfying three-term recurrence relations.*

University of Northern Colorado (4)

MATHEMATICS AND APPLIED STATISTICS

Brophy, Richard, *Development of aberrancy indices based on pattern-response analysis.*

Teng, Pao-Sheng, *A study of the sampling distribution of the Kurtosis and confidence limits determined using the jackknife and bootstrapping procedures.*

Yen, Chen-E, *A factor analytic study of selected factors related to mathematics anxiety among eighth grade students in Taiwan, Republic of China, and comparison to a U.S. population.*

Zelle, Claire, *Multivariate analysis of selected classification data in market research.*

INDIANA

Purdue University (9)

INDUSTRIAL ENGINEERING

Banerjee, Prashant, *A manufacturing layout reasoning architecture based on an automated integration of linear objective optimization and non-linear qualitative analysis.*

Chandra, Jayanta, *Optimization-based opportunistic part dispatching in flexible manufacturing systems.*

Cook, John R., *Cognitive and social factors in the design of computerized jobs.*

Foley, James P., *The effect of law and training on all-terrain vehicle riders' safety-related behaviors.*

Heim, Joseph, *Integration of distributed heterogeneous simulation models for design of manufacturing systems.*

Lee, Ching-En Charles, *An integrated methodology for the analysis and design of cellular flexible assembly systems.*

Lin, Alan, *Automated assembly planning for three-dimensional mechanical products.*

Papantonopoulos, Sotiris A., *A decision model for cognitive task allocation.*

Wang, Ming T., *A geometric reasoning methodology for manufacturing feature extraction from a 3-D CAD model.*

MICHIGAN

Western Michigan University (8)

MATHEMATICS AND STATISTICS

Abay Asmerom, Ghidewon, *Graph products and covering graph imbeddings.*

Craft, David L., *Surgical techniques for constructing minimal orientable imbeddings of joins and compositions of graphs.*

Hevia, Hector, *A representation of chemical reactions by labeled graphs.*

Jarrett, Elzbieta, *Transformations of graphs and digraphs.*

Mull, Bruce P., *Enumerating the orientable 2-cell imbeddings of complete n-partite graphs.*

Nouh, Jamal, *Improving network reliability.*

Sprague, Thomas B., *Shape preserving piecewise cubic interpolation.*

Tian, Songlin, *On distance in graphs and digraphs.*

NEW JERSEY

Stevens Institute of Technology (3)

PURE AND APPLIED MATHEMATICS

Berry, Kevin A., *Riemann surfaces, transcendental functions and combinatorial group theory.*

Kolodzieski, Scott J., *Delta-pseudo orbit shadowing in a family of trapezoidal maps.*

Lasser, Lewis L., *A degree condition for Hamiltonian cycles in t-tough graphs with* $t > 1$.

TEXAS

Texas A&M University (4)

MATHEMATICS

Dai, Xingde, *Norm closed bimodules of nest algebras.*

He, Tian-Xiao, *C^1 quadratic finite element analysis and its applications.*

Li, Xin, *Hankel approximation and its applications.*

Sepanski, Steven J., *Normalization methods in the Bootstrap Central Limit Theorem.*

WASHINGTON

University of Washington (3)

APPLIED MATHEMATICS

Pernarowski, Mark, *The mathematical analysis of bursting electrical activity in pancreatic beta cells.*

Siems, Steven, *Numerical simulations of cloud-top entrainment instability and related experiments.*

Zhang, Roxin, *Problems of hierarchical optimization: nonsmoothness and analysis of solutions.*

Doctoral Degrees Conferred 1989–1990

Supplementary List

The following list supplements the list of thesis titles published in the November 1990 *Notices*, pages 1231–1250, the May/June 1991 *Notices*, page 419, and the November 1991 *Notices*, pages 1121-1122.

CANADA

University of Alberta (1)

MATHEMATICS

Skantharjah, M., *Amenable hypergroups.*

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
Providence, RI 02940

or electronically to notices@math.ams.com

Some Comments on Education

Richard Askey
University of Wisconsin-Madison

At the joint summer meeting, Pi Mu Epsilon has a program. Undergraduate students are there to talk about their research. In addition to these talks, there is a reception, a banquet, and an hour talk. For ten years I have gone to the banquet and reception to talk with some of the students. Last summer at Orono I had two conversations which tell a lot about the current situation in mathematics education.

At the reception, I was talking to three students from a small liberal arts college who were there to talk on their research. After listening to descriptions of their work, I asked them a mathematics question. I was going to use a new calculus book in the fall semester and, as often happens, there was a mistake in a problem. I wanted to see how these students would react to a problem that does not have an answer, so I asked how they would attack the following problem.

Find $f(x)$ which satisfies

$$\int_0^x f(t)\,dt = \frac{1}{1+x} \tag{1}$$

The first suggestion was to evaluate the integral. Since I did not know how they would do that, I asked. They said the value was

$$f'(x) - f'(0).$$

After talking about the fundamental theorem of calculus, they finally realized they should differentiate. Then I asked what they got. Their response surprised me again. They said

$$f(x) = \ln(1+x).$$

After further talking, they realized that

$$\frac{d}{dx}\frac{1}{1+x} = \frac{-1}{(1+x)^2},$$

and then claimed that

$$f(x) = \frac{-1}{(1+x)^2}$$

I responded that this was the right derivative, but that $f(x)$ does not satisfy (1). Could they tell me what was wrong? They said they had forgotten the constant of integration. The banquet was announced, so I did not have five minutes to help them see what was wrong and just told them.

I had not expected them to see that the author had forgotten the constant of integration, but their answers surprised and shocked me. Students doing undergraduate research should not have such a poor grasp of calculus.

At the banquet I sat next to two students. One was studying at Princeton and the other at Washington University. After asking what they had done, they asked what I did. One had said he had spent the summer computing Kazhdan-Lusztig polynomials. I said I had caught the q-disease about 15 years ago, and, while it was related to these polynomials, it was a complicated story and I could not outline it then. They asked what the q-disease was, so I first asked if they knew the binomial theorem. They responded with

$$(x+y)^n = \sum_{k=0}^{n} \binom{n}{k} x^{n-k}y^k \tag{2}$$

and when asked said that

$$\binom{n}{k} = \frac{n!}{k!(n-k)!} \tag{3}$$

counted the number of ways of putting k objects of one type and $n-k$ of another into n places.

I responded that (2) required that $yx = xy$, and if this was not true, a different result is needed. When x and y are independent, the complete symmetric function of degree n in two variables is the result. This is an important function, as is (2), so it is natural to ask if anything else exists with a different commutation rule. In particular, if

$$yx = qxy, qx = xq, qy = yq \tag{4}$$

and if $\left[\begin{smallmatrix} n \\ k \end{smallmatrix}\right]_q$ is defined by

$$(x+y)^n = \sum_{k=0}^{n} \begin{bmatrix} n \\ k \end{bmatrix}_q x^{n-k} y^k, \tag{5}$$

could they find a formula for these coefficients? To get them started, I stated

$$(x+y)^2 = x^2 + (1+q)xy + y^2 \tag{6}$$

and

$$(x+y)^3 = x^3 + (1+q+q^2)x^2y + (1+q+q^2)xy^2 + y^3 \tag{7}$$

and asked if they could tell me the next case. They started with

$$(x+y)^4 = x^4 + (1+q+q^2+q^3)x^3y + \cdots .$$

The one stating this said he did not see the pattern for the next coefficient, but the other two were obvious. I saved them time and stated the coefficient of x^2y^2 as

$$1 + q + 2q^2 + q^3 + q^4$$

and asked if they could now figure out the general case. The same student said he did not see the pattern. The other responded by saying this could be factored as

$$(1+q^2)(1+q+q^2)$$

and then together they rewrote (6) and (7) and the case $n = 4$ as

$$(x+y)^2 = x^2 + \frac{(1-q^2)}{(1-q)}xy + y^2$$

$$(x+y)^3 = x^3 + \frac{(1-q^3)}{(1-q)}x^2y + \frac{(1-q^3)}{(1-q)}xy^2 + y^3$$

and

$$(x+y)^4 = x^4 + \frac{(1-q^4)}{(1-q)}x^3y + \frac{(1-q^4)(1-q^3)}{(1-q^2)(1-q)}x^2y^2 + \frac{(1-q^4)}{(1-q)}xy^3 + y^4$$

Then they said the general result was clear.

That was very impressive, and I suspect I was talking to two people who will be good mathematicians. This split bothers me very much. If the first group of students is at all typical, and I am afraid there are many more like them, then we have very serious problems which will be masked by the obvious ability of the second group. We need students like the second pair, but we also need a large middle class of students who understand mathematics, are comfortable with it, and are able to use it. Since I have become worried about this group of students, I have tried to find out what our students know when they start mathematics at college.

A year ago, while teaching a short section on analytic geometry in a calculus lecture, it suddenly dawned on me that their knowledge of geometry was probably even worse than their knowledge of algebra, so it would be a good idea to prove the Pythagorean theorem before using it to motivate the distance between points. Because this was not calculus and was not in the book, there was the obvious problem of encouraging them to think about the proof. My solution was to ask them to give a proof for an extra 5 points, out of 600. After they turned in this quiz, I gave a proof and told them they would get an extra 3 points if they turned in at the next lecture a correct proof different than mine. Sixty-five students turned in something for the quiz. Most tried to prove it using trigonometry.

$$x = r\cos\theta$$
$$y = r\sin\theta$$

and

$$\sin^2\theta + \cos^2\theta = 1$$

so

$$x^2 + y^2 = r^2.$$

Many others stated the law of cosines and then took the angle to be a right angle. One student gave a correct proof.

In the fall of 1991, I was teaching an honor section of second semester calculus. All the students were in their first semester at a university and had had their previous calculus in high school. The first day they were asked to tell something about their background, such as, was there a mathematics club in their high school; had they gone; and what did it do? I also gave them two problems. The first was to state and prove the theorem of Pythagoras and the second was to derive a formula for the sum of a finite geometric series. This was stated as $1 + r + \cdots + r^n$ since it was unlikely all knew what a geometric series was.

There were 22 students the first day, and the results were somewhat better than the previous year, as they should have been since this was an honor section. Only one student knew how to prove that $c^2 = a^2 + b^2$, but the rest knew they did not know how to prove it and did not give obviously false proofs. However, no one knew how to derive a formula for $1 + r + \cdots + r^n$; one knew the formula but could not prove it and one knew what it was when $r = 2$. These two questions so shocked some of the students that they changed to a regular section. Only 15 were there for the second

week and 14 took the final. They were asked the geometric series question again, and all except one knew how to derive the formula. In the middle of the semester, two students talked to me separately and each said they were taking an economics course. When the professor started to talk about the multiplier effect of money, a geometric series was used, and they were the only students in their respective lectures who knew how to derive this formula. I then talked to a friend who is a professor in the economics department and asked if their students should know how to sum a geometric series. He said, "Of course, but they never do, so we always do it ourselves." That says something to us, as well as to high school teachers.

I went to the local high school to talk to some teachers, to see if I had unrealistic expectations. I think our best students should know how to derive a formula for the sum of a geometric series. The calculus teacher said I was being unrealistic since these students had not seen these series for two years. It was really one and a half years and I think they should have used them in calculus. When they were taught this in precalculus, many series were taught at the same time, and the teacher did not see any reason why the students should remember this one rather than some others. In fact, they did not remember any, but should have known this and a finite arithmetic series, and the best should know the binomial theorem.

The teacher who teaches advanced geometry said he would have been surprised if the students could prove the Pythagorean theorem. It was proved in class, but the students were never tested on its proof, only on applications of it. I said I would have asked them to give two proofs and then write an essay on which proof showed more insight, or which one they liked better and why.

This is a good high school with more National Merit semifinalists than any other school in Wisconsin. If the teachers there do not understand what their better students should learn, then we have failed in teaching them what is important and what is of secondary importance. I think understanding these two results is important. After all, many of our students wear a button which says "Question Authority." Here they can understand something, and so do not have to take the facts from an authority. That is an important message to give them, and these facts are important enough that they should be understood by the better high school students.

I gave the q-binomial theorem problem mentioned above to the students in the honor section of calculus. Two groups, one of two students, one of three, solved it. The students were not dumb; they had never been challenged sufficiently, and too little had been expected of them.

Before you try shock treatment, as I did the first day, consider an unintended consequence. There were six women in the class the first day, and none were there at the end of the week. I called them over the weekend and was able to talk one into staying. The others said they did not want to work as hard as it seemed they would have to in an honor section, so they stayed with the regular sections they had transferred to. I do not believe mathematical ability is different by gender, but it seems likely that confidence is. I returned the quiz the next day and told the class how poorly everyone had done, so they were all in the same position, but this was not enough to keep from scaring some of the students. Next time I teach a class of bright first year students, I will move somewhat more slowly to show them that higher expectations are necessary if they are to profit from their chance to get an education.

Edited by Keith Devlin

Tales of Gods and Heroes: "The Nectar of the Gods"

M. C. Nucci*

Once upon a time, there was one God called Har-wa-re.

One of his sons was Sof-wa-re.

One of Sof-wa-re's sons was Sym-ba-lg.

From him all the Gods descended.

The Gods were living on a mountain called Csy-ple-uce, drinking nectar and eating ambrosia. The mortals down on the earth venerated and feared them. They could not understand the Gods' Mysteries.

Life was hard on the earth. Some mortals, called Mat-hm-cians, had to work huge fields in the Land of Mat-hm-ics. Their tools were small and inadequate. They called them penandpapers.

Although the Gods were enjoying themselves, life was pretty boring. One day the Gods had a bad argument about an Apple. The Mount Csy-ple-uce was shaken by an earthquake and split into three horns: Ma-csy-ma, Ma-ple, and Red-uce. Three new religions were born.

First was Ma-csy-ma. It was the only religion which was allowed to use twice the holy word Ma.

Second was Ma-ple which was allowed to use Ma once.

Third and the most neglected was Red-uce, which was not allowed to use Ma at all. The Gods of Red-uce lost the argument and were punished by the absence of Ma.

It is said that the argument started because some of the Gods wanted to help the poor Mat-hm-cians, but others opposed it very strongly and won.

On the earth, the fanatics of Ma-csy-ma and Ma-ple were very loud and started a holy war against the red-ucians. Red-uce became very unpopular because of its few sacrifices and mysteries.

The mortals adored what was luxurious and incomprehensible.

The red-ucians never fought back. They adored their Gods in silence. Red-uce was a religion for the poor. Some of the red-ucians could not venerate the First God, Har-wa-re. They could not afford even a small altar of Har-wa-re. Few red-ucians were lucky enough to use somebody else's altar.

In spite of the new religions, life was still miserable for the Mat-hm-cians. Only a few mortals were aware of the Threefold and venerated the new religions. Most of the Mat-hm-cians were still working hard by using penandpapers.

One day a God called Mercury, who was the patron of the merchants, deserted the Three Horns. It is said that he was tired of being an immortal automaton and thought that life among the mortals could be more exciting. He soon realized that the rich mortals only could afford to be excited. How could he become rich?

Mercury had an idea. He decided to sell to the mortals a diluted type of the Nectar of the Gods. Also, he added some artificial flavors and colors to appeal more to the unsophisticated taste of the mortals. The price was very high, yet it was a commercial success.

The mortals liked it a lot. Everybody wanted it. They felt like Gods. After all, nobody knew the difference between the real and the diluted Nectar. The mortals decided that there was no reason to venerate the Gods anymore.

The Gods felt threatened. What could they do to reinstate their authority? The Three Horns had a meeting. They decided that the only way out was to make the real Nectar available to the mortals.

Unfortunately, the real Nectar was hard to sell, in spite of being cheaper. The real Nectar had a very ugly taste, and none of the additives. However, some of the poorest Mat-hm-cians bought it.

The real Nectar had a strange effect on them. At first, they felt light-headed, wandering around, and hitting all the keys (sic) they could find. Then they spent hours looking at all the windows, cursing the Gods, and neglecting their own fields. Finally, after many drinks, they got used to it and began to realize how strong they were. They could take care of their fields without the small tools. They could use

*Maria Clara Nucci is a tenured researcher in mathematical physics at the University of Perugia in Italy. She spent three academic years at the Georgia Institute of Technology as a visiting assistant professor. One of her areas of research is the solution of differential equations implemented by symbolic computation. She can be reached by email at: nucci@ipgaix.unipg.it.

the power of the real Nectar to cultivate their fields faster and better.

Unfortunately, the Gods imposed a very strict rule to go with the sale of the real Nectar. No mortal was allowed to use the newly acquired power without the Gods' help and advice.

But what could one expect from a bunch of ungrateful mortals? Some of the Mat-hm-cians disobeyed. The worst were the Mat-hm-cians who came from a very low-class area called Ap-pli-mat. They drank the real Nectar and used the new power without the Gods' advice. Not only that, but they also dared to cultivate strange vegetables thought to be an inferior type of ambrosia. The Ap-pli-matcians made themselves hated both by the other Mat-hm-cians and by the Gods.

The other Mat-hm-cians liked only the diluted Nectar with its additives. They could not bear the strong taste of the real Nectar and disliked the ambrosia-like vegetables, which had a very bad smell for their delicate nostrils.

At that time, the Gods had left the Three Horns and were living among the mortals. They were considered strange people, eating strange food and talking an unintelligible language. They were called X-per-ts. Some of them became judges and decided to punish the Ap-pli-matcians for breaking their rules.

They sentenced the guilty Ap-pli-matcians to death. The capital sentence was administered by an old device called nogrant. However, the X-per-ts were still Gods, and their punishment went beyond those sinners' death. In Hell, the souls of those bad Ap-pli-matcians were forced to go around for eternity begging for bits of cpu.

From then on, everybody lived happily on the earth.

Editorial

The remainder of this month's column is devoted entirely to two reviews of the new Version 2.0 of the *Mathematica* system, covering implementations for the NeXT Cube, the Sun Sparc 1+ and Sparc 2, the Macintosh IIfx, and Windows. Familiarity with the previous Version 1.2 is assumed.

One of the two reviewers also takes a look at two small, related products, *Mathematica Help Stack* and *Mathematica Quick Reference Booklet*, both from Variable Symbols.

The column plans to run reviews of other large scale mathematics systems in the coming months.

Editor's address:

Professor Keith Devlin
Department of Mathematics and Computer Science
Colby College
Waterville, Maine 04901

Correspondence by electronic mail is preferred, to:

kjdevlin@colby.edu

Reviews of Mathematical Software

Mathematica 2.0

Reviewed by Sha Xin Wei*

Abstract

The *Mathematica* computer system is reviewed from the perspective of a mathematical user. Familiarity with version 1.2's basic features is assumed.

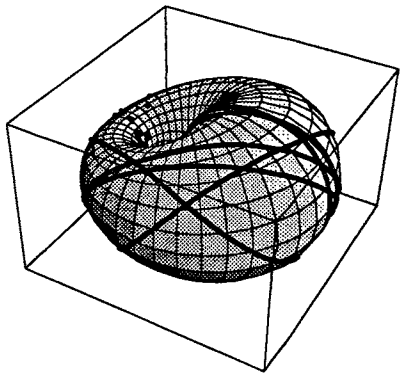


Figure 1: Geodesic on a Dupin torus (A. Gray).

Introduction

Mathematica 2.0 is at once a programming language, a symbolic calculator, a multimedia structured editor supporting computed or sampled sound, graphics, animation, and a virtual operating system shell. It is available from Wolfram Research, Inc.[1]

The computation Kernel runs on all major computers, including Macintosh and IBM DOS machines; the multimedia outline-structured Front End runs on Mac, NeXT, and Windows machines.[2] Prices range from a few hundred to thousands of dollars, depending on the machine and whether you run *Mathematica* over a network.[3] This review is based on *Mathematica* 2.0 beta 3 on a NeXT Cube 2.0, Sun Sparc 1+, Sparc 2, as well as the release version 2.0 for the Macintosh II fx. The window/os are NeXT 2.0, X Windows, and Mac Systems 6.0.5 and 7.0.

*Sha Xin Wei is a graduate student in mathematics at Stanford University, working on a dissertation in differential geometry. He serves as the mathematics and scientific simulations consultant in the Academic Software Development group at Stanford. He can be reached by email at: xinwei@otter.stanford.edu.

[1]Wolfram Research, Inc., 100 Trade Center Drive, Champaign, Illinois 61820-7237, telephone: 217-398-0700, email: info.wri.com.

[2]The X Notebook Front End is rumored to be coming in a year.

[3]*Mathematica* is bundled free with the NeXT for academic purchasers.

Reviewer's Perspective

Having written mathematical applications in languages ranging from APL to Object Pascal and NeXTStep, until *Mathematica* no commercial program seemed useful for research in my own field, differential geometry. Like many, I found existing symbolic manipulation programs (smp) much too cumbersome to learn, and too limited to use. I'll try to take the perspective of a mathematician who's familiar with programming but prefers to work in a language as high-level as possible, so more emphasis will be placed on the expressivity and mathematical naturalness of the language than on computational time/space-efficiency.

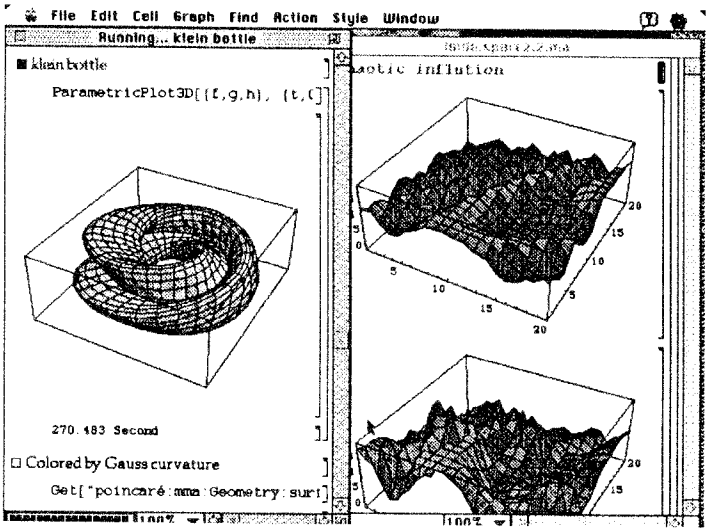
First Look – The Interface

Following Victoria Bush's suggestion,[4] let's take a tour of *Mathematica* 2.0 on the NeXT.

Upon launch, we see that version 2.0 retains the outline structure of the original Notebook Front End, with strongly typed cells (input, output, graphics, etc.) which can be rearranged and hierarchically regrouped. One of *Mathematica*'s chief distinctions among smp's is its sophisticated interface, which integrates formatted text, and computed or sampled graphics and sound with "live" algebraic expressions. The Front End supports noncontiguous selection, plus Mac-style Cut-Copy-Paste and limited Undo.

Menu groups have been rationalized so veteran users will have to re-orient themselves. Zoom and cell type popup menus have been attached to the new Front End.[5] Indeed, features such as rulers providing much better control over layout, multi-style text cells, indexing, and the luxurious Find menu enable one to prepare books entirely within *Mathematica*. One may view the page at an enlarged scale while printing at the finer scale on paper, thus reducing the need to change font sizes or cell types just to keep expressions contained on the screen.

The Graph menu suggests one of the principal reasons to use the Front End. Special recognition should be given for the embedded PostScript interpreter. One can drag-expand a graphics cell to arbitrary size, read off point coordinates, copy and paste points, even translate graphics between several representations including PostScript, *Mathematica* Input Form, PICT, or TIFF, depending on the machine. Animation is quite straightforward: select a set of graphics cells, then choose Animate Selected Graphics. VCR controls appear that allow you to vary the speed and direction or single-step through the frames.[6] Printing is also simple: select your graphics and choose Print Selection; *Mathematica* ships PostScript to the printer.



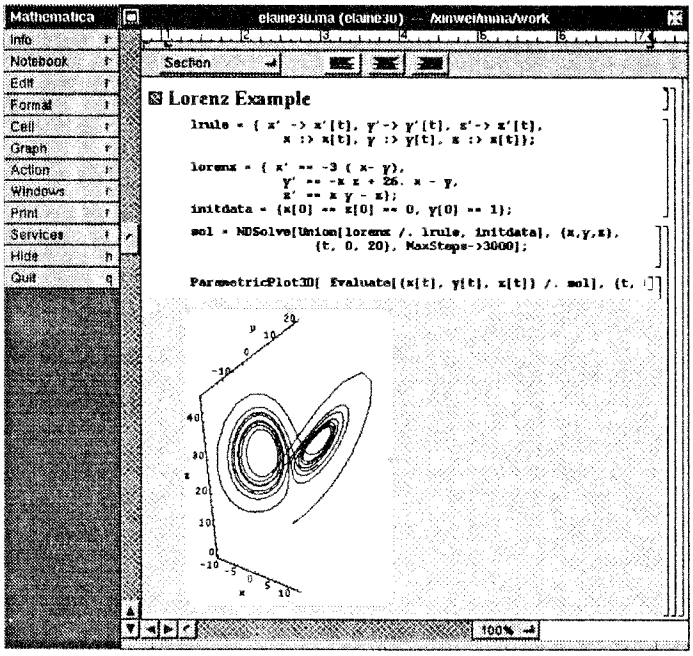


Figure 2: Macintosh and NeXT Notebook Front Ends.

Unfortunately, the Front Ends do not support the interactivity common to Macintosh programs: direct manipulation, mouse-select-drag-scaling, object-oriented graphics, and the like.[7] Understandably, WRI labors under the cross of lowest common denominator graphic user interface technology, by committing to a uniform notebook interface across X and Windows, as well as Mac and NeXT systems. One would appreciate, however, at least the ability to rotate or translate

[4] AMS *Notices*, **37**, 10 (December 1991).

[5] In two small but annoying respects, the new Front End seems less friendly than version 1.2: key equivalents for the cell types don't work until you first click a cell's border, and on the NeXT one must dig farther into the menus in order to change a cell attribute (using Style Inspector).

[6] Animation on non-NeXT unix machines requires the Animation.m package and must be mediated by the graphics driver appropriate to the window graphics system. WRI supplies the necessary files.

[7] *Milo* had a very elegant rectangle-select zoom feature. *Theorist* even supports this on its 3D surface plots. *Theorist* allows you to spin a surface by mousing on it directly, rather than going to a separate dialog. *Theorist*, however, is overly encrusted with buttons and popup menus for my taste. Both of these Mac programs support direct manipulation algebra, which should come into its full strength in the emerging pen-based computers.

an object by directly mousing on the graphic.[8]

Despite some calls for it, the new Front End does not support TEX, relying instead on a crude but readable fixed-width font, line-oriented format.[9]

Four of the most useful help commands in the Front End, besides Cut-Copy-Paste of course, are command completion (^k), parentheses matching (^B), query mode (^?), and template (^i).

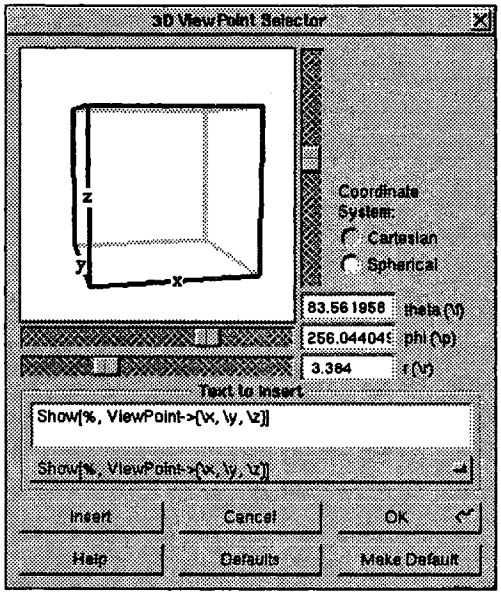


Figure 3: 3D View Point Selector Panel.

Kernel Features

Over 280 objects have been added to Version 2, but this is not an unalloyed blessing. The plethora of structure operators described below might more sensibly be merged into one polymorphic structure operator; similarly with the graphics functions.

Graphics

One of *Mathematica*'s great strengths is its integrated set of graphics operations. The Front End set a standard with Postscript-based script-generated graphics which could be manipulated in the same window as the algebraic formulas used to describe and transform them. In *Mathematica*, you simply type

```
Plot[ {Cos[x], Cos[x] + Sin[x^ 3]/2^ x}, {x, 0, 3/2 Pi}]
```

to plot a set of curves. (Figure 4)

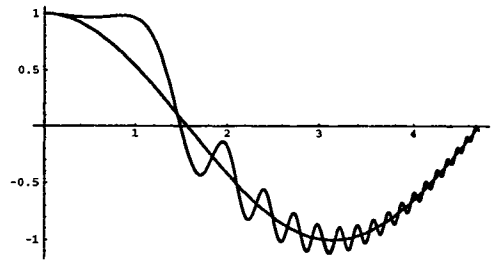


Figure 4: Plot of $\cos(x)$ superposed with $\cos(x) + \frac{\sin(x^3)}{2^x}$.

Mathematica takes care of myriad details such as placing tick marks, scaling axes, perspective, and color shading, most of which you can adjust via options. The almost overly rich set of plotting functions[10] draw parametrized curves and surfaces, level sets, as well as complexes of geometric primitives: points, discs, polyhedra, etc.

```
ParametricPlot3D[ { y Sin[x], x + Cos[y], Sin[y] Cos[x]}, {x,0,4}, {y,-1,2}, Boxed→False, Axes→ True, AxesEdge → {{-1,-1},{-1,-1},{-1,-1}}, AxesLabel→{"x", "y", "z"}, ViewPoint→{-0.783, 3.228, 0.647}]
```

`ParametricPlot3D` (Figure 5) for both curves and surfaces is now a built-in function. Following the laudable principle of unifying treatment of graphics objects and algebraic objects, graphics can now be nested or presented as arrays, superposed, colored according to custom functions, or projected under arbitrary maps. Graphics now can be transformed (cast) from one type to another.[11] Unfortunately, not all information survives this casting: level curve point lists in ContourGraphics cannot be extracted, for example, even after casting into general Graphics3D type.

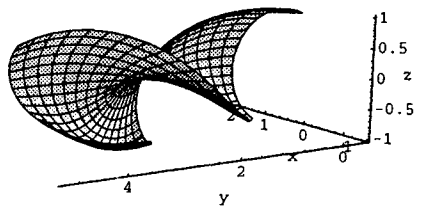


Figure 5: A parametric plot.

3D perspective has been slightly generalized to allow choice of both `Viewpoint` (where the eye is placed) and `ViewCenter` (where the eye looks), but it's still nearly impossible to get inside a complicated surface and view it inside out, because the `ViewPoint` cannot be placed close to the origin. In fairness, we note that no other common smp has as sophisticated a rendering system. Some defaults arguably could be improved, e.g. `ClipFill` could default to `None` to avoid spuriously filling in holes on truncated surfaces.

[8] I understand that it would be quite difficult to "invert" a mouse location through a PostScript rule-description, but one need not have a complete inversion of mouseloc→(point in model space), merely a way to map mousedrags to rotations, which is a much simpler matter. After all, that's what the ViewPoint selector does already, but in a separate window.

[9] The Kernel, however, can convert *Mathematica* expressions to TEX, C, or Fortran formats. TEXForm works best with expressions that fit on a single line.

[10] Plot, Plot3D, ParametricPlot, ParametricPlot3D, DensityPlot, ContourPlot, plus analogous functions for arrays.

[11] For efficiency reasons, geometric objects are represented in various formats, e.g., Graphics (curves or points in the plane), SurfaceGraphics (graphs $z = f(x, y)$), or most generally, Graphics3D.

Algebra

Mathematica's `Solve` and sister functions work best with rational functions; version 2 has been augmented by a general inverse function notation that is of debatable value, especially when dealing with transcendental functions or functions with no global inverse. Currently, the algebraic operators tend to be too fine, or too coarse.[12] For polynomials, there is an extensive set of special operators—`Together`, `Collect`, `Simplify`, `Expand`, etc.—to factor out and collect expressions, some of which work only over **Q**. Experience with smp's suggests that flexible, robust medium/fine grain algebraic operators such as `Expand` or `Collect` are more useful than behemoths. To illustrate with a toy example, take the expression `Q` derived from a quadratic expansion of $\frac{1}{2-\sin(t-a)}$ about $t = 0$:

```
Q = Normal[ Series[1/(2-Sin[t-a]),t,0,4]];
```

We collect terms and extract the numerator:

```
Q = Together[Q]; P = Numerator[Q];
```

and then extract the coefficients of t^2 in `P`:

```
Factor[Coefficient[P, t,2]] 12 (2 + Sin[a])^2
(2 Cos[a]^2 + 2 Sin[a] + Sin[a]^2)
```

Most mathematicians are disappointed to discover that symbolic expressions tend to mushroom under automatic symbolic transforms, unlike numerical calculations, which can be controlled slightly better. For example, algorithms for numeric matrix inversions are of $O(n^2)$ at worst, whereas symbolic inversions are $O(n!)$. General algebraic simplification of general expressions can be quite difficult to design because the computer doesn't possess a human mathematician's heuristics, yet. Tensor calculations are a good example. We typically apply symmetries and identities in our head and expand terms only when necessary, keeping other terms under control by symbolic substitution. Without heuristics, an smp like *Mathematica* (or its siblings) finds it difficult to avoid exponential blowup of symbol complexity. Though the authors note that there is no general finite procedure for checking symbolic identity,[13] one basic criticism of *Mathematica* is that it doesn't present algebraic expressions in human-readable canonical form even in some fairly standard domains like rational functions or matrices. Unfortunately, `Short` provides too brief a structure synopsis while the new `Shallow`, which presents the top level of an expression tree, often fails to capture interesting features:

```
Shallow[Q] (384 + Times[<<3>>] + Times[<<3>>]
+ Times[<<3>>] + Times[<<3>>] + Times[<<3>>] +
Times[<<3>>] + Times[<<2>>] + Times[<<3>>] +
Times[<<3>>] + <<20>>) / (24 Plus[<<2>>] )^5
```

Canonical forms for certain types of objects, and some way to customize the structure of representation of algebraic expressions (e.g., placement of minus signs and reciprocal powers) would ameliorate this generally intractable problem.

Linear programming problems (both equality and inequality) can be solved using built-in functions. Basic matrix operations include `Inverse`, `Transpose`, `RowReduce`, `Eigenvalues`, and `Eigenvectors`, now supplemented by `PseudoInverse`, `SingularValues`, `QRDecomposition`, and `SchurDecomposition` for numerical matrices. The standard Linear Algebra packages now include more matrix (column, row, block) operators and an extended SymbolicSum.

One of *Mathematica*'s most powerful features is the general mechanism for dealing with array structures, using APL/LISP-like functions such as generalized inner and outer products. Version 2.0 augments the set of structure operators—`Select`, `Sort`, `Cases`, `Count`, etc.,—yet there are gaps: `Cases` and `Position` should accept boolean tests, and `Select` should accept patterns.

Analysis

In addition to the splendid variety of special functions, ranging from `AiryAi` and `Erf` to Riemann `Zeta`, a reasonable complement of basic tools are available, such as `FindRoot`, `FindMinimum`, `Series`, `Limit` and differentiation `D`. Directional limits are useful as far as it goes, though in one of the rare lapses into "magic numbers," the notation $+1$ or -1 could have been replaced by more descriptive names. One wishes for a generalization to direction vectors in multivariate real functions, as well as a more robust way of handling singularities, perhaps. `Limit` and a few other functions have been generalized to RealInterval set values. For example

```
U = Limit[ Sin[x], x-> Infinity ]
```

returns

```
RealInterval[{-1,1}]
```

which works in simple cases. However, although one can, for example, evaluate

```
V = 1/(U + 4)
RealInterval[{1/5, 1/3}]
```

evaluating any but the simplest functions reveals some limitations:

```
ArcTan[V]RealInterval[{Min[ArcTan[1/5],
ArcTan[1/3]], Max[ArcTan[1/5], ArcTan[1/3]]}]
```

`f[RealInterval[{a,b}]]` is formally defined as the shortest interval containing the image of the interval `[a,b]` under map `f`. The Kernel does not support set-valued maps or interval arithmetic, though the designers may be aiming in such directions.[14]

Novices will have to sort out differences between `D` and `Derivative`: `D` is the operator on the space of differentiable functions, whereas `Derivative` is used to denote its images. *Mathematica* 2.0 can now handle an appreciably extensive range of indefinite integrals, but still suffers from some problems. For example, while the positive branch of $\sqrt{1+\cos(x)}$ is plotted by default, the integral $\int_0^{\pi} \sqrt{1+\cos(x)}dx$ is evaluated to $-2^{\frac{3}{2}}$.

Moreover, the definite integral doesn't try to look for singularities in the integrand, hence $\int_{-1}^{1} \frac{1}{x^2}dx$ evaluates to

[12] *Maple*'s op structure operator is another example of a powerful but too complicated way to extract subexpressions.

[13] Wolfram, p. 270.

[14] There is an instructional package NumericalMath'IntervalArithmetic.

−2. *Maple* and *MACSYMA* reportedly share these sorts of defects but to a lesser degree.[15] A useful enhancement would be a general change of variables user option.

DSolve and especially *NDSolve* now provide convenient ways to study ordinary differential equations; *DSolve* finds closed solutions for linear systems and simple nonlinear systems for which the derivatives can be easily isolated. Arguably the more useful function, *NDSolve* uses a fairly robust adaptive mix of integrators, the Adams predictor-corrector method for non-stiff ODEs and backward differentiation formula/Gear method for stiff ODEs. (Figure 2)

Numerical Operations, Data Analysis

Now numeric functions can be compiled for speedier evaluation, especially in plotting and integration of complicated expressions. Some control structures can be compiled, but not array structures.

The built-in `Fit` function apparently duplicates the `LinearRegression` function that comes with the Data Analysis packages. It's quite convenient for "back of the envelope" data analysis, as are the new approximation functions `InterpolatingFunction` and `InterpolatingPolynomial`. Unfortunately, these work only on one-dimensional data. Now data can be approximated by piecewise polynomials with specified degree and boundary derivative values.

Don't expect *Mathematica* to find eigensystems for 1000×1000 matrices; there are plenty of applications plus extensive libraries of public domain code more suitable for numerical analysis.[16] Unless you are a specialist, however, *Mathematica*'s arbitrary precision and rational arithmetic eliminate any need for a calculator program, particularly if you use its powerful array operators and functional algebra. One should be mindful that computers treat ratios of integers quite differently from decimal representations, and *Mathematica* is no exception: zeroes of functions or solutions to differential equations may be found more accurately when coefficients are given in one form and not the other.

Version 2.0 now handles numerical FFT's in arbitrary dimension.

Language: naturalness, extensibility, expressivity

While the interface is most important as one learns a complex smp—and frequently determines whether or not an smp is tried at all—the most important aspect of an smp for experienced users, to my mind, is its scripting language. First of all, names should be fully spelled out, without cryptic letter hashes like *Maple*'s `dpoly, op` or `int`.[17] We can extend *Mathematica*'s basic functions by defining our own functions in scripts using a syntax close to mathematical usage, unencumbered by nonmathematical directives as in a typesetting language like TEX. The language is an expressive amalgam of functional, procedural, list/array-based, and rule-based styles, inheriting ideas from LISP, C, APL, and older smp's.

At the most fundamental level, *Mathematica* works by replacing sequences of strings by other sequences of strings, hence the description, rule-based symbolic manipulation. *Mathematica*'s rule-based rewrite system allows you to quite easily teach it formal manipulations such as group relations or algebraic simplifications.

As a simple example, to reduce polynomials in the ring $Q[a]$, where a is a root of an irreducible polynomial, say Cyclotomic[9, x], we generate a rule

```
rule = AlgebraicRules[ Cyclo- tomic[9, x]==0]
x^6 -> -1 - x^3
```

then apply it,

```
(1-x)^12 /. rule
```

to obtain

```
-1143 + 846 x - 441 x^2 - 1143 x^3
+ 1287 x^4 - 1287 x^5
```

Algebraic algorithms can be written naturally and with concision. Still, rule-based symbolic rewriting, while powerful, can be tricky to use, especially since the order of application may not be precisely controlled. A rule to complete the square, for example, would be easier to write if there were some way to control an expression's canonical ordering.

The functional syntax allows one to compose operators on abstract objects, such as `Ricci[metric]` and `RiemannCurvature[metric]` which can be defined without specifying the dimension or the metric in advance.

One can write, for example, a procedure which automatically generates a lattice difference scheme directly from a differential equation. Consider a differential equation of the form:

$$\frac{\partial f}{\partial t} = \Phi[f, Df, D^2 f]$$

where function $f : R^n \times R \to R$ is represented discretely by an n-dimensional lattice of real values for each t, which we'll denote by `f`. Partial derivatives of f are represented conventionally as symbols, e.g.,

$$\frac{d^2 f}{dx^1 dx^3} \to \texttt{f13}$$

Given the dimension of the domain n the rewrite rules

```
diffRel = {f1 -> dD[1, f],...,f13 -> dD[1,
3,f],...}
```

themselves can be automatically generated, using string operators, where `dD` is a difference operator defined on lattices of arbitrary dimension defined by rules like:

```
dD[1, f_] := RotateLeft[f] - f
```

One then can translate the differential equation simply by appending the rewrite rule `diffRel`:

```
df_dt = Phi[f, Div[f], Hessian[f]] / . diffRel;
f += df_dt; (* f = f + df_dt;*)
```

The second statement is a matrix transform $f \to f + \frac{df}{dt}$ (assuming unit time step for simplicity). There are no trivial

[15] Many examples have been posted on the sci.math.symbolic bboard.

[16] Examples: Matlab—numerical arrays, S—statistical programming, NetLib—scientific computation source code.

[17] Using aliases or the Front End's command completion, slow typists need not peck out long names in full.

iterate-loops and no indices. We gain tremendous flexibility, concision, and clarity by writing programs using a high-level language whose syntax is essentially standard math syntax.

Operating Systems, MathLink

As mentioned above, *Mathematica* is broken into two parts: a Kernel which performs the core computations—like graphics calculations, polynomial algebra, bignum arithmetic—and a Front End which presents the multimedia notebook interface and deals with all human interaction.

Version 2 contains a virtual operating system which provides machine-invariant means to list, create, or read files, change directories, and execute external routines. The Kernel communicates with external processes in three ways: (1) by reading and writing data in ascii files, which is quite straightforward, (2) by calling compiled code from within *Mathematica*, and (3) by calling *Mathematica* from within your own program. WRI supplies a compiler script named `mcc` and files to be included in your custom code so that it can be invoked just as any built-in function. The most powerful extension is to compile WRI's MathLink methods in your own program to pass typed strings to the Kernel and interpret its answers in your code. You can, in this way, write your own interface and treat *Mathematica* as a symbolic/graphic computation engine. Command-line "front ends" have been written in emacs[18] and TEX; friendlier ones have been written on the NeXT.[19] One could perform a service to the community by writing a direct manipulation graphics front end incorporating some ideas from *Live*[20] or *Theorist*, or structured array front ends for matrices or sequences of groups.

Packages

Mathematica comes with an extensive and growing set of "packages" that contain scripts to be loaded when needed. The `DeclarePackages` method prepares *Mathematica* to automatically load a package when one of the package's functions is invoked. There's a constant tension between keeping the kernel small for speedy launch, flexibility, extensibility—which requires more package juggling—and stuffing the kernel with everything for speedy execution of individual kernel functions—which requires a smaller package library. *Mathematica*'s balance still needs adjustment. Why are some quantum mechanical functions built-in when there are no good built-in rules to handle complex arithmetic? On Unix platforms, one may "compile" packages into a custom image of *Mathematica*, a useful feature for experts.

Package topics now include recurrence equations, special matrix forms, permutation and rotation groups, symbolic sums,[21] symbolic Laplace and Fourier transforms, Padé approximation, computational geometry, vector analysis, animation, and a host of graphics functions mentioned above. The packages vary in robustness and sophistication, but are generally well documented, with references to literature where applicable; some can serve as examples of scripts.

Public domain packages are available by anonymous ftp from Internet sites throughout the country, including otter.stanford.edu. As the editor of the otter archive, I encourage submissions of research or instructional applications that may be useful to the mathematical community. The computer bulletin boards sci.math and sci.math.symbolic occasionally post useful information. Also, Addison Wesley's *Mathematica Journal* provides an Electronic Supplement with each issue.

Remarks on Limitations

I have highlighted a few design problems, though unlike some earlier reviewers, I have focused on mathematical rather than computer science issues such as garbage collection, speed, internal representation of data, or the lexical representation of some binary operators.

Correctness

Mathematica 1.0's bugs in algebra and integration disappointed early users. Experience with large software systems teaches one to take a more sanguine view of any new complex code, expecting hosts of bugs to be reported and—if the authors are responsible—corrected. Version 2.0's algebra and integration routines have been speeded up and made more correct, modulo the branch cut problem, and now approach *Maple* in "accuracy" if not speed.

Sets, Inequalities, Logic

Mathematica's chief mathematical shortcoming is the lack of a general typing mechanism—a way to define mathematical structures. For example, while one can define a custom membership function which indicates which symbols explicitly belong to a class:

```
QuaternionQ[a_] :=  (Head[a] == Quaternion)
```

there is no general mechanism to declare that a Real is a Complex is a Quaternion; moreover, no type checking is performed unless you redefine functions to explicitly do so. Related to this type problem is the absence of the notion of a general abstract set, which was noted in the review of version 1.[22] Most computer programmers instinctively assume that all interesting sets are enumerable. Other shortcomings are the absence of inequalities or logic calculus.

One rigorous general solution might be to implement some sort of facility that installs facts, such as "if f is odd and integrable, then its integral over R is zero" in a knowledge system. It seems safe to say that current semantic reasoning systems are too cumbersome and weak to deserve space in a working mathematician's hard disc. On the other hand, the utility of partial solutions should be

[18] D. Dill; D. Jacobson, *Mathematica Journal*, vol 2, no. 1

[19] including T. Gray's *RealTime Algebra*, M. Mezzino's *PhaseScope*, and Objective Technologies' *MathPalette*.

[20] *Live* is a graphics front end written by J. Friedman for Silicon Graphics.

[21] `Sum[a[k],k,kmin,kmax]`, where $\frac{a[k+1]}{a[k]}$ is a rational function, replaces Version 1's GosperSum.

[22] *AMS Notices*, November 1988 [3]

investigated, especially if that would strengthen automatic algebraic simplification.[23]

Help, Documentation

Mathematica's online help is exemplary among smp's. Some effort has been put into placing the cursor near where the parser chokes and generating meaningful error messages. On all platforms `?foo` elicits the usage statement for symbol `foo` from the Kernel's database on built-in or user-defined functions. `Context`, `Names`, `Path`, coupled with wildcarding, provide ways to locate symbols defined in several contexts, a useful feature when multiple packages may be loaded into memory. The Front Ends provide additional help as mentioned in section 3.[24] One defect is that there's apparently no way to get a list of the acceptable values of an option. For example, `Options[Plot3D]` provides a list of Plot3D's options, including the default value `AxesStyle→Automatic`, but `?AxesStyle` doesn't retrieve its alternate values. Even Wolfram's reference manual does not list the values in one location.

Usage messages can be associated with any function; even the language of the help messages can be specified. To WRI's great credit, they are committed to internationalizing their system, though it's unfortunate that they cannot take full advantage of Apple's internationalization support (e.g., Chinese or Arabic systems) because other operating systems are deeply bound to Roman languages. The most complete non-European conversion is their Japanese edition. There's even a proximity spellchecker which can be useful for novices; experts can turn it off.

WRI has responded to widespread requests for recipes by publishing a series of Technical Reports describing the theoretical bases and usage for its graphics, integration, polynomial algebra, ordinary differential equations routines, etc. While several Reports contain careful treatments of the theory (e.g., the article on definite and indefinite integrals), more precise descriptions of Kernel algorithms would be desirable.

Speed, Memory, Networks

What counts is the time it takes from the birth of a question in your mind to comprehending the computer's response, not cpu clock speed! In one case culled from netland, *Mathematica* 2.0 took about 45 seconds to solve a system of ODE's, where *Maple* V took 3 (on a Sun Sparc), but adding the days it took for the user to get a correct reply to a query about *Maple* syntax, *Mathematica* won hands down. In the early stages of exploration, one prefers flexibility, naturality, and expressivity over speed of execution, and often this suffices. On the other hand, this is definitely a workstation program, not something one should expect to run on an IBM PC or Mac SE with only a couple of megabytes of RAM.

To appease hardware heavies, speed benchmarks have been collected on a range of machines.[25] A very coarse estimate of relative times is

```
MacIIfx : Sparc1 : NeXT2: Sparc2: MIPS
    10  :    9   :   8  :    5  :  2
```

where the numbers are average benchmark times, though the relative times for individual operations can vary broadly. Floating point speeds don't enter directly into most of these symbolic tests, and the graphics speed depends critically on how Postscript is rendered on a particular device.

Experience teaches that raw cpu speeds, whether measured in mips or mflops, have much less to do with how fast you can do mathematics with a computer than the algorithms implemented, the language you use to communicate with the machine, and how data is presented. Order of magnitude differences in speed and memory can be significant, but anything less is usually not. Connectivity, on the other hand, can be radically important. A Mac or Sun Sparc on a network becomes a completely different beast from a standalone machine. *Mathematica*'s designers had this in mind when they decided to write the program in two parts, and to store complete notebook structure information in ascii files so they could be sent by email or ftp between any two machines on a network.

Since the Kernel and the Front End may sit on different machines, one can optimize use of hardware. One arrangement I recommend is to run the Front End on a Mac or NeXT, hooked via Ethernet to a fast compute server, say a MIPS or Silicon Graphics with lots of memory. This way you can perform large calculations with as little as 4 M local memory on a cheap, friendly machine. One can even run *Mathematica* over a network, with several instances of the kernel collaborating on a computation. Sun Sparcstations running X Windows work well either as servers or clients, but without a true Front End for non-NeXT Unix machines, viewing, transforming, or printing graphics remains relatively cumbersome.

Cost

It's a shame that WRI has been rather tight-fisted with universities, refusing until recently to give substantial discounts to academic clients. Some universities have been able to negotiate site licenses with WRI, but only after extensive consultation.

Conclusion

Among the many interesting applications written in *Mathematica*, substantial systems include S. Christensen & L. Parker's *MathTensor* – tensor analysis with explicit metrics, J. Lee's *DG* – exterior calculus tensor analysis on bundles, Schlumberger, Inc.'s *Mathematica* to C/Fortran translator, as

[23] *Maple* is beginning to implement such a facility. *MACSYMA* had such features. *ScratchPad* is designed around such semantic lines, but appears to be somewhat labyrinthine.

[24] The Mac Front End even carries its own version of balloon help (Balloon Help is a trademark of Apple Co.) which presumably will be subsumed under System 7.0's general help system. A COMMAND-? turns the cursor into a "?" which you touch on any window part or menu item to be described.

[25] All machines had at least 8 M RAM. Benchmarks are available by anonymous ftp from otter.stanford.edu.

well as J. Uhl and H. Porta's Calculus&Mathematica course. These deserve independent reviews in this column.

Mathematica's algebra and calculus, though systematically corrected, still suffer from significant defects. Unlike other smp's, *Mathematica* was designed from the ground up for machine-independent use, integrated graphics and algebra, and mathematical naturality. As a general purpose smp, geometric visualization and mathematical programming language, it ranks among the costliest and the best.

References

[1] *Mathematica Journal,* **1** no. 1–4 (1991), **2** no. 1 (1992).

[2] *Mathematica in Education,* **1** (1991).

[3] Jon Barwise et. al. *Mathematica, AMS Notices*, **35** no. 9 (1988) 1333–1349.

[4] Richard Fateman. A review of *Mathematica, preprint* (1991).

[5] Barry Simon. Four computer mathematical environments. *AMS Notices* **37** no. 7 (1990) 861–868.

[6] Stephen Wolfram. *Mathematica—A system for doing mathematics by computer*, Addison-Wesley, 2nd ed. (1991).

Mathematica 2.0 for Windows

Reviewed by Fernando Q. Gouvêa*

Computer algebra systems have become part of the standard work tools of most mathematicians. They are used as research tools, allowing a much greater range of experiments and calculations on personal computers than has ever been possible before, and also as teaching devices, allowing students to look beyond the boring technical complexity of computing derivatives and integrals or row-reducing matrices, so that, one hopes, the focus of our teaching may go to the conceptual side of mathematics where it belongs.

Of the many available systems, *Mathematica* seems to have achieved the greatest popularity. This is due, perhaps, to its very well-designed interface, which makes using the program less tedious and more intuitive than is the case for many of the other systems. This interface (the "front end," in *Mathematica* lingo) also makes the system an excellent teaching tool, allowing the program to show a friendly face to students who might be intimidated by the greater complexity of interacting directly with the program kernel and also allowing instructors to create "notebooks" that function as interactive tutorials.

The incarnation of *Mathematica* under review brings all this to the Windows 3.0 environment, which seems to have become the dominant graphical operating environment for MS-DOS computers. Considering the popularity of both *Mathematica* and Windows, the appearance of this version is only fitting and expected. Windows, as a graphical environment, allows the use of the "notebook" interface to *Mathematica* that is one of the most attractive features of the Macintosh and NeXT implementations of the program, so that a Windows version might be much better to work with than the command-line oriented DOS version available before now. The marriage of the two programs, however, raises some concern. After all, both Windows and *Mathematica* have a certain reputation for being primadonnas: they are finicky, occasionally unstable programs, and they are both particularly demanding on the systems they run in. Running *Mathematica* under Windows seems like asking for trouble.

Unfortunately, these fears seem to have been entirely fulfilled in the version under review: the main impression one gets is that of using an unfinished product, rather than a release version of a major program costing a great deal of money. This is largely a matter of problems with the front end, rather than with the "kernel" (which does the computations); unfortunately, the front end is our only doorway to the kernel. Since this is a review of the Windows implementation, rather than of the *Mathematica* system as a whole, we will largely focus on this side of things, with only a few comments relating to the *Mathematica* kernel. For a more complete description of that side of things, see the review by Sha Xin Wei, also in this issue.

How good is your system? As might be expected, *Mathematica* makes serious demands on the computer system on which it is to run. First of all, the program requires at least a 386 processor with a 387-compatible arithmetic coprocessor; it would probably be happier on a 486. Next, the kernel requires about 10 MB of memory to load (this is *in addition* to the memory used by Windows itself and by the "front end."). For most users, this will mean that one must create a permanent swapfile for Windows and use it for virtual memory. The tests we report on were done on a 386+387 system running at 33 MHz, with 8 MB real memory and using a 15 MB permanent swapfile for Windows. To use the program regularly and intensely, users should consider upgrading their systems to at least 12 MB of memory.

Installation went surprisingly well, considering how often it is that one runs into trouble with automatic installation programs (which tend to assume that every user is running a plain-vanilla Windows with a VGA graphics driver and with Program Manager as the shell). The installation procedure copies all the relevant files to the directory you specify, creates a new Program Manager group, and returns you to Windows. No information is given as to which files are being installed.

The first run: So let's try it. Double-click on the new Program Manager icon, and... instant lockup. One can see a dialog box on the screen asking for the usual name and company information (and an unusual request for a numerical password), but the mouse is dead, keys do not respond, and even a warm boot through the Control-Alt-Del keystroke fails to work. Reset time.

Restart the computer, think. Since the mouse pointer froze immediately (which is not the case for most Windows crashes), one suspects the mouse driver, which is the new mouse driver from Microsoft (version 8.10), and includes

*Fernando Gouvêa is an Assistant Professor of Mathematics at Colby College in Maine. His email address is: fqgouvea@colby.edu.

a utility for fiddling with the color and size of the mouse cursor. So let's not use that utility (which runs a separate process of its own under Windows), but keep the new driver. Try again.

This time, we get further. The dialog box pops up, asking for name, organization (why do software companies assume that everybody belongs to some organization?), and a password to be found in a card that accompanies the program. Look up the password (long), type it in, and the front end begins to load (as usual, the kernel is not loaded until necessary). Before anything else can happen, however, we get a UAE.

Those who have never used Windows have probably never met the dreaded UAE: the Unrecoverable Application Error message which Windows posts when some program has done something naughty and needs to be killed. The dialog box has an "OK" button; clicking on it will, if one is lucky, kill the application while allowing one to exit gracefully from Windows. (If one is unlucky, Windows gets killed too, and one is left with either a locked-up machine or is dumped back to DOS.) Fortunately, Microsoft has provided a little utility called "Dr. Watson," which gives some clue as to what is going on. In this case, "FE failed in DISPLAY," which points to some evil interaction between the Front End and the video driver.

Very well, the video driver is known to be a little flakey (it is the "Turbo Windows" driver supplied with the Diamond SpeedStar super-VGA card, which is very fast but occasionally interacts badly with other programs). So, change the video driver, restart.

This time, it works, but with one surprise. A dialog box pops up, asking the user to retype the long password from the license card. Once that is done, the program starts normally, and the kernel loads when requested, using up an alarming amount of memory. A little readout at the bottom right says how much memory is free; it keeps getting smaller as one works, since the kernel does not seem to be able to clean out unused data from memory. Still, the program is now usable.

Calling for support is the next step. At the very least, one hopes that Wolfram Research will be able to give some useful information on the incompatibility with the mouse driver, which is, after all, a Microsoft product. The call reaches a friendly technician, who explains that he is a Macintosh person who really knows nothing useful about the Windows implementation and suggests that an email message detailing the problems might be more effective. Write up the message, send it out.

That was two months ago. No answer has been received, not even to my query asking for a reply. Now, of course, my reviewer's package does include a phone number to call with questions, but since a normal user sure won't have that number, I decided to refrain from calling it. The lack of response to my request for support is quite a serious problem, I feel. Many users of the program will lack the expertise to figure out how to juggle their system around so as to get things to actually work.[1]

Using the program: The most immediate thing one has to deal with is the password business. The program would frequently ask for the password, usually on loading, but occasionally in later stages, too. My first impression was that this was a particularly annoying form of copy-protection. It slowly became clear, however, that this was not the case, as reports from other users on the internet described different symptoms. After some experimenting, I found the answer in a tip from Dan Halem at UCSC:

> I cured the password problem by changing my QEMM setup. If you are using QEMM or something like it add "x=e000-e7ff". Then erase the password line from the MATH.INI file in your windows directory. Then the next time you run it, reenter the information. It worked on my system. WRI said they didn't know what the problem was, but they thought it was related to QEMM, so I started playing with it...

This suggestion does work, and for the most part eliminates the repetitive request for the password, provided one is not using the "stealth" feature in QEMM.[2] However, I do still get an occasional "please enter the password" message, especially after the system has been in a strange state, such as very low system resources.

Having solved that problem (or, before it was solved, having typed in the password), one can play with the program. In general, it behaves very much like other versions of *Mathematica*, and thus has the virtues and defects characteristic of that system (see below for some idiosyncratic comments). As usual, the graphics capabilities of the program are impressive, including the use of Display PostScript technology that allows very detailed control of the graphics output. (Doing graphics eats up memory, however, and the Windows version does not have the "save after every computation" option that can be used to free up memory in the Macintosh version.) The program is also a competent symbolic manipulator and very good at numerical work. For example, I computed a large number of the Fourier coefficients of several modular forms, drew pictures of the platonic solids and made animations from them, used several of the number theory packages that come with the program, all without problems.

There are, however, several glitches.

The most immediately noticeable is that the program is pretty much unable to print. In fact, on my computer, I have never issued a "print" command to *Mathematica* without

[1]The following may offer an interesting contrast: a few weeks after discovering the conflict between *Mathematica* and the new Microsoft mouse driver, I saw a (unrelated) posting on the Usenet by one of the Microsoft mouse programmers. I sent him a note describing the problem. He immediately acknowledged it, thanked me, and a few weeks later sent me a note saying that the problem has been identified, and perhaps can be solved soon.

[2]This is a memory-management program, one of two "standard" programs used for this on DOS machines. The interaction between *Mathematica* and QEMM probably stems from the fact that *Mathematica* directly accesses some region of memory, and the fix amounts to telling QEMM to exclude that region from its managing.

getting a UAE, and the fault has usually been serious enough to crash the Windows session entirely (one is left at the DOS prompt at once). This is almost certainly due to some interaction between the front end and another of my drivers (the Adobe Type Manager? the video driver?). It happens irrespective of whether I try to print to a dot matrix printer or try to get PostScript output to a file (and therefore is very likely not a problem with the printer driver itself). I assume the issue is solvable, but by now I am getting into "why bother" mode.

Similarly, not all the usual examples work. For example, on page 702 of the *Mathematica* book, there is the example of solving the Lorenz differential equations numerically. Attempting this will consistently produce a UAE. The same is true for the examples that involve file access: as far as I can tell, none of them work.

All these problems suggest that one should glance at the manual, and among the many bits of documentation one finds some "release notes" that inform us of other potential problems. For example:

> In the current release, you must be careful when you use Complete Selection. Remember to select the word fragment that you want to complete before you choose Complete Selection. Then you must choose one of the completed words from the menu that appears on your screen. Do not click outside this menu in the *Mathematica* window; if you do, you will not be able to dismiss the menu, and you will have to quit *Mathematica*.

There are several other warnings in that vein, including one that says that unchecking the "Group output cells with input" option will cause the program to crash at the next calculation. An experiment confirmed that the crash will indeed happen. What is more, the program will remember your change in setting, and will keep on crashing until you change it again. (Why this menu choice was not "grayed out" is beyond me.)

A more subtle issue has to do with the Windows "system resources." It is my impression that *Mathematica* occasionally will fail to release the resources it no longer requires, leading to a situation where resources are very low and the system starts to behave strangely. This is not systematic and may be due to some strange interaction with other programs.

All of this says "unfinished" to me. The bugs are known, and probably will be fixed.[3] However, the version being tested is not some prerelease version, but rather the shipping version. It seems unreasonable to release a program that has problems like this without correcting them.

[3]Word on the internet is that version 2.1 should be out in a few months.

The Mathematica kernel is the heart of the *Mathematica* system, and it is not clear that any of the problems described above have to do with the kernel itself. They seem to relate, rather, to the "front end." In fact, the Windows implementation of the *Mathematica* kernel seems to be functionally equivalent to the Macintosh version (which is the only one I compared it with). Notebooks transfer quite easily between the two platforms (they are text files, so no serious translation problems arise), and the output is essentially identical too.

The usual set of *Mathematica* benchmarks indicated that the speed of this version compares quite well with that of the Macintosh version. To be specific, I ran the benchmarks under Windows and on a Macintosh Quadra 900. As expected, the Quadra is significantly faster, but not unreasonably so. For example, `FactorInteger[2^2^6+1]` took 6.04 seconds under Windows and 4.08 seconds on the Quadra, and

```
Show[Graphics3D[Stellate[Stellate[Icosahedron[]
]]]]
```

took 12.02 seconds under Windows and 11.22 seconds on the Quadra. All in all, the timings seem quite respectable.

The virtues and defects of the kernel itself are becoming well known, and are discussed in Xin Wei's article. As a whole, I find the *Mathematica* system usable, but occasionally rather strange. Perhaps the fact that so many of the functions behave in a "natural" way underscores the few that do not. For example, there are the usual annoying bugs in the definite integration routines. My current favorite is

```
Integrate[Sqrt[1+Cos[x]],{x,0,Pi}]
```

which returns a negative answer. I assume this reflects the usual "branch cut problem," though doing the integral by hand does not seem to lead through any dangerous turnings.

While *Mathematica* may not be perfect, it is still quite an impressive system for "doing mathematics by computer." The kernel is a powerful computational tool, and the graphically-oriented interface is relatively easy to learn. In order to be useful for teaching and research, however, such a program must be stable and dependable, and the current implementation of *Mathematica* for Windows unfortunately is anything but.[4] It seems very likely that version 2.1 of *Mathematica* for Windows will soon be released, and that most of the problems will by then be corrected. Interested users would do well to bide their time.

[4]A recent press-release from Wolfram Research asserts that *Mathematica* 2.0 is significantly more stable under Windows 3.1; I have not been able to test this, since version 3.1 is being released as this is written. The same document mentions a forthcoming version for Windows NT (which is still only a promise). It conspicuously fails to mention an OS/2 version.

Inside the AMS

Annual Report of the Secretary

Robert M. Fossum

Strategic and Long Range Planning

The pages of the 1991 *Notices* are replete with news about the Society's planning for the future. The January 1991 issue announces the creation of a Strategic Planning Task Force (SPTF). The complete report of the Task Force, which was approved by the Executive Committee and Board of Trustees (ECBT) at its meeting in May 1991 (albeit not unanimously), appears in the July/August 1991 issue of the *Notices*. The Task Force identified eight strategic issues that the Society should address. These are:

1. The Mission of the AMS.
2. AMS Publications, Meetings, and Membership.
3. Other AMS Programs and Services.
4. External Challenges Facing the AMS and the Mathematics Community.
5. Vitality of the Mathematics Profession.
6. Fragmentation of the Mathematics Community.
7. Membership, Voluntary Leadership, and Governance.
8. Internal Management of the AMS.

The Mission of the AMS

While the original mission statement of the Society appears to be broad, it is nevertheless rather vague. The Task Force thought that it did not serve to guide the organization in its role definition and decision-making. Thus a revision was suggested and proposed to the Council in August 1991. After some discussion, the Council passed the following resolution:

The Council of the American Mathematical Society adopts the following statement of mission:
The AMS, founded in 1888 to further the interests of mathematical research and scholarship, serves the national and international community through its publications, meetings, advocacy, and other programs, which
• promote mathematical research, its communication and uses,
• encourage and promote the transmission of mathematical understanding and skills,
• support mathematical education at all levels,
• advance the status of the profession of mathematics, encouraging and facilitating full participation of all individuals, and
• foster an awareness and appreciation of mathematics and its connections to other disciplines and everyday life.

AMS Publications, Meetings, and Membership

These are the most important and visible programs for the Society. The publications program costs about 75% of the total Society budget and furnishes a similar amount of the income. In addition to the recent downturn in the economy, there are other issues that will affect the publication program, such as electronic forms for delivery of published material. The major part of the publication effort is expended on *Mathematical Reviews*. Efforts to cut costs while still maintaining the usefulness of the product are under consideration.

The Society offers two types of broad interest meetings, National and Sectional Meetings. These have evolved into a fairly routine pattern. However, one can question whether the current patterns address the needs of all the members of the Society and whether these meetings should include activities other than Special Sessions and Invited Addresses. These questions are now under consideration by an *ad hoc* committee on Meetings.

And perhaps there are other areas in which the Society can provide services to its members without significantly increasing the cost to these members. For example, the Society has established e-MATH, which has many electronic services. e-MATH is currently being supported by grants from the National Science Foundation.

Other AMS Programs and Services

Reports from various Society committees and/or groups concerning these activities, as well as other issues and activities mentioned elsewhere in this report, will appear from time-to-time in the *Notices*.

External Challenges Facing the AMS and the Mathematics Community

The SPTF identified major external issues as:

- the volatile job market for mathematicians,

- the renewal of the profession,
- mathematics education reform at all levels,
- national public policy development in support of the sciences and mathematics, and
- creating a more positive image of mathematics and mathematicians.

These issues are being considered by various committees and task forces within the Society.

Vitality of the Mathematics Profession
The Committee on Science Policy and the Committee on Education are addressing access, recruitment, and retention aspects of the profession.

Fragmentation of the Mathematics Community
An initial response to the problem of fragmentation has been the appointment of the joint AMS-MAA Committee on Cooperation mentioned below.

Membership, Voluntary Leadership, and Governance
A principal concern in this area is to have effective Volunteer Leadership that is maintaining excellent lines of communication with the membership and staff. President Artin asked the Committee on Committees to look into the structure of committees of the Society. The Committee on Committees suggested that a subcommittee be appointed, with supplemental members from outside the Committee, to consider the committee structure. This subcommittee has been active during 1991. It expects to have a report ready for the Fall 1992 ECBT meeting.

Meetings

The Annual Meeting of the Society in 1991 was held in San Francisco, California, in January. The Colloquium Lectures were delivered by Robert MacPherson and the Gibbs Lecture was given by Michael Atiyah. In honor of the 20th Anniversary of the founding of the *Association for Women in Mathematics*, there was a joint AMS-AWM-MAA Invited Address delivered by Christel Rotthaus. G.D. Mostow, President of the AMS in 1987 and 1988, delivered his Retiring Presidential Address. There were three AMS-MAA Invited Addresses, five Invited Addresses, sixteen Special Sessions, and many sessions for contributed papers.

The 1991 Summer Meeting of the Society was held in Orono, Maine on the campus of the University of Maine in August. The meeting marked the introduction of a new format for summer meetings: The Summer Mathfest. Under this format, the scientific portion of the meeting is limited to three days, with Invited Addresses and the like held in the morning and Special Sessions, sessions for contributed papers, and committee meetings limited to the afternoon (and evening if necessary). Prizes for the AMS and MAA were awarded at a joint banquet held the evening before the meeting began. The Orono Mathfest featured three AMS-MAA Invited Addresses, an AMS History of Mathematics Lecture delivered by George W. Mackey, two Progress in Mathematics Lectures, one by H.W. Lenstra, Jr.and one by Richard M. Schoen. There were eight Special Sessions and the usual complement of sessions for contributed papers.

Since the International Congress on Mathematical Education (ICME) will take place in mid-August 1992 in Quebec City, Canada, the AMS-MAA Joint Meetings Committee decided not to hold a Summer Mathfest in 1992. The MAA will hold meetings of some of its committees and Board of Governors just before the ICME. Meetings of the Council of the AMS and other committees will be arranged.

The AMS and MAA have agreed to meet jointly with the Canadian Mathematical Society in August 1993 at the University of British Columbia in Vancouver, British Columbia. The three organizations are planning an exciting scientific program.

Prizes and Awards

A feature of Annual and Summer Meetings is the awarding of prizes. At the Annual Meeting in San Francisco in January 1991, the Society awarded the Oswald Veblen Prize in Geometry, the Ruth Lyttle Satter Prize in Mathematics, and a Citation for Public Service. At the Summer Meeting in Orono in August 1991, the Society awarded three Steele Prizes.

The Oswald Veblen Prize in Geometry
The 1991 Oswald Veblen Prize in Geometry was awarded to Andrew J. Casson of the University of California at Berkeley and to Clifford H. Taubes of Harvard University. Casson received the prize for his work on the topology of low dimensional manifolds and Taubes received the prize for his work in Yang-Mills theory. The prize is named in the memory of Oswald Veblen (1880–1960) who served as President of the Society in 1923 and 1924. It is funded by contributions from former students of Veblen and supplemented from the Steele Prize Fund.

Ruth Lyttle Satter Prize
The first Ruth Lyttle Satter Prize was awarded to Dusa McDuff of the State University of New York at Stony Brook for her work on symplectic geometry. The Council established this prize to honor the memory of Ruth Lyttle Satter. It is to be awarded to a woman mathematician every other year for an outstanding contribution to research in mathematics during the past five years. This prize is endowed by a gift from Joan S. Birman.

Leroy P. Steele Prizes
The Leroy P. Steele Prizes for 1991 were awarded at the Summer Meeting of the Society held in Orono. The 1991 Steele Prize for Expository Writing went to Jean-François Treves for his book *Pseudodifferential and Fourier Integral Operators* (Volumes 1 and 2) published by Plenum Press in 1980. The 1991 Steele Prize for a Fundamental Paper went to Eugenio Calabi for his fundamental work on complex differential geometry. The 1991 Steele Career Prize was awarded to Armand Borel for his work in laying the foundations of the theory of linear algebraic groups. The

Leroy P. Steele Prizes were established in 1970 in honor of George David Birkhoff, William Fogg Osgood, and William Casper Graustein and are endowed by a bequest from Leroy P. Steele.

AMS Centennial Fellowships

AMS Centennial Fellowships were awarded in 1991 to Daniel Bump of Stanford University and to Kari Villonen of Brandeis University. 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. They are awarded to individuals who have received a Ph.D. from seven to twelve years prior to winning the award. The stipend in 1991 was $38,000. Funds for these awards are supported by contributions from members of the Society. The Society contributes to the program from its general fund.

Sectional Meetings

There were six sectional meetings of the Society in 1991 at which nineteen Invited Addresses were delivered and numerous Special Sessions were held. Attendance at these sectional meetings continues to improve. The Society displays its books, journals, and its MathSci database at these sectional meetings. In addition, registration by credit card is now available at most sectional meetings.

Other Meetings and Conferences

The Society sponsored its annual AMS Summer Research Institute. In 1991 the topic was *Algebraic Groups and Their Representations*, organized by Igor Frankel, Eric Friedlander, William Haboush (chair), Jens Jantzen, and Brian Parshall. The Institute was held at the Pennsylvania State University, University Park, PA, in July 1991.

The Joint Summer Research Conferences in the Mathematical Sciences were held at the University of Washington, Seattle, from 22 June to 2 August 1991. These were sponsored by the AMS, SIAM, and the Institute for Mathematical Statistics (IMS). Topics in 1991 were: *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.*

The twenty-fifth annual Symposium on Some Mathematical Questions in Biology on *Theoretical approaches for predicting spatial effects in ecological systems* was held on 8 August 1991 in San Antonio, TX during the Annual Meeting of the Ecological Society of America. This symposium is sponsored by the AMS, SIAM, and the Society for Mathematical Biology.

The AMS helped to support mathematical sciences activities at the American Association for the Advancement of Science (AAAS) by contributing to the sponsorship of speakers in mathematical symposia it cosponsors with AAAS.

Science Policy

The Committee on Science Policy (CSP) has been active during 1991. The Long Range Planning Committee, the ECBT, and the Council have recommended that the CSP develop long range plans for Society science policy, in particular to address the strategies outlined by the SPTF. The CSP is currently working with internal task forces to develop these plans in several different areas.

The CSP has recommended that the Society and its officers engage in closer cooperation with MAA. To this end, a joint AMS-MAA Committee on Cooperation has been established. This committee has met several times and is in the process of identifying areas of close cooperation and mutual support.

Education

As mentioned above, the Council has established a Committee on Education. It has now met several times. Its current agenda is concerned mostly with developing a set of policies in line with the strategies mentioned above for the Society to follow in the education arena.

JPBM

The Joint Policy Board for Mathematics (JPBM) is a cooperative venture sponsored by the Society, the MAA, and SIAM. Each of the three participating organizations have three representatives on JPBM. These nine members then appoint a tenth member as the Chair. One of JPBM's major activities has been to direct its Office of Governmental and Public Affairs (OGPA) in Washington, DC. Ed Connors served as Director of OGPA until mid-summer. He has returned to his position as Professor of Mathematics at the University of Massachusetts. After Connors departed, JPBM appointed Richard Herman of the University of Maryland as Chair of JPBM and Director of OGPA. This change took effect in the Fall of 1991.

Committees

As part of the long range planning process, a study of the committee structure has commenced. A list of charges for all committees of the Society, including the joint committees, is being assembled. A good portion of this work was finished in mid-1990. As of the end of 1991, there were 96 committees listed in the 1992 Professional Directory (which represents the status at the end of 1991). In the middle of 1991 there were 431 members of Society committees. These represented 136 institutions from 38 of the 50 states, 5 different institutions in Canada, and a handful of institutions from outside North America.

Elections and officers

The election of officers in 1991 featured a first for the Society—a contested election for the position of President-

Elect. The Council agreed to try contested elections for this position, with a review of the process after six years. In 1991 the Council nominated Ronald Graham and Stephen Smale as candidates for President-Elect. Also, the Council appointed Nominators Gian-Carlo Rota and Raoul Bott to write articles for the *Notices* about the respective candidates. This material appeared in the September 1991 *Notices*, just before ballots were mailed.

The 1991 election also marked the introduction (at least to the Secretary) of email campaigning. At least one candidate used electronic mail to request recipients for their vote. Perhaps this portends the time when all campaign material will be sent out via electronic mail.

Steve Armentrout had announced that he would serve only one more term as Associate Treasurer, so a search was initiated to identify a new Associate Treasurer. The search committee reported to the November 1991 ECBT, which approved the report. The January 1992 Council then appointed B. A. (Al) Taylor of the University of Michigan as the Associate Treasurer Designate. He will serve in this capacity during 1992 and take office as Associate Treasurer on 1 February 1993.

The results of the 1991 Election have been reported elsewhere in the *Notices* and will not be repeated here.

Conclusion

These are only a part of the activities of the Society during 1991. The economic downturn had its effects on the Society budget. In particular, the Society noticed a marked decrease in journal subscriptions and other purchases. The financial situation is reported by the Treasurer in this issue of the *Notices*. As always, the Officers and Staff of the Society welcome input, suggestions, and comments from you, the members.

Report of the Treasurer (1991)

Franklin P. Peterson

I. Introduction

During 1991, the Society's revenues increased 7% over 1990, while its expenses increased only about 1%. The result was an excess of revenues over expenses in 1991 of $1,038,000 compared to a small deficit in 1990. I will explain some of the more significant reasons for this below.

As I explained last year, the Society has taken several steps to improve its book publishing program. These steps include initiatives in acquisition, production, and marketing. These efforts have begun to pay off. Book revenues are up about 30% over 1990, and the publication of new titles in books in series is up 68%.

MathSci revenues have increased significantly without significant increases in expenses. These increases were nearly all in sales of MathSci Disc.

The Society's balance sheet remains healthy. As of December 1991, there was no long-term or short-term bank debt, and unrestricted fund balances amounted to 40% of total assets, about 1% lower than 1990.

II. Summary Financial Statements

The Treasurer this year again presents to the membership summary financial statements of the Society. A copy of the Society's audited financial statements, as submitted to the Trustees and the Council, will be sent from the Providence Office to any member who requests it from the Treasurer. The Treasurer will be happy to answer any questions members may wish to put to him concerning the financial affairs of the Society.

SUMMARY STATEMENT OF ACTIVITY
For the Years Ended December 31, 1991 and 1990
(Thousands of Dollars)

Revenue	1991		1990	
Journals	$10,227	58%	$ 9,780	59%
Books	2,131	12%	1,636	10%
Dues	1,669	9%	1,532	9%
Membership Activities	367	2%	237	1%
Meetings	595	3%	533	3%
Grants and Contracts	996	6%	1,263	8%
Investment Income	690	4%	725	4%
MathSci Online/Tapes and Disc	626	3%	448	3%
Other	469	3%	443	3%
Total revenue	$17,770	100%	$16,597	100%

Expense	1991		1990	
Journals	$ 9,720	58%	$ 8,533	51%
Books	1,769	11%	1,426	9%
Marketing	474	3%	594	4%
Membership Records	390	2%	391	2%
Membership Activities	662	4%	508	3%
Meetings	647	4%	712	4%
Grants and Contracts	1,036	6%	1,342	8%
Software Development Projects	424	2%	873	6%
MR Database Development Project	118	1%	679	4%
MathSci Online/Tape and Disc	401	2%	379	2%
Other	1,091	7%	1,173	7%
Total expense	$16,732	100%	$16,610	100%
Excess (Deficiency) of Revenues over Expenses	$ 1,038		($ 13)	

SUMMARY BALANCE SHEET
December 31, 1990 and 1991
(Thousands of Dollars)

Assets	1991	1990
Cash & temporary investments	$ 5,125	$ 3,315
Other short-term investments	970	833
Investments in Treasury Notes	516	

Receivables-members & others (less allowance doubtful accounts)	1,299	1,325
Due from invested funds	26	
Deferred prepublication costs	867	977
Inventory of completed books & back volumes of journals	1,665	1,234
Prepaid expenses and deposits	1,015	1,014
Property and equipment (less accumulated depreciation)	4,691	5,176
Total operating assets	16,174	13,874
Long-term investments (unrestricted)	7,217	6,755
Total operating assets and unrestricted investments	23,391	20,629
Long-term investments (restricted)	2,285	2,280
Total assets	$25,676	$22,909
Liabilities and fund balances		
Accounts payable	$ 1,197	$ 954
Subscriptions, dues, and other revenues received in advance	10,147	8,600
Other miscellaneous liabilities	1,655	1,713
Total liabilities	12,999	11,267
Unrestricted fund balances:		
Operating fund balance	3,175	2,607
Unrestricted invested fund balances:		
Economic Stabilization	7,065	6,594
Friends of Mathematics	124	124
Other	28	37
Total unrestricted invested funds	7,217	6,755
Total unrestricted fund balances	10,392	9,362
Restricted invested fund balances:		
Endowment funds:		
The Endowment Fund	100	100
Robert Henderson	548	548
Joseph Fels Ritt	23	23
Prize funds	183	183
Waldemar J. Trjitzinsky	196	189
C. V. Newsom Fund	100	100
Centennial Research Fellowship	31	31
Pooled Income Fund	5	5
Eliakim Hastings	3	3
Undistributed net gains on investment transactions	1,070	1,098
Total restricted invested funds	2,259	2,280
Due to operating funds	26	
Total liabilities and fund balances	$25,650	$22,909

III. Operations

I now turn to a more detailed discussion of the Society's 1991 operations.

Journals. Journals provide the largest fraction of the Society's revenues and expenses. In the past, journals have operated at a net loss (the net loss on *MR* was greater than the combined net income of the other journals). Since 1985, journals (in the aggregate) have operated in the black and provided a very significant portion of the Society's surplus (the excess of revenues over expenses in the summary financial statements above). It can be expected that the amount of surplus generated by journals will decrease over the next few years. This is a result of pressure from subscribers to keep prices low, increases in costs which are largely outside of the control of the Society, and attrition in subscribers. Alternative cost saving opportunities and alternative sources of support are being sought to compensate for the higher expenses. MathSci Disc is a good example of the latter.

Books. Included in this category are not only books (monographs or collections of articles) but review volumes and indexes to journals. In 1991 book sales increased 30% over 1990 sales. This increase reflects the publication of a record number of books. Much of the increase over prior years was in translated books, an area which the AMS has given particular attention in 1990 and 1991.

Dues, Membership Activities, and Membership Records. The Society has about 489 institutional members and 27,300 individual members. Of the latter, about 11,800 pay no dues because they are student nominees, emeritus members, or reviewers without convertible currency. Individual member dues are two-tiered to provide some relief to lower paid members. Increases in dues for individual members are set annually by a cost-of-living index.

Costs which can be considered to be partially covered by dues include the cost of maintaining membership records, the deficits of *Abstracts*, *Bulletin*, *EIMS*, the *Notices*, and the *Professional Directory*, deficits from meetings, including the Employment Register, and the AMS support of the Joint Policy Board on Mathematics.

Meetings. Meetings has operated at an overall deficit, as a service to the mathematics community. The 1991 deficit was significantly less than the 1990 deficit. This was the result of increases in registration fees and increases in the number of registrants at meetings.

Grants and Contracts. Grant support is mainly for travel and subsistence for participants in research conferences, institutes, and seminars, plus the Society's cost in preparing and running these conferences. The money received from government agencies is reimbursement only, with no profit to the AMS. The Society also has contracts to perform services for other organizations, and this helps to recover some fixed costs. The decrease in this category reflects a 1990 grant for travel support to ICM90.

Software Development Projects. The primary project included in this group is the development of a system for the

management of order fulfillment, customer and membership databases, and related functions. The costs involved include personnel costs, computer usage charges, and other indirect costs. This is intended to benefit all of the publications and membership related activities of the Society.

***MR* Database Development.** This is another software development project. It is a rewrite of the *MR* database, which is used for the management of the information used in the preparation of *Mathematical Reviews* and related publications. Its cost also includes personnel costs, computer usage charges, and other indirect costs.

Other Revenues and Expenses. The principal components of other revenues and expenses are e-Math (the single largest item), TEX related products, UME Trends, Video Tapes, and the AMS support of the Joint Policy Board on Mathematics.

IV. Assets and Liabilities

So far, this report has dealt with sources of revenue and applications of expense. Another aspect of the Society's finances is what it owns and owes, or its assets and liabilities, which are reported in the Summary Balance Sheet. The Society maintains its accounts in fund groups. The operating funds include membership and publications activities; the invested funds include both endowment funds (gifts and bequests whose principal is required to be invested in perpetuity and whose income must be used for the purpose stated by the donor) and quasi-endowment funds (those funds set aside by the Board of Trustees for designated purposes). Most of the quasi-endowment investments have been reserved as an economic stabilization fund, as a hedge against future economic difficulties.

The Society's fiscal year coincides with the period covered by subscriptions and dues. Since dues and subscriptions are generally received in advance, the Society reports a large balance of cash and temporary investments on its fiscal year-end, December 31. This amounted to about $6,611,000 in 1991 and $4,148,000 in 1990. The recorded liability for the revenues received in advance was about $10,147,000 and $8,600,000 on the same dates. The difference can be thought of as having been invested in the Society's other assets. Effectively, the Society borrows from its subscribers to finance current operations and long-term investments. This is a common practice in the publishing industry and allows the Society to maintain a very low amount of bank debt, which was zero throughout 1991 and 1990.

The Society's property and equipment include land, buildings and improvements, and office furniture, equipment and software. The Society also owns a small amount of transportation equipment. The land, buildings, and improvements include the Society's headquarters building in Providence and the Mathematical Reviews offices in Ann Arbor. The largest part of the Society's office equipment is its investment in computer facilities.

JPBM Committee on Professional Recognition and Rewards

The Joint Policy Board for Mathematics (JPBM) Committee on Professional Recognition and Rewards met in Baltimore in January and again in Washington in March. The charge to the committee was sharpened and approved, the course for the committee's work was set, and plans were made to visit five institutions to talk to faculty and administrators about the local recognition and rewards system.

The committee was appointed in response to growing awareness that the rewards structure is one of the key factors supporting and inhibiting the renewal of the profession, the revitalization of precollege, undergraduate, and graduate education, and the promotion of interdisciplinary work and efforts by the mathematics community to reach out to other disciplines and to industry. The problems faced by the community and the role of the rewards system are documented in a number of recent reports, particularly the National Research Council report "Renewing U.S. Mathematics, A Plan for the 1990s", the Carnegie Foundation for the Advancement of Teaching report by Ernest Boyer titled "Scholarship Reconsidered, Priorities for the Professoriate", and the National Science Foundation report "America's Academic Future, A Report of the Presidential Young Investigator's Colloquium on U.S. Engineering, Mathematics, and Science Education for the Year 2010 and Beyond".

The Committee has accepted the following seven-point charge: initiate a dialogue on these issues within the mathematical sciences community; identify contributions that should be recognized and rewarded; determine how those involved (faculty members, department chairs, deans, mathematicians, and managers employed in industry) value the various contributions and determine how the rewards system works in practice; study methods of evaluation of types of contributions that are identified as being important; articulate the ways contributions are, and can be, rewarded; make recommendations on the contributions that should be recognized and rewarded and on methods to evaluate these contributions; and produce a plan to lead the community toward implementing the recommendations.

Calvin C. Moore, Associate Vice-President for Academic Affairs, University of California, is the chair of the committee; the other members are: Barbara T. Faires, Westminster College; Gene H. Golub, Stanford University; Phillip A. Griffiths, Institute for Advanced Study; Shirley A. Hill, University of Missouri at Kansas City; William E. Kirwan, III, University of Maryland; Peter D. Lax, Courant Institute, New York University; Carolyn R. Mahoney, California State University, San Marcos; Barry Mazur, Harvard University; Gary C. McDonald, General Motors Research Laboratory; Stephen B. Rodi, Austin Community College; Richard A. Tapia, Rice University; John A. Thorpe, State University of New York, Buffalo; Andrew B. White, Jr., Los Alamos National Laboratory; and Carol S. Wood, Wesleyan University.

Creating a dialogue within the mathematical sciences community is viewed as one of the most important charges to the committee. This dialogue will begin with the five site visits planned for April and May 1992. Fifteen to twenty additional site visits will be made during the 1992–1993 academic year, mathematical sciences departments will be surveyed, and panel discussions will be organized at national and regional meetings of the three organizations that comprise JPBM: the American Mathematical Society; the Mathematical Association of America; and the Society for Industrial and Applied Mathematics. Comments and suggestions from individuals are welcomed and should be brought to the attention of the project director, William Adams, Department of Mathematics, University of Maryland, College Park, MD 20742 or via email to wwa@math.umd.edu.

Transactions of the American Mathematical Society Temporary Policy Change

The *Transactions of the AMS* has found that it has a backlog of distressing dimensions. In order to reduce the backlog quickly, the editors have agreed to a policy, which has already been implemented, of sharply higher standards for publication. As a consequence, many papers that formerly would have been easily accepted now cannot be accepted at all, and those that are accepted are still subject to the backlog. The change in policy is temporary, but will continue until the situation is remedied. We hope it will require less than a year. Updated information about the backlog is to be published in each issue of the *Transactions*.

James E. Baumgartner
Managing Editor, *Transactions*

Trjitzinsky Awards Made to Students

The January 1992 issue of the *Notices*, page 22, carried an announcement of four awards made through the Society's Waldemar J. Trjitzinsky Memorial Fund. The mathematics departments at Duke University, Howard Payne University, Montana State University, and the University of Scranton each received $2500 to assist needy students of mathematics. The departments were asked to select students to receive the awards. The Society has received word from the four institutions about the students receiving the awards.

Duke University selected three students. ROBERT LANE BASSETT competed in various mathematics contests while in high school and says he finds mathematics "valuable as a pure, logical system of thought." He says he hopes to find a job in applied mathematics, but is also considering graduate school. LINIE YUNWEN CHANG attended the North Carolina School of Science and Mathematics and is currently a junior at Duke. She says she hopes to participate in a mathematics research project this summer. She plans to attend medical school and become a pediatrician. KARA LEE LAVENDER, a sophomore at Duke, received the IBM Award for achievement in mathematics in her senior year in high school. She is undecided about her career goals after earning her undergraduate degree, but she is considering teaching or an area in which mathematics is applicable. She says she enjoys mathematics and hopes to put her degree to good use.

Howard Payne University selected PAMELA JO CHANEY. Geraldine Boyd, head of the mathematics department, reports that Ms. Chaney is a very capable student with great potential to be successful in graduate school. Selected both for her mathematical promise and her financial need, Ms. Chaney is a thirty-two year old wife and mother of three children. She had dropped out of high school in her senior year. Her return to school has been a great success: she has maintained a 4.0 average for her first three semesters while carrying a heavy courseload, working twenty hours per week, and caring for her family.

Montana State University selected three students. MELISSA COCKERILL is a senior from Maryland. She will attend graduate school in the fall and is planning on a career in government or industry. DEBORAH FAGAN is a senior from Montana who also plans to attend graduate school next year. A member of Beta Alpha Psi, a national accounting honorary society, she is planning a career in industry and may continue on to a doctorate. SHERRY HEIS is a senior from Montana. Graduate school is also in her future, though she has not fixed on a career plan. She is a member of Phi Kappa Phi and has received another scholarship award from the mathematics department.

The University of Scranton selected THOMAS A. SHIMKUS. Gary Eichelsdorfer, chairman of the mathematics department, reports that Mr. Shimkus is the son of a Lithuanian immigrant who has been unemployed since the summer of 1991, with no job prospects. Mr. Shimkus graduated second in a class of 165 from Scranton Preparatory High School and currently is a junior in mathematics with a GPA of 3.9. "A genuine love of learning motivates this young man," says Professor Eichelsdorfer. "He approaches his studies with an eagerness and enthusiasm that makes him a welcome member of any course." In addition to tutoring students in a work-study program, Mr. Shimkus works as a dishwasher at a local restaurant and sold Christmas trees over the winter holidays. When asked what he would like to do after graduation, he says he would like to continue his education with the goal of becoming a college professor or an actuary. In his spare time, Mr. Shimkus enjoys weight lifting and reading. When asked what kind of books he likes, he replied: "Mathematics, of course."

These four schools were selected for awards in a random drawing from the pool of AMS institutional members. The recipients of the next round of Trjitzinsky awards, to be given annually, will be announced in an upcoming issue of the *Notices*. For more information about the Trjitzinsky fund, contact Timothy J. Goggins, Development Officer, AMS, P.O. Box 6248, Providence, RI 02940-6248.

Washington Outlook

This month's column is written by Richard Herman, Chair of the Joint Policy Board for Mathematics and dean of the College of Computer, Mathematical, and Physical Sciences at the University of Maryland, College Park.

The fiscal year 1993 budget for the National Science Foundation (NSF) poses some interesting questions for our community. By and large, any incremental funding appears as "initiative" directed within the Division of Mathematical Sciences (DMS). Looking at the Foundation increase as a whole, 88% went for specified areas, with roughly half of that due to initiatives such as Global Change, High Performance Computing and Communications, etc., generated by the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET). The other NSF specified activities include Foundation initiatives in environmental research and manufacturing and other programs such as the Laser Interferometer Gravitational Wave Observatory and the U.S. Antarctic Program. This leaves about $54 million, or 12%, unspecified.

Before going on, let me add a few words about the FCCSET process. Judith Sunley, Director of the DMS, points out that, "The FCCSET process is very complex, with ideas coming up through several agencies, circulating through the FCCSET committees and returning to the agencies for implementation". This is meant to avoid duplication of effort and encourage cooperation and, in particular, would have "NSF focus on the basic research end of an initiative." This year, we have been presented, or, more properly, confronted, boldly with the results of the fact that the NSF, much as any other agency, has to make appealing arguments for its increases. (In actual fact, dollar increases to the Foundation for items such as the Antarctic program would not necessarily be available for other items.) Walter Massey, Director of the NSF, pointed this out at the Joint Mathematics Meetings in Baltimore in January, when he remarked that, "(part of his) job is to increase the total resources flowing to NSF."

That the budget request is less than what the NSF originally requested of the Office of Management and Budget in the fall of 1991 is probably true. Some directives came from without and, quite clearly, some from within. Given the numbers above, it is evident that there was some flexibility within the Mathematical and Physical Sciences Division (within which lies the DMS). Assistant Foundation Director David Sanchez, the Director of the Mathematical and Physical Sciences Division, revealed that he had $16.4 million of discretionary funds. He made a decision to provide his discretionary resources to some disciplines that had not received initiative funding, feeling that "not to do so was unacceptable."

To set the consequences of this budget in perspective, it is useful to look not only at mathematics, but at most other disciplines. Take the biological sciences. The increment in this area is $46.4 million or 16.9%. This large percentage is *entirely* initiative directed and is consistent with the NSF strategy of "Strengthening the research base in areas critical to enhancing the nation's education and research enterprise" (through support of individual investigators). This is not meant to justify actions but to indicate the process. The result in mathematics is the same, of course, where we now see no increment in "disciplinary research."

Does this mean that those doing disciplinary research are out of the picture? I suppose to some extent this depends on whom you ask and what you mean by the question. It's hard to imagine that much of this incremental funding will not be available to some (but not all) of those doing disciplinary research. On the one hand, we see an 8.1% increase for DMS and, on the other, no increase for the traditional disciplines. The small relative increases afforded to most mathematical subdisciplines in recent years could have led us to the conclusion that one day we would be so confronted. Nevertheless, the bold nature of the budget has led some to a foreboding view.

The budget divisions are unnecessarily stark. However, I doubt that anyone imagines that cross-disciplinary work could be spoken of without acknowledging the importance of the disciplines. In fact, Sunley remarks that, "Interdisciplinary work that is on the intellectual frontier requires disciplinary input that is likely to be deep, broad, and very imaginative. Without cutting edge results coming from the disciplines, you don't make progress on the interdisciplinary front." This statement would seem to suggest that "disciplinary" workers have to take a good hard look at the Request For Proposals, which should be appearing soon. In

the long run, participation in the initiatives (to which we have a great deal to offer) is likely to enhance the position of mathematics.

So we are left to ask "what next?" This would seem to break down into short- and long-term plans. With regard to the latter, perhaps some comfort is offered by the fact that there is only likely to be one more initiative at the FCCSET level. (There has already been an announcement of a Manufacturing Initiative in fiscal year 1994.) Moreover, additional involvement should help us shape future budgets. To date, as Sunley points out, "Mathematicians have been involved only in a marginal way in FCCSET process. This changed with the recent appearance of Ed David and Phil Griffiths before the FCCSET committee. A sustained effort is needed." Yet it is likely that the imprint of this year will be with us for some time (the FCCSET process requires five-year plans). This calls for a recognition that this is not business as usual and that we need to be thinking now about how the fiscal year 1994 budget should more amply reflect the needs of the community as well as those to whom we answer. (While this column has been motivated to some extent by the NSF budget, it should be clear that we need to have discussions with all the agencies. For example, the aggregate mathematics budget for Department of Defense agencies *decreased* by 1.2%.)

Many different approaches to the short-term issues have already been suggested by members of the community. Various meetings have taken place. One particular meeting with Walter Massey served to present concerns and helped to set the situation in perspective. Speaking to community leaders, Massey suggested that we need to be proposing new strategies for continued growth. The Joint Policy Board for Mathematics, acting through its constituent societies, is endeavoring to help structure long-range strategies for the community.

News and Announcements

Lawrence J. Corwin 1943–1992

Lawrence J. Corwin, professor of mathematics at Rutgers University, died on March 19, 1992 at the age of 49.

Born on January 20, 1943 in East Orange, New Jersey, Professor Corwin received his A.B. in 1964, A.M. in 1965, and Ph.D. in 1968, all from Harvard University. He was a C.L.E. Moore Instructor at the Massachusetts Institute of Technology (1968–1970), a visiting member at the Courant Institute of the Mathematical Sciences (1970–1971), and an assistant professor at Yale University (1971–1975). From 1972 to 1974, he was a Sloan Foundation Fellow. He joined the faculty of Rutgers University in 1975 and advanced to the rank of professor in 1980. He held visiting positions at the Institute for Advanced Study at Princeton (Fall 1973) and at the Institut des Hatues Etudes Scientifiques, Bûres-sur-Yvette (Spring 1974).

An active researcher in Lie groups, representation theory, and harmonic analysis, Professor Corwin was the coauthor of three books and numerous articles. He presented invited lectures in many institutions in the U.S., Canada, Europe, and South America. He was also very active in administration at Rutgers University, serving as chair of the mathematics department from 1975 to 1981 and as associate provost for the mathematical and physical sciences and engineering from 1988 to 1990. Professor Corwin served as a member-at-large of the AMS Council from January 1989 to January 1992.

He is survived by his wife, Amy Cohen, also on the mathematics faculty at Rutgers, and a son, Nathan.

MacPherson Receives NAS Mathematics Prize

Robert D. MacPherson of the Massachusetts Institute of Technology has received the National Academy of Sciences (NAS) Award in Mathematics for "his role in the introduction and application of radically new approaches to the topology of singular spaces including characteristic classes, intersection homology, perverse sheaves, and stratified Morse theory." The award, presented every four years, was established by the AMS in honor of its Centennial in 1988. The first recipient of the award was Robert Langlands.

A more extensive piece on MacPherson and his work is under preparation and will appear in a future issue of the *Notices*.

Majda Receives NAS Applied Mathematics Award

Andrew J. Majda of Princeton University has received the National Academy of Sciences Award in Applied Mathematics and Numerical Analysis. The $10,000 prize is given every three years. Professor Majda was cited for "his extraordinary insight and invaluable contributions to the analysis and application of partial differential equations especially to supersonic flow, combustion, vortex motion, and turbulent diffusion."

Professor Majda was born in East Chicago, Indiana on January 30, 1949. He received his B.S. in mathematics in 1970 from Purdue University and his M.S. and Ph.D. in mathematics in 1973, both from Stanford University. In 1973, he became a Courant Instructor at the Courant Institute of Mathematical Sciences at New York University. He moved to the University of California at Los Angeles as an assistant professor in 1976 and advanced to the rank of associate professor in 1977. In 1979, he joined the faculty of U.C. Berkeley as a professor. Since 1984, he has been a professor at Princeton University.

Professor Majda has held visiting professorships at the Courant Institute, the Collège de France, the Institute for Mathematics and its Applications at the University of Minnesota, and the Mathematical Sciences Research Institute in Berkeley.

In 1990, Professor Majda presented a plenary lecture at the International Congress of Mathematicians in Kyoto. He was an invited speaker for the AMS symposium, Mathematics into the Twenty-first Century, held during the AMS Centennial in Providence in August 1988. His other honors and awards include an Alfred P. Sloan Foundation Fellowship (1977–1979), the Medal of the Collège de France (1982), and the John von Neumann Award and Lecture of the Society for Industrial and Applied Mathematics (1990). In January 1984, he presented an invited address at the Joint Mathematics Meetings in Louisville. Since 1987, he has been an associate editor of the *Journal of the AMS*.

Bourgain Receives Ostrowski Prize

JEAN BOURGAIN of the Institut des Hautes Etudes Scientifiques and the University of Illinois at Urbana-Champaign has received the 1991 Ostrowski Prize. The prize of 50,000

Swiss francs is to be awarded on May 8, 1992 at a ceremony at the mathematical institute of the University of Basel.

Jean Bourgain

Bourgain was cited for his contributions to several areas of mathematics: harmonic analysis, ergodic theory, functional analysis (particularly Banach space theory), complex analysis, and classical convexity theory. The prize citation said: "In all these areas, J. Bourgain solved dozens of central long standing open problems and developed new powerful research tools and directions. In his work he uncovered numerous suprising connections between these various subjects. As a result of Bourgain's achievements several large domains in these areas changed completely."

Among his many achievements, the prize citation mentions in particular his ergodic theorem on arithmetic subsequences, the construction of $\Lambda(p)$ sets, his maximal function theorem in R^2, and the recent restriction and multiplier theorems.

Alexander M. Ostrowski (1893-1986), a professor of mathematics at the University of Basel, established a foundation for awarding an international prize for higher mathematics. The Ostrowski Prize is conferred every two years to an individual or group for outstanding mathematical accomplishments. The first award, presented in 1989, went to Louis de Branges.

Burdzy Receives Rollo Davidson Prize

The trustees of the Rollo Davidson Trust have awarded the 1992 Rollo Davidson Prize to KRZYSZTOF BURDZY of the University of Washington at Seattle. Burdzy was cited for his work on the geometry of Brownian paths.

Petryshyn Receives Prize and is Elected to Ukraine Academy

Wolodymyr V. Petryshyn of Rutgers University was elected to full membership in the Academy of Sciences of Ukraine. He was cited "for the outstanding contribution to the growth of nonlinear functional analysis and, in particular, for the development of the original theory of A-proper operators and its application to the solvability of ordinary and partial differential equations."

The Presidium of the Academy also awarded to Professor Petryshyn, jointly with Ihor I. Skrypnik of the Institute of Applied Mathematics and Mechanics in Donetsk, the Krylov Prize for 1992. This prize is the highest and most prestigious award the Academy bestows upon a scholar for original contributions to mathematics. The prize is to be presented in May in Kiev.

The prize honors M. M. Krylov, who, during the 1920s, made fundamental contributions to the theory of constructive methods in mathematical physics and, during the 1930s, founded (jointly with his student, N. N. Bogolyubov) the theory of nonlinear mechanics. Established by the Academy in 1964, the prize is presented annually to one or two scholars for outstanding and original contributions in mathematics, mathematical physics, and theoretical cybernetics. Previous recipients of the Krylov Prize include N. N. Bagolyubov, V. M. Glushkov, M. G. Krein, A. P. Pagorelov, and A. V. Skorokhod.

Elections to the American Academy

The American Academy of Arts and Sciences has announced the election of 205 new fellows in recognition of their distinguished contributions to science, scholarship, public affairs, and the arts. Also named were forty Foreign Honorary Members.

The Academy was founded in 1780 by John Adams and other leaders of the young republic, who chartered the learned society "to cultivate every art and science which may tend to advance the interest, honor, dignity, and happiness of a free, independent, and virtuous people." The Academy conducts a program of scholarly projects, studies, and publications which address issues of public interest.

Among the elections were several that are likely to be of interest to the mathematical sciences community: MICHAEL ASCHBACHER, California Institute of Technology; DONALD LYMAN BURKHOLDER, University of Illinois at Urbana-Champaign; JOHN HORTON CONWAY, Princeton University; DAVID DONOHO, University of California at Berkeley; BENEDICT H. GROSS, Harvard University; MELVIN HOCHSTER, University of Michigan; ROBERT MACPHERSON, Massachusetts Institute of Technology; MARINA RATNER, University of California at Berkeley; and ALAN DAVID WEINSTEIN, University of California at Berkeley.

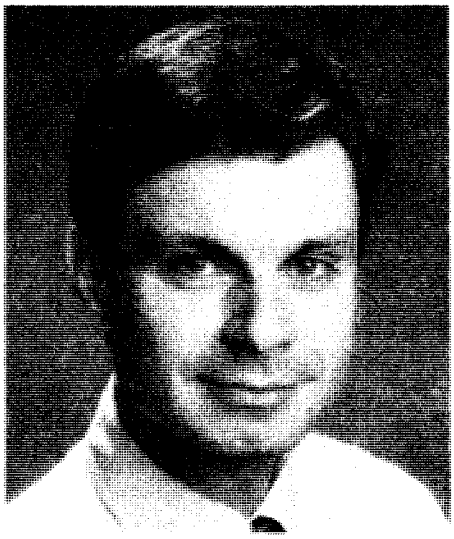
Elected as Honorary Foreign Members were: FRIEDRICH ERNST PETER HIRZEBRUCH, Max Planck Institut, Bonn; GREGORI MARGULIS, Yale University and IPPA, Moscow; SHIGEFUMI MORI, Research Institute of Mathematics, SCI, Kyoto; DAVID RUELLE, Institut des Hautes Etudes Scientifiques, Paris; and JACQUES TITS, Collège de France, Paris.

AMS Centennial Fellowships Awarded

The Society has awarded three Centennial Fellowships for 1992–1993. The recipients are KRZYSZTOF BURDZY of the University of Washington, Seattle; WILLIAM MENASCO of State University of New York, Buffalo; and DAVID MORRISON of Duke University.

Krzysztof Burdzy

Krzysztof Burdzy received his Ph.D. in 1984 from the University of California, Berkeley, under Jim Pitman. He spent one year at the University of California, San Diego, as an S. E. Warschawski Assistant Professor. He worked for two years at the Institute of Mathematics of the Polish Academy of Sciences in Wroclaw and he visited Purdue University for one year. Since 1988, he has been at the University of Washington, Seattle, where he is currently an associate professor.



Krzysztof Burdzy

His research is focused on path properties of Brownian motion and boundary problems in "classical" potential theory.

William Menasco

William Menasco received his Ph.D. in 1981 from the University of California at Berkeley under the direction of Professor Rob Kirby. He was a Hill Assistant Professor at Rutgers University, New Brunswick, from 1981 to 1984. He joined the faculty of the State University of New York at Buffalo in 1985. In 1991 he became associate professor at Buffalo. He intends to use the AMS Centennial Fellowship for a leave of absence to visit the Institut des Hautes Etudes Scientifiques.

Menasco's research interests include low dimensional topology, knot theory, and hyperbolic geometry. He considers himself fortunate to have collaborated with Joan Birman, Joel Hass, Alan Reid, Morwen Thistlethwaite, and Abby Thompson.

William Menasco

David Morrison

David Morrison received his Ph.D. in 1980 from Harvard University under the direction of Phillip Griffiths. He was on the faculty at Princeton University from 1980 to 1986, with a leave during 1984–1985 at Kyoto University. He was partially supported by an NSF Postdoctoral Fellowship during 1982–1984, and by the Japan Society for the Promotion of Science while in Japan. Since 1986, he has been associate professor of mathematics at Duke University.

David Morrison

Morrison's research interests include algebraic geometry over the complex numbers and geometric mathematical physics, particularly superstring theory. He will spend next year at the Institute for Advanced Study, where he expects to devote much of his attention to understanding the recently discovered phenomenon of "mirror symmetry".

Information about the competition for the 1993–1994 AMS Centennial Fellowships will be published in the Funding Information for the Mathematical Sciences section of the next issue of the *Notices*.

Guggenheim Fellowships Awarded

The John Simon Guggenheim Memorial Foundation has announced awards to 149 artists, scholars, and scientists in its sixty-eighth annual competition. The awards, gleaned from 3162 applications, were made on the basis of unusually distinguished past achievement and exceptional promise for future accomplishment. A total of $3,925,000 will be awarded this year.

There were five mathematical scientists among the awardees this year. Their names, affiliations, and areas of research are:

SIMEON M. BERMAN, Courant Institute of Mathematical Sciences, New York University, stochastic models of immunological variables in HIV infection; BRUCE HAJEK, University of Illinois at Urbana-Champaign, stochastic algorithms; PHILIP J. HANLON, University of Michigan, studies in algebraic combinatorics; RICHARD B. MELROSE, Massachusetts Institute of Technology, analysis and geometry of manifolds with corners; and ILYA PIATETSKI-SHAPIRO, Yale University and Tel-Aviv University, studies in automorphic forms.

Fulbright Awards Announced

The J. William Fulbright Scholarship Board and the U.S. Foreign Scholarship Board have announced the names of 950 academics, professionals, and independent scholars who have received awards to lecture, consult, or conduct research abroad during the 1991–1992 academic year.

A number of scholars in the mathematical sciences have received these awards. Their names, affiliations, and the country in which they will use the scholarships are listed below.

RAYMOND G. AYOUB, Pennsylvania State University, Syria; SARAH A. DOUGLAS, University of Oregon, India; STEPHEN J. GARLAND, Massachusetts Institute of Technology, Israel; JACOB E. GOODMAN, City College of the City University of New York, Sweden; DIANNE C. HANSFORD, Arizona State University, Germany; R. NEAL HART, Sam Houston State University, Oman; JOSEPH HOROWITZ, University of Massachusetts at Amherst, India; SURENDER K. JAIN, Ohio University, India; WILLIAM B. JONES, University of Colorado at Boulder, Norway; SAMI KHURI, Wellesley College, Yugoslavia; RICHARD W. MADSEN, University of Missouri at Columbia, Malawi; ANTHONY N. MICHEL, University of Notre Dame, Austria; JOHN A. NOHEL, University of Wisconsin at Madison, Czech and Slovak Federal Republic; VLADIMIR I. OLIKER, Emory University, Brazil; ALEXANDER G. RAMM, Kansas State University, Israel; RAE M. SHORTT, Wesleyan University, Germany; and WALTER S. SIZER, Moorehead State University, Ghana.

Sloan Fellowship Awardees Announced

The Alfred P. Sloan Foundation has awarded fellowships to ninety young scientists who are faculty members at fifty-three colleges and universities in the U.S. and Canada.

The grants of $30,000 each for a two-year period are administered by each fellow's institution. Fellows, once chosen, are free to pursue whatever lines of inquiry are of most interest to them, and they are permitted to use the fellowship funds in a wide variety of ways to further their research aims.

More than 400 nominations for the 1992 awards were reviewed by a panel of distinguished scholars. The panelists in mathematics were Spencer J. Bloch, Richard B. Melrose, and William P. Thurston. Candidates for the fellowships are nominated by department chairs and other senior scholars.

Among this year's awardees are twenty in mathematics. Their names and affiliations are:

BRUCE J. BAYLY, University of Arizona; CHRISTOPHER BISHOP, State University of New York at Stony Brook; SHELDON CHANG, Massachusetts Institute of Technology; ETHAN S. DEVINATZ, University of Washington; RANDALL DOUGHERTY, Ohio State University; LISA J. FAUCI, Tulane University; GIAN MICHELE GRAF, California Institute of Technology; ANDREW JAMES GRANVILLE, University of Georgia; MANOUSSOS G. GRILLAKIS, University of Maryland; ZHENG-XU HE, Princeton University; JUHA M. HEINONEN, University of Michigan; NIGEL DAVID HIGSON, Pennsylvania State University; NICOLAOS KAPOULEAS, Brown University; JIAN-SHU LI, University of Maryland; XIAO-SONG LIN, Columbia University; THOMAS MOUNTFORD, University of California at Los Angeles; ALAN NADEL, University of Chicago; IGOR REIDER, University of Oklahoma; NICOLAI RESHETIKHIN, University of California at Berkeley; DONNA MARIE TESTERMAN, Wesleyan University;

Nominations for candidates for the next round of Sloan Fellowship awards are due by **September 15, 1992**. Candidates must be members of the regular faculty at a college or university in the U.S. or Canada and must be at an early stage of their research careers. For further information on making nominations, write to: Sloan Research Fellowships, Alfred P. Sloan Foundation, Suite 2550, 630 Fifth Avenue, New York, NY 10111.

NSF-NATO Postdocs Awarded

The National Science Foundation (NSF) has announced the names of fifty-eight young U.S. scientists and engineers who will receive 1992 NSF-NATO Postdoctoral Fellowship in Science Awards. The awards, designed to foster closer collaboration in science and technology research among members of the North Atlantic Treaty Organization, will enable fellows to conduct their postdoctoral research abroad.

The NSF-NATO awards, made annually since 1959, provide recipients with a $2600 monthly stipend to study and conduct research in institutions and laboratories in NATO countries other than the U.S. In addition to the stipends, some support is also provided to fellows for research-related expenses, travel expenses, and dependents.

Forty-two men and sixteen women were selected to be this year's fellows. There were four recipients in the mathematical sciences. Following are their names, their current institutions (in parentheses), and the institutions at which they will hold the postdoctoral fellowship.

JAMES W. ANDERSON (State University of New York at Stony Brook), University of Warwick, England; LEA R. BIRMIWAL (University of Connecticut), University of Toronto, Canada; CHRISTIAN HOUDRE (University of Maryland at College Park), University of Paris, France; and RACHEL A. KUSKE (Northwestern University), University of Utrecht, Netherlands.

NSF Awards Mathematical Sciences Postdoctoral Research Fellowships

The National Science Foundation (NSF) has awarded Mathematical Sciences Postdoctoral Research Fellowships to forty recent recipients of doctoral degrees in the 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," says Judith Sunley, director of NSF's division of mathematical sciences. "The Fellowship Program helps to provide these opportunities and serves to focus attention on this issue throughout the broad mathematical sciences community."

Awards are made to U.S. citizens, nationals, or permanent residents based on their demonstrated ability and on the significance of career improvement the fellowship would potentially provide. The program is designed to allow

recipients to choose research programs at host institutions that will have maximum 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 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.) Partial support for seven of the awards was provided by the following disciplinary divisions at the National Science Foundation: Computer and Computation Research, Advanced Scientific Computing, Integrative Biology and Neuroscience, and Atmospheric Sciences.

DWIGHT BARKLEY (Princeton University), University of Texas at Austin; CURTIS BENNETT (Michigan State University), University of Illinois at Chicago; DANIELLE CARR (Duke University), Boston University and Courant Institute of Mathematical Sciences; DER-CHEN CHANG (University of Maryland), Princeton University and University of Maryland; PETER CHOLAK (University of Michigan and University of Victoria), University of Michigan and Cornell University; DAVID CHOPP (University of California, Los Angeles), University of California, Los Angeles; MARIE DILLON DAHLEH (University of California, Los Angeles), University of California, Los Angeles; DAVID DOBSON (University of Minnesota), University of Minnesota; WILLIAM DORAN (University of Michigan), Massachusetts Institute of Technology; DAVID FARMER (Oklahoma State University), Columbia University and Mathematical Sciences Research Institute; ELIOT FRIED (Carnegie Mellon University), Pennsylvania State University; MASAAKI FURUSAWA (Stanford University), Stanford University; IRENE GAMBA (Trenton State University), Courant Institute of Mathematical Sciences; DAVID GOLDBERG (Purdue University), Purdue University; DANIEL GOLDSTEIN (University of California, Santa Cruz), University of California, Santa Cruz and Harvard University; ALBERT GOODMAN (University of Chicago), University of Oregon; WILLIAM GRAHAM (Massachusetts Institute of Technology), University of Chicago; MICHELANGELO GRIGNI (University of British Columbia), Princeton University; MATTHEW GURSKY (University of Chicago), University of Chicago; MARY ANN HORN (University of Virginia), University of Minnesota; CHRISTIAN HOUDRE (University of Maryland), University of Maryland; ALEXANDER IZZO (University of Michigan), Brown University; PHILIP KEENAN (Rice University), Rice University; TAKASHI KIMURA (University of Texas at Austin), University of North Carolina; ISAAC KLAPPER (Columbia University), University of Arizona; RACHEL KUSKE (Northwestern University), Stanford University; CHUN-NIP LEE (Northwestern University), Northwestern University; EUGENE LERMAN (University of Pennsylvania), University of California, Santa Cruz; YAIR MINSKY (Yale University), University of Michigan; DANIEL NAKANO (Northwestern University), Northwestern University; RAFAIL OSTROVSKY (Massachusetts Institute of Technology), University of California, Berkeley and International Computer Science Institute; TONIANN PITASSI (University of Toronto), University of California, San Diego; CHRISTOPHER RAPHAEL (Brown University), Stanford University; ALYSON REEVES (Cornell University), Brandeis University; VICTOR REINER (University of Minnesota), University of Minnesota; LORENZO SADUN (University of Texas at Austin), University of Texas at Austin; LEONARD SCHULMAN (Massachusetts Institute of Technology), University of California, Berkeley; MICHAEL SHAPIRO (Ohio State University), City University of New York Graduate Center; BRIAN SPENCER (Northwestern University), California Institute of Technology; and FREDERICK WILHELM (University of Maryland), State University of New York at Stony Brook.

Information abaout the NSF Mathematical Sciences Postdoctoral Research Fellowship Program for 1993 will be published in the Funding Information in the Mathematical Sciences section of a future issue of the *Notices*.

NSF Awards Minority Graduate Fellowships

The National Science Foundation (NSF) has announced the names of 120 minority students who have been offered fellowships for graduate study in the natural and social sciences, mathematics, and engineering.

The NSF Minority 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.

Applications were submitted by 1480 minority students nationwide and were evaluated by a panel assembled by the National Research Council. Awards were made in thirty-four states, and fifty-nine went to women.

The eight 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. [**Editor's Note:** The institution of graduate study listed for each recipient is from the original application form and, in many cases, may change before study actually begins.]

KAREN MARIE APODACA (New Mexico State University), New Mexico State University; MARIA F. BASTERRA (University of Texas at Austin), Univer-

sity of California at Berkeley; JOSEPH COOK (Baldwin-Wallace College), University of California at Berkeley; EUGENE ANDRES HOUSEMAN (University of California at Berkeley), University of Wisconsin at Madison; KATHRYN MARIE LEWIS (University of Kentucky), Purdue University; CASSANDRA MOORE (Southwestern University), Rice University; JOHN ANTHONY QUINTANILLA (Stanford University), University of Maryland; and DORN VERNESSA VERNON (Howard University), Howard University.

NSF Graduate Fellowships Awarded

The National Science Foundation (NSF) has announced the names of 740 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.

Applications were submitted by 7723 individuals nationwide and were evaluated by a panel assembled by the National Research Council. Awards were made in all fifty states, and 290 went to women.

The awards include forty-two in the mathematical sciences and thirty-two 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. **[Editor's Note:** The institution of graduate study listed for each recipient is from the original application form and, in many cases, may change before study actually begins.]

DANIEL JONATHAN ALLCOCK (University of Texas at Austin), University of California at Berkeley; MARTIN ZDENEK BAZANT (University of Arizona), University of Arizona; WALTER JOHN BOSCARDIN, JR. (Brown University), University of California at Berkeley; HUBERT LEWIS BRAY (Rice University), Princeton University; HOWARD ANDREW CHAMBLIN (Rice University), University of Oxford; WILLIAM CHEN (Washington University), University of California at Berkeley; ELAINE CHEW (Stanford University), Stanford University; MARK THOMAS CHRISMAN (University of California at Davis), University of California at Berkeley; MICHAEL COLE (Hofstra University), University of Chicago; BRIAN DAVID CONRAD (Harvard University), Princeton University; KEITH CONRAD (Princeton University), Harvard University; KAREN ELIZABETH EDWARDS (University of California at Berkeley), University of California at Berkeley; AVROM IRWIN FADERMAN (University of California at Los Angeles), University of California at Berkeley; LISA KAREN FLEISCHER (Harvard University), Cornell University; KEVIN BRUCE FOLTINEK (University of Calgary), Duke University; FRANCIS YEIN CHEI FUNG (Kansas State University), Princeton University; MICHAEL GIDEON GREENBLATT (California Institute of Technology), University of Chicago; DAVID GREGG GUPTA (Georgia Institute of Technology), Massachusetts Institute of Technology; DAVID JOHN HAROLDSEN (Utah State University), University of Arizona; BRENDAN EDWARD HASSETT (Yale University), Harvard University; RONALD JAMES HOWARD (University of Chicago), Princeton University; ALAN JAFFRAY (California State University at Sonoma), University of Chicago; JEREMY ADAM KAHN (Harvard University), University of California at Berkeley; JOHN ALLEN KUCHENBROD (Transylvania University), Harvard University; GREGORY DAVID LANDWEBER (Princeton University), Harvard University; LEWIS KUO-WEI LEE (Stanford University), Harvard University; LUCY LIFSCHITZ (University of California at Los Angeles), Yale University; BRADLEY WILLIAM MANN (Princeton University), Harvard University; WINSTON CHIH-WEI OU (Princeton University), University of Chicago; DAVID MICHAEL PATRICK (Carnegie-Mellon University), Princeton University; NICHOLAS PHAT (Princeton University), Harvard University; CHRISTOPHER SCOTT RAYMOND (California Institute of Technology), University of Arizona; MICHAEL SEAN RICHMAN (Brown University), Princeton University; KATHY ELIZABETH RUSSELL (Rice University), Texas A&M University; WILLIAM ALAN SCHNEEBERGER (Duke University), Princeton University; KEITH GOODWIN SOLLERS (University of California at Davis), Cornell University; ERIC JOEL STOLLNITZ (Swarthmore College), California Institute of Technology; CATHERINE ANN SUGAR (Pomona College), Princeton University; STEVE C. WANG (Cornell University), University of Chicago; ERIC KARL WEPSIC (Harvard University), University of California at Berkeley; THOMAS PETER WITELSKI (Cooper Union), California Institute of Technology; and MICHAEL ERNEST ZIEVE (Harvard University), University of California at Berkeley.

Modeling Contest Winners Announced

A national panel of judges, including representatives from the Operations Research Society of America and the Society for Industrial and Applied Mathematics, is pleased to announce the winners of the 1992 Mathematical Contest in Modeling. They are: Pomona College, University of Colorado at Boulder, North Carolina School of Science and Mathematics (a high school), Oklahoma State University, and Washington University.

The yearly contest presents two open-ended problems to teams of three undergraduates, who choose one of the problems to solve. This year, the first problem was to determine the power to be radiated by an air traffic control radar at a major metropolitan airport; the second problem was to arrive at an optimal prioritized scheduling system for an emergency power restoration system. The contest drew 292 teams representing 189 schools in six countries—the U.S., Canada, China, Ireland, Lithuania, and Hong Kong. Teams were given four days, from Friday February 21 through Monday February 24, to research the topic and come up with a solution. Contestants may not seek help from anyone, but they may use inanimate sources to support their solutions.

This contest differs from others in that it is the only national contest in which the teams of students work together to find a solution; other contests either have the students work alone or have the individual team members work alone and combine scores for a team total. In addition, the problems call upon a variety of skills and talents, including writing skills, organizational skills, as well as mathematical knowledge.

The two teams judged outstanding in their solution of the air traffic control problem were Pomona College and the University of Colorado at Boulder. For the power system problem, three teams were judged to be outstanding: North Carolina School of Science and Mathematics, Oklahoma State University, and Washington University. More than forty teams were cited for meritorious solutions, and nearly seventy received honorable mentions.

The Consortium for Mathematics and its Applications administers the contest. For more information, write to: COMAP, Suite 210, 57 Bedford Street, Lexington, MA 02173.

EPSCoR Awards Announced

The National Science Foundation (NSF) announced awards totaling more than $13.7 million in fiscal year 1992 to eleven states and one territory through the Experimental Program to Stimulate Competitive Research (EPSCoR).

Alabama, Arkansas, Kentucky, Louisiana, Maine, Mississippi, North Dakota, Oklahoma, Puerto Rico, South Carolina, South Dakota, and Wyoming will each receive from $1 million to $1.3 million per year over three years to strengthen academic departments and support improved research activities. In addition to NSF support, the recipients will provide nearly $93 million to support the improvements.

EPSCoR is designed to help governments and their academic institutions improve the quality of science and engineering research, increase the number of scientists and engineers that are able to compete successfully for federal grants, and foster long-term improvements in research and education.

Since the program's inception in 1978, approximately $66 million in NSF support has been awarded to the eighteen EPSCoR-eligible states and Puerto Rico. Previous awards were made in 1980, 1985, 1987, and 1989.

New NSF Assistant Director Named

William Harris has been named Assistant Director for Mathematical and Physical Sciences (MPS) of the National Science Foundation (NSF). He replaces David A. Sanchez, who finished a two-year tour of duty at the NSF and has returned to Lehigh University, where he is vice president and provost.

As the head of the MPS directorate, Harris will oversee the Division of Mathematical Sciences, as well as research divisions in astronomy, chemistry, materials research, and physics. The total budget of this directorate exceeded $623 million in fiscal year 1992.

Harris, formerly assistant to the director for science and technology, provided advice to NSF director Walter Massey on a broad range of scientific and policy matters, including long-range planning and cross-directorate activities. Previously, he was director of the NSF's Office of Science and Technology Infrastructure, where he oversaw the Science and Technology Centers, Research Facilities, and Academic Research Instrumentation programs.

A chemist, Harris first came to the NSF in 1977 as a program director in physical chemistry. Previously, he was at Furman University in Greenville, South Carolina. He was an undergraduate at the College of William and Mary and received his Ph.D. in chemistry from the University of South Carolina in 1970. He did postdoctoral work at the National Institutes of Health.

Group Recommends Action to Stem Soviet "Brain Drain"

The U.S. government should act "immediately and aggressively" to help reorient the basic scientific and technological capabilities of the former Soviet Union (FSU) and stem the "brain drain" as many Soviet scientists look beyond their borders for lucrative jobs, says a group of U.S. scientists and engineers.

Meeting on March 3, 1992 at the National Academy of Sciences in Washington, the group of more than 120 scientists and engineers drafted a letter to D. Allan Bromley, assistant to President Bush for science and technology. Bromley requested the meeting to obtain advice on what the U.S. government might do to preserve science in the FSU. A number of representatives of the AMS and the mathematical sciences community attended the meeting.

"Achieving U.S. goals of shrinking and redirecting the FSU military [research and development] effort and developing the science and technology component of the civilian economy will require providing opportunities for both FSU weapon scientists and nonweapon scientists," the letter says. "The U.S. can play a leadership role among Western countries in revitalizing former Soviet science and technology if we act quickly." The group also noted that collaborations with world-class research groups in the FSU can benefit American science and business.

Among its many recommendations, the group suggested that:

- funding from the existing $400 million in the Department of Defense budget for FSU weapons dismantlement should be used this year for immediate support of new research opportunities for critical FSU weapon scientists and the most highly qualified nonweapon scientists.
- in addition to funding support of $25 million for weapon scientists through the newly proposed International Science and Technology Center in Moscow, $25 million or more this fiscal year should be made available for cooperative programs for nonweapon scientists outside the center.
- a special fund of $50 million to $100 million should be established to help replenish and refurbish equipment, journals, and books used in laboratories of special importance. The U.S. should take the lead in obtaining the necessary funds from bilateral and multilateral assistance agencies for this purpose.

The meeting divided into working groups that developed separate recommendations on four topics, one of them being basic research. The group emphasized that U.S. cooperative activities should not ignore those Soviet scientists who chose not to participate in the military-industrial complex. To address short-term emergency needs, the group suggested that $5 million to $10 million of the $25 million for nonweapon scientists should be provided over the next six months to the extramural research programs of U.S. agencies for supplements to American grantees. These supplements would "expand or initiate collaborative activities with former Soviet scientists" in areas of direct interest to the U.S. In addition, the group recommended considering a binational foundation for support. Emphasizing that it did not call for "a welfare system for [FSU] scientists," the group urged expansion of "mutually advantageous binational collaboration with well-known scientists and high-quality research groups based on evaluations by American scientists."

The summary of recommendations from the March 3 meeting is available free from: Office of Central Europe and Eurasia, National Academy of Sciences, 2101 Constitution Avenue, NW, Washington, DC 20418; telephone 202-334-2644.

News from the Center for Nonlinear Analysis

Carnegie Mellon/Hampton Universities

A workshop on Computational Methods in Materials Science will be held September 16–18, 1992 at Carnegie Mellon. The organizers are R.A. Nicolaides and D. Kinderlehrer. Topics will include the numerical treatment of liquid crystals, phase transitions, interfacial phenomena, and superconductivity.

Diffusion approximations of discrete stochastic systems will be the subject of a workshop to be held in the fall of 1993 and organized by T. Kurtz of the University of Wisconsin and S. Shreve of CMU.

In June, the Center is sponsoring a four-week Summer Mathematics Institute for undergraduate students who have completed their junior year. This Institute is designed to give participants insight into research areas of the Center faculty, and also to acquaint them with the rigors of advanced mathematics. Both Hampton and Carnegie Mellon faculty will be involved in the Institute.

For more information about activities of the Center for Nonlinear Analysis, contact the Center at the Department of Mathematics, Carnegie Mellon University, Pittsburgh, PA 15213-3890; Fax: 412-268-6380; email: cn0s@andrew.cmu.edu.

News from the Mathematical Sciences Institute

Cornell University

The Mathematical Sciences Institute (MSI) will host five workshops at Cornell University in the coming months and will cosponsor five others throughout the country and abroad.

J. Remmel of UCSD and P. Clote of Boston College are the organizers of Feasible Mathematics II on May 28–30, 1992. Invited speakers include: M.L. Bonet-Carbonell, S.R. Buss, D. Cenzer, B. Kapron, P. Kolaitis, J. Krajicek, T. Pitassi, A. Razborov, and G. Takeuti.

Logical Methods in Mathematics and Computer Science, a workshop to honor MSI Director Anil Nerode's 60th birthday, is being organized by R. Shore, J.N. Crossley, J. Remmel, and M. Sweedler. It will meet at Cornell from June 1–3, 1992. J. Hartmanis, D. Kozen, V. Lifschitz, S. Mac Lane, G. Metakides, J. Remmel, G. Sacks, D. Scott, and R. Soare will give invited talks. They will be joined by more than twenty other speakers.

J. Guckenheimer of Cornell will host an extended workshop on Patch Dynamics to meet in Ithaca, NY from June 22–July 17, 1992.

M. Cranston from the University of Rochester will organize a workshop on Stochastic Analysis to be held September 13–15, 1992. The workshop will focus on the interplay of analysis and probability. Invited speakers include: R. Banuelos, C. Bishop, K. Burdzy, D. Burkholder, E. Carlen, M. Freidlin, E. Hsu, N. Krylov, P. March, M. Pinsky, T. Salisbury, and Z. Zhao.

Jumelage 92, the third annual meeting of the logic and computer science community, will meet at MSI October 15–17, 1992. Anil Nerode will organize this discussion of the modern lambda calculus, functional programming, and the implementation of constructive logic systems.

In addition, Cornell's M. Stillman and B. Sturmfels are organizers for the Regional Institute in Geometry and Computational Algebraic Geometry to meet at Amherst College from July 6–13, 1992; A. Nerode is program chair for the symposium on Logical Foundations of Computer Science to meet at Tver University, Russia from July 20–24, 1992; M. Sweedler is an organizer for the International Symposium on Symbolic and Algebraic Computation (ISSAC) to meet in Berkeley from July 27–29, 1992; C. Mueller will organize a workshop on Stochastic Partial Differential Equations to meet at the University of Rochester from July 17–18, 1992; and A. Brown, Jr. and H. Blair are organizers for a workshop on Documents, Computation, and Preference to meet in Washington, DC from October 21–23, 1992. MSI researchers will participate in the Tenth U.S. Army Mathematics Conference, organized by the U.S. Army Research Office and meeting at West Point, NY from June 16–19, 1992.

For information about any of these events, contact J. Chiment at the Mathematical Sciences Institute, 409 College Ave., Ithaca, NY 14850, 607-255-8005, jjc@cornellc.cit.cornell.edu.

News from the Institute for Mathematics and its Applications

University of Minnesota

The Institute for Mathematics and its Applications (IMA) Postdoctorates in Industrial Mathematics program, initiated in fall 1990 with four positions has now grown to seven one-to-two year positions. These appointments are in addition to the regular IMA postdoctoral program and are funded jointly by the National Science Foundation (NSF) and IMA and by the participating industries. They are designed to prepare mathematicians for research

careers involving ongoing academia—industry interaction. Familiarity with PDE and/or numerical analysis is desired, but no knowledge in engineering is required. Postdoctorates spend 50% effort working with industrial scientists from a sponsoring industry and 50% effort in their personal research and in the regular IMA program. For fall 1992, positions have been filled in the following research areas: Air Quality Modeling (Ford); Diffractive Optics (Honeywell); Imaging Analysis (Siemens, Princeton); Micromagnetics (3M); Near-Infrared Imaging (3M); Robust Control (Honeywell); and Semiconductors (Siemens, Munich).

The IMA 1992 summer program will be **Environmental Studies: Mathematical, Computational and Statistical Analysis**, July 6–31. The Organizing Committee is M. Wheeler (Chair), J. Chang, M. Ghil, D. McTigue, J. Seinfeld and P. Switzer. This summer program is designed to provide a much needed interdisciplinary forum for joint exploration of recent advances in the formulation and application of (A) environmental models, (B) environmental data and data assimilation, (C) stochastic modeling and optimization, and (D) Global climate modeling. These four conceptual frameworks provide common themes among a broad spectrum of specific technical topics at this workshop. The program will bring forth a mix of physical concepts and processes such as chemical kinetics, atmospheric dynamics, cloud physics and dynamics, flow in porous media, remote sensing, climate statistics, stochastic processes, parameter identification, model performance evaluation, aerosol physics and chemistry, and data sampling together with mathematical concepts in stiff differential systems, advective-diffusive-reactive PDE's, inverse scattering theory, time series analysis, particle dynamics, stochastic equations, optimal control, and others. The program consists of four parts:

A. Weeks 1 and 2: Environmental models

B. Weeks 2 and 3: Environmental data and assimilation

C. Weeks 3 and 4: Stochastic modeling and optimization.

D. Week 4: Global climate modeling.

The overlap in each segment of the program is intended to increase interaction among scientists and mathematicians working in specified areas.

The 1992–1993 academic year program at the IMA will be **Control Theory and its Applications**. The Coordinators for this program are H.J. Sussmann (Chairman), W.H. Fleming, P.P. Khargonekar, P.R. Kumar, D.L. Russell, and S.E. Shreve. The year is divided into three parts (corresponding to fall, winter, and spring quarters) although it is expected that there will be considerable fluidity between the various parts.

(1) Fall: September 8–December 30, 1992, Linear and distributed parameter systems

(2) Winter: January 2–March 30, 1993, Nonlinear systems and optimal control

(3) Spring: April 1–June 30, 1993, Stochastic and adaptive systems

Fall quarter highlights are a **Tutorial**, (September 8–11, 1992, organized by P.P. Khargonekar and D.L. Russell; a workshop on **Robust Control Theory**, September 21–25, 1992, organized by B.A. Francis and P.P. Khargonekar; a workshop on **Control Systems Design for Advanced Engineering Systems: Complexity, Uncertainty, Information, and Organization**, October 12–16, 1992, organized by D. Enns, M. Morari, and C.N. Nett; a workshop on **Control and Optimal Design of Distributed Parameter Systems**, November 9–13, 1992, organized by J.E. Lagnese, D.L. Russell, and L. White; and a period of concentration on **Flow Control**, November 16–20, 1992, organized by M. Gunzburger.

For more information about IMA activities, see the Meetings and Conferences section of this issue or contact the IMA (ima_staff@ima.umn.edu).

Call for Nominations for the AAAS Award for International Cooperation

Many scientists and engineers contribute their time to conduct research and develop programs of an international nature. The American Association for the Advancement of Science (AAAS), in collaboration with its affiliated organizations, would like to recognize such contributions through the AAAS Award for International Scientific Cooperation.

This monetary prize of $2500 includes a certificate of citation and travel expenses to the AAAS meeting. The award is open to any living individual (or individuals) in the international scientific and engineering community. Contributions worthy of the award include but are not limited to: promotion of innovative international research, teaching, publications, program or project administration, development, technology transfer, scientific standards, or networking activities.

Nominations for the award should be submitted by **September 15, 1992**. For more information on the nomination procedure and the award, contact: Elizabeth J. Kirk, CAIP Coordinator, American Association for the Advancement of Science, 1333 H Street, NW, Washington, DC 20005; telephone 202-326-6650.

Call for Nominations for Fermat Prize

The Fermat Prize recognizes the work of a research mathematician in the areas in which Pierre de Fermat worked, specifically: principles of variational theory, foundations of the calculus of probabilities and analytic geometry, and number theory. The prize is given by Université Paul Sabatier and Matra Marconi Space.

Within these parameters, the spirit of the prize is to recognize those results that are accessible to the largest number of professional mathematicians.

The prize includes 100,000 FF, donated by Matra Marconi Space, and is awarded every two years in Toulouse. The third award will be made in spring 1993. The first award, in 1989, went to Abbas Bahri and Kenneth Ribet; the second award, in 1991, went to Jean-Louis Colliot-Thélène.

For more information on the prize rules and on how to nominate candidates, write to: Prix FERMAT de Recherche in Mathématiques, Service des Relations Publiques, Université Paul

Sabatier, 118 route de Narbonne, 31062 Toulouse Cédex, France. The deadline for submitting nominations is **December 19, 1992.**

Ferran Sunyer i Balaguer Prize

The Institut d'Estudis Catalans announces the Ferran Sunyer i Balaguer Prize, an international mathematical research prize competition open to all mathematicians. The prize honors the memory of Ferran Sunyer i Balaguer (1912–1967), a self-taught Catalan mathematician who, in spite of a serious physical disability, was very active in research in classical analysis and achieved international recognition.

The prize will be awarded for a mathematical monograph of an expository nature presenting, at the level of graduate students or nonspecialists, the latest developments in an active area of research in mathematics, based mainly on the applicant's own work. The monograph must be in English and run at least 150 pages. The winner will be chosen by a committee consisting of Gerhard Frey, Universität Essen; Joan Girbau, Universitat Autònoma de Barcelona; Paul Malliavin, Université de Paris VI; Joseph Oesterle, Université de Paris VI; and Alan Weinstein, University of California at Berkeley. The prizewinner will be announced in Barcelona on April 22, 1993.

The prize carries a monetary award of 12,000 ECU. In addition, the winning monograph will be published in Birkhäuser Verlag's series, "Progress in Mathematics," subject to the usual regulations concerning copyright and author's rights. The committee will also recommend publication of those nonwinning monographs which are judged to be of high scientific value.

Monographs, preferably typeset in TEX, must be submitted before **December 31, 1992** to: Fundació Ferran Sunyer i Balaguer, Institut d'Estudis Catalans, Carme, 47, 08001, Barcelona, Spain; email: icrm0@ebccuab1.bitnet. Preliminary versions, in a form suitable to be refereed, will also be considered. Submission of a monograph implies acceptance of all conditions of the competition.

Giovanni Sacchi Landriani Prize

In honor of the memory of Giovanni Sacchi Landriani, who tragically died while at the height of his scientific activity, a competition for a prize of 10 million Italian Liras is sponsored by the Istituto Lombardo of the Accademia di Scienze e Lettere in Milan, Italy.

The prize recognizes original important contributions to the field of numerical methods for partial differential equations. Last year's recipient of the prize was Douglas Arnold of Pennsylvania State University.

In order to be considered for the competition, papers submitted by applicants should have been accepted for publication in a journal of international standards after January 1, 1987, but not later than the deadline of this announcement. The following documents must be enclosed: short curriculum vitae of the applicant; brief description of the research conducted; list of publications presented; off-prints of the publications presented (a typescript can be accepted only if accompanied by a formal letter of acceptance for publication in a journal, signed by the editor).

Applications will be examined by a committe of three members, two of whom will be chosen by members of the Class of Mathematical, Physical, and Natural Sciences at the Istituto Lombardo from among members of the Class. The third member will be chosen by the Landriani family. In case the latter were to resign, the third member would be chosen by the head of the Department of Mathematics of the University of Pavia, where Landriani worked as a CNR researcher. The prize cannot be awarded to more than one individual. In case the prize is not awarded, the prize funds will be used for a subsequent competition.

The deadline for admission to the competition is **November 14, 1992.** Applications received after this date will not be considered, regardless of the reason for delay. Application materials should be sent to: Presidente dell'Istituto Lombardo, Palazzo de Brera, via Borgonuovo 25, 20121 Milano, Italy.

Meeting of NSF Advisory Committee for DMS

As this issue of the *Notices* was going to the printer, the Advisory Committee for the National Science Foundation's Division of Mathematical Sciences (DMS) concluded a three-day meeting. A report on this meeting is being prepared for a future issue. However, the Advisory Committee passed, unanimously, several resolutions, two of which are particularly important to the mathematical community. These resolutions are reported below.

- The Advisory Committee feels that the decision by the NSF to request 0% increase for Disciplinary Research in the DMS 1993 budget is a terrible mistake. It sends a very negative message about the value placed on disciplinary mathematical sciences. Disciplinary research in the mathematical sciences is and must remain the central part of the DMS program.
- In order to implement our resolution of unlinking award sizes to salaries, the Advisory Committee recommends that the DMS consider a two-tier award system. These tier awards should be at the junior and senior levels and, in each category, the award size should only vary moderately from the mean. Support for budget items such as graduate students, postdocs, and equipment should be either based on justification for the items within the proposal and awarded independently of the tier system or based on a separate proposal.

One of the intentions of this resolution is to significantly increase the number of principal investigators supported.

Funding Information for the Mathematical Sciences

DoE Announces New Postdoc Program

The Department of Energy (DoE) has announced a new program that will provide postdoctoral research opportunities at the DoE national laboratories for scientists and engineers.

The fellowships, which include a $52,800 stipend, will be awarded to those who have earned doctorates in the physical, engineering, or computational sciences, areas most critical to DoE. Up to ten fellowships will be awarded each year and may be extended for up to two additional years. Selection of awards will be made by panels of experts within the discipline, including DoE laboratory scientists and others.

Applications may be requested from: Science/Engineering Education Division, Oak Ridge Institute for Science and Education, P.O Box 117, Oak Ridge, TN 37831-0117; or call 615-576-9934.

Information from the Office of Special Projects

Among the various programs within the Division of Mathematical Sciences at the National Science Foundation (NSF) is the Office of Special Projects, which supports research, education, and infrastructure in a variety of modes different from the usual disciplinary research projects. In particular, it provides support for several types of research conferences, including symposia, workshops, regional conferences, and special research years.

The NSF is committed to enlarging and enhancing the science personnel base of the U.S. Organizers of research workshops, conferences, and special research years have an opportunity to contribute to this effort. Conferences will be supported only if equivalent results cannot be obtained at regular meetings of the professional scientific societies. Requests should follow the general format of "Grants for Research and Education in Science and Engineering" (NSF 90-77). Activities of an annual, semiannual, or recurring nature in a specific research area should be submitted to the appropriate disciplinary research program for consideration rather than the Office of Special Projects.

For conferences, there will be two submission deadlines each year: **November 1** for conferences to be held the following June through November; and **May 1** for conferences to be held the following December through May. For a special academic year or fall semester/quarter, the deadline is **November 1** of the previous year. For a spring semester/quarter, the deadline is **May 1** of the previous year. These deadlines apply to conference proposals originating with academic institutions.

Requests for international travel by groups of mathematical scientists ordinarily originate with educational institutions or professional scientific societies. The Office of Special Projects will not consider individual requests for international travel. Proposals should be submitted **one year** before the requested travel is to occur.

For conference, special year, or international travel proposals, the criterion of overall impact on the U.S. mathematical sciences community will be paramount in making decisions among otherwise equally meritorious proposals. Proposals that have an impact on the nation's science personnel base, especially with regard to doctoral recipients, graduate students, women, minorities, and persons with disabilities, will be given a higher priority than otherwise equally meritorious proposals which do not.

Additional information about support for these kinds of activities, including format and evaluation criteria, is available in the program announcement, "Conferences, Workshops, and Special Years in the Mathematical Sciences" (NSF 91-91). This publication also contains information about special research conference activities supported by the NSF through the AMS, the Society for Industrial and Applied Mathematics, and the Conference Board on the Mathematical Sciences. In addition, "Opportunities in the Mathematical Sciences 1992" (NSF 91-143) contains additional information about programs of interest to the mathematical sciences community.

Both publications may be requested from: Office of Special Projects, Division of Mathematical Sciences, National Science Foundation, Room 339, 1800 G Street NW, Washington, DC 20550; telephone 202-357-3453. Electronic versions may be obtained through STIS, the NSF's online publication system. For an electronic copy of an information flyer on STIS (NSF 91-10), send an email message to stisfly@nsf.gov (Internet) or stisfly@nsf (Bitnet). Instructions for using STIS appear in the *Notices*, September 1991, page 796.

For Your Information

Calculus Reform Study Group Formed

At the Joint Mathematics Meetings in Baltimore in January 1992, a new group on improvement of calculus instruction took shape. The Calculus Reform Study Group, chaired by Marcelle Bessman of Frostburg State University, is a network of people working on calculus reform projects, with or without outside funding. The Study Group seeks to provide a forum for ongoing reports, dialogue, and debate about all aspects of calculus teaching.

To further this goal, the Study Group is sponsoring the following activity at the Joint Mathematics Meetings in San Antonio in January 1993:

- A panel discussion, "Calculus Reform and the AP-Calculus Program," organized by Howard Lewis Penn of the U.S. Naval Academy and George M. Rosenstein, Jr. of Franklin and Marshall College. More information will appear in the Meetings sections of future issues of the *Notices*.

- A poster session for calculus reform projects. This session is being organized by James F. Hurley of the University of Connecticut and Paul Zorn of St. Olaf College.

- An informal open forum for those involved in calculus reform or interested in becoming involved. Organized by Marcelle Bessman, this forum will provide an opportunity for discussion of issues related to calculus reform and improvement. More details will appear in the Meetings section of future issues of the *Notices*.

The poster session is co-sponsored by the AMS and by the Committee on Calculus Reform And the First Two Years (CRAFTY) of the Mathematical Association of America. CRAFTY has been at the forefront of calculus reform and has for several years sponsored panel discussions and sessions for contributed papers and posters at national meetings. The Society's co-sponsorship of the poster session reflects the concern with improved mathematical instruction at all levels, which is articulated in the mission statement appearing in the AMS strategic plan. The session will feature displays of information about and materials from current calculus reform projects of all types. It will bring those interested in working on calculus reform together with project directors who have already gone through the start-up process. Those interested in displaying materials at the poster session should contact, as early as possible, James F. Hurley, University of Connecticut, Department of Mathematics, U-9, Storrs, CT 06269-3009 (electronic mail: hurley@uconnvm.uconn.edu), or Paul Zorn, Department of Mathematics, St. Olaf College, Northfield, MN 55057 (electronic mail: zorn@stolaf.edu). A brief abstract of 150–300 words should indicate how long the project has been under way, the nature of the activity, and how many students will participate during 1992–1993.

Open Letter to the Mathematical Community from the New Assistant Director at NSF

As incoming Assistant Director for the Mathematical and Physical Sciences Directorate [MPS], I feel it is very important to put a strong team in position quickly. I have asked Judy Sunley, currently Division Director for the Mathematical Sciences [DMS], to join that team as Executive Officer for MPS. In this position, Dr. Sunley will have the opportunity to bring to bear on all of MPS the many skills that have characterized her exemplary and effective service as Division Director for DMS.

Initially, Dr. M. Kent Wilson, a capable and experienced NSF executive, will serve as Acting Division Director. We will be recruiting someone from the mathematical sciences community to serve as Dr. Sunley's replacement during the period of her MPS assignment (up to two years). The Advisory Committee for the Mathematical Sciences will play a major role in the recruitment process. We welcome suggestions from all sources, made to either myself, Dr. Sunley, or Dr. Jerry Bona, Chair of the Advisory Committee.

William C. Harris, Assistant Director Designate
Mathematical and Physical Sciences

Editor's Note: Addresses for contacting the above individuals are:

Dr. William C. Harris or Dr. Judith S. Sunley
Mathematical and Physical Sciences, Room 512
National Science Foundation
1800 G Street, N.W., Washington, DC 20550
Telephone: 202-357-9742
email: wharris@nsf.gov or jsunley@nsf.gov

Professor Jerry L. Bona
Department of Mathematics
Pennsylvania State University
215 McAllister Avenue, University Park, PA 16802-6401
email: bona@math.psu.edu

1992 AMS Elections

Council Nominations

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 1992.

The vice-president will serve for a term of three years effective February 1, 1993. The Council has nominated two candidates for the position, namely:

Melvin Hochster Anil Nerode

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

James H. Curry Peter Li
Gloria C. Hewitt Kenneth A. Ribet
Svetlana R. Katok Philip D. Wagreich
Steven George Krantz Jonathan M. Wahl
James I. Lepowsky Susan Gayle Williams

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

Roy L. Adler Richard W. Beals

President's Candidates

Nominating Committee for 1992 and 1993

Three members of the Nominating Committee are to be elected in the fall of 1992. Continuing members are: Michael Aschbacher, Daniel M. Burns, Jr., Jerry L. Kazdan, Joseph Lipman, Walter David Neumann, Carol S. Wood. President Michael Artin will name six candidates for the three positions.

Editorial Boards Committee

Two members of the Editorial Boards ommittee are to be elected in the fall of 1992. Continuing members are: Richard James Milgram, Bhama Srinivasan, Nolan R. Wallach, Robert J. Zimmer. President Michael Artin will name four candidates for the other two places.

Robert M. Fossum
Secretary
Urbana, Illinois

Joint Meeting
June 29 - July 1, 1992
Cambridge, England

Dear Colleagues:

The American Mathematical Society and the London Mathematical Society have joined forces for the first joint meeting in Cambridge, England, from Monday, June 29 to Wednesday, July 1, 1992. A Joint Program Committee consisting of members of both societies has worked diligently to create an excellent scientific program consisting of five Invited Addresses and ten Special Sessions. There will also be sessions for shorter contributed papers.

It is the first time that the two societies have collaborated in this way and we trust the event will be a model for future similar joint meetings. We hope this meeting will encourage cooperation between members of the two societies and among mathematicians throughout the world.

The Joint Meeting is being held at a propitious time for the UK mathematical community. The first symposia at the Isaac Newton Institute for Mathematical Sciences recently established in Cambridge, will start immediately after the meeting. We hope that participants will take the opportunity to visit the Institute during their stay in Cambridge.

We hope this will be a mathematical feast that will most certainly be memorable. We are pleased that our societies are working together to offer our members a meeting of this nature and we are sure that it will be a rewarding experience for all.

Sincerely yours,

Michael Artin
President
American Mathematical Society

John Kingman
President
London Mathematical Society

Joint Meeting of the American and London Mathematical Societies Cambridge, England June 29–July 1, 1992

King's College Chapel

The first joint meeting of the American Mathematical Society (AMS) and the London Mathematical Society (LMS) will be held at the University of Cambridge, England, from Monday June 29 to Wednesday July 1, 1992.

Joint Program Committee

The members of the Joint Program Committee are William Abikoff, Sir Michael Atiyah, Hyman Bass, Robert M. Fossum, and Sir John Kingman.

Local Organizing Committee

The members of the Local Organizing Committee are Professor J. H. Coates (chair), Dr. W. B. R. Lickorish, Mrs. S. Lowe, Miss S. M. Oakes, Dr. A. R. Pears, Dr. N. I. Shepherd-Barron, and Dr. R. L. Taylor.

Invited Addresses

By invitation of the Joint Program Committee, there will be five invited one-hour addresses. The speakers, their affiliations, and the titles of their talks are:

John M. Ball, Heriot-Watt University, Edinburgh, *Energy minimization and microstructure.*

Lawrence Craig Evans, University of California, Berkeley, *Harmonic maps and Hardy spaces.*

Benedict H. Gross, Harvard University, *Langlands parameters in representation theory and number theory.*

Nigel J. Hitchin, University of Warwick, *Einstein metrics and algebraic geometry.*

Edward Witten, School of Natural Science, Institute for Advanced Study, Princeton University, *Localization and gauge theories.*

Special Sessions

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

Discrete group actions, **Alan Beardon**, University of Cambridge, **William J. Harvey**, King's College London, **Caroline. M. Series**, University of Warwick.

Probabilistic combinatorics, **Béla Bollobás**, University of Cambridge, and **Ronald L. Graham**, AT&T Bell Laboratories.

Number theory, **John H. Coates**, University of Cambridge.

Discrete geometry and convexity, **Jacob E. Goodman**, CUNY, City College, New York, and **David Larman**, University College, London.

The microstructure of crystals, **Richard D. James**, University of Minnesota, Minneapolis.

Operator algebras, **Vaughan F. R. Jones**, University of California, Berkeley, **E. Christopher Lance**, University of Leeds, and **Antony J. Wassermann**, University of Cambridge,

Current trends in numerical analysis of nonlinear problems, **Rangachary Kannan**, University of Texas at Arlington.

Groups: finite and algebraic, **William M. Kantor**, University of Oregon, and **Jan Saxl**, University of Cambridge.

Geometric topology in low dimensions, **W. B. R. Lickorish**, University of Cambridge.

Classical analysis, **Cora S. Sadosky**, Howard University.

Contributed Papers

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

Activities of Other Organizations

Materials of the Association for Women in Mathematics (AWM) and the European Women in Mathematics (EWM) are on display in the exhibit area. An informal lunch is being arranged; details will be posted at the display table in the exhibit area and available from Bettye Anne Case, Cora Sadosky or Caroline Series.

Other Events of Interest

Book Exhibits and Exhibits

All meeting participants are invited to visit the Book Exhibits in the Mill Lane Lecture Room Block (MLLRB). Books published by the two Societies together with publications of Cambridge University Press, Oxford University Press, and several other publishers are on display. Books will be sold at discounted prices. The Book Exhibit is open from 9:00 a.m. to 5:00 p.m. on Tuesday and Wednesday.

The book, educational media and software exhibits are open from 9:00 a.m. to 5:00 p.m. on Tuesday and Wednesday. Their exact location will be announced at the meeting.

Sculpture Exhibit

An exhibition of sculpture is being presented by Gabriella Bollobás on Monday, June 29, from 6:00 p.m. until 11:00 p.m., at Robinson College. The exhibition features bronze busts and full size plaster cast figures of mathematicians and physicists, including Sir Isaac Newton, P. A. M. Dirac, G. H. Hardy, J. E. Littlewood and Stephen Hawking, and bronze plaques of Euler, Gauss, Hilbert, Ramanujan, and others. In addition, there are numerous drawings and photographs of contemporary mathematicians.

The Isaac Newton Institute for Mathematical Sciences

The Isaac Newton Institute for Mathematical Sciences has been established in Cambridge as a British national research institute with Sir Michael Atiyah as Director. Its activities will encompass pure mathematics, applied mathematics, statistics, engineering, computer science, theoretical physics, and all the other sciences in which mathematics is applied. Construction of a purpose-designed building for the Institute will be completed shortly before the meeting. There is an "Open Day" on Thursday, July 2, from 10:00 a.m. until 3:00 p.m.

Registration

No provision has been made for on-site registration. Registered participants should pick up their badge, program and tickets (where applicable) at the Registration Desk. Participants who wish to obtain a guest badge for their guest(s) should do so at the Registration Desk. The Registration desk will be located at Robinson College on Monday, June 29, from 10:00 a.m. to 5:00 p.m., and at the Mill Lane Lecture Room Block on Tuesday, June 30, from 9:00 a.m. to 5:00 p.m.

Social Events

The LMS is providing a complimentary reception for all registered participants in the Dining Hall of Robinson College at 9:15 p.m. on Monday, June 29.

A Conference Dinner for all participants resident at Robinson College and a limited number of non-residents (based on availability) will be held in the Dining Room in Robinson College at 7:30 p.m. on Tuesday, June 30.

Registered participants who purchased tickets to the Conference Dinner should pick up their tickets along with their badge and program at the Registration Desk. **It is regretted that tickets cannot be purchased at the meeting.**

Abstracts

Participants desiring a personal copy of the booklet containing the AMS and LMS abstracts presented at this meeting may request a copy at the Registration Desk.

Message Board

There will be a personal message board set up in the Registration Area on Tuesday, June 30, at the Mill Lane Lecture Room Block.

Accommodation

Reservations for Robinson College, the University Arms Hotel, and the Holiday Inn Hotel can be obtained through the Mathematics Meetings Service Bureau (MMSB) through May 29, 1992. After this date, participants who are interested in obtaining accommodation at the University Arms Hotel or the Holiday Inn Hotel should call these facilities directly. The MMSB can no longer guarantee availability of rooms

or special convention rates. **No provision has been made for on-site reservations at Robinson College.**

Robinson College

Participants who reserved a room during preregistration at Robinson College should check in at the Porters' Lodge, which is open 24 hours a day. Here, they will be given a room key, a map of the college and a leaflet about Robinson College. They will then be directed to their accommodation and to the meeting's Registration Desk.

Robinson College is Cambridge University's newest college. It is set on several acres of wooded gardens, and only a ten-minute walk from the Mill Lane Lecture Room Block and the Babbage Lecture Theatre, where all the meeting activities will take place.

A room and board package at a cost of $424.08/£228.00 will include a bed for the nights of Monday, Tuesday, and Wednesday; a buffet meal on Monday evening; breakfast, lunch, and dinner on Tuesday and Wednesday; and breakfast on Thursday. A limited number of rooms will be available for Sunday, June 28, at an extra charge of $81.84/£44.00 and includes breakfast on Monday. It is regretted that accommodation at Robinson College is not available outside this period. The MMSB can provide further information on Robinson College before the meeting.

University Arms Hotel

The University Arms has been Cambridge's leading hotel since 1834. It has been extensively modernized, but still retains the elegance of former times. Single, twin, or double en suite bedrooms are available at a nightly rate of $159.96/£86.00 for a single room and $195.30/£105.00 for a twin or double room. For further information and reservations, please call 022-335-1241 or fax at 022-331-5256.

Holiday Inn Cambridge

The Holiday Inn is Cambridge's newest hotel, having opened in 1991. Its facilities include an indoor swimming pool. Single, twin, or double en suite bedrooms are available at a nightly rate of $130.20/£70.00 for a single room and $204.60/£110.00 for a twin or double room. For further information and reservations, please call 022-346-4466 or fax at 022-346-4440.

Please note that the dollar rates listed above for accommodation are subject to market fluctuation and may be more or less at the time of the meeting than shown above.

Other Hotels and Guest Houses

Information about other accommodation in Cambridge can be obtained from the **Cambridge Tourist Information Centre**, Wheeler Street, Cambridge CB2 3BQ, United Kingdom. The Information Centre publishes a booklet titled *Accommodation for Visitors in and around Cambridge* which gives details of hotels, guest houses, and establishments providing bed and breakfast. It should be noted that the City of Cambridge is a great tourist attraction. Meeting participants who are interested in making accommodations of this type are forewarned that it is **usually necessary to make a reservation long in advance of the date of the meeting.**

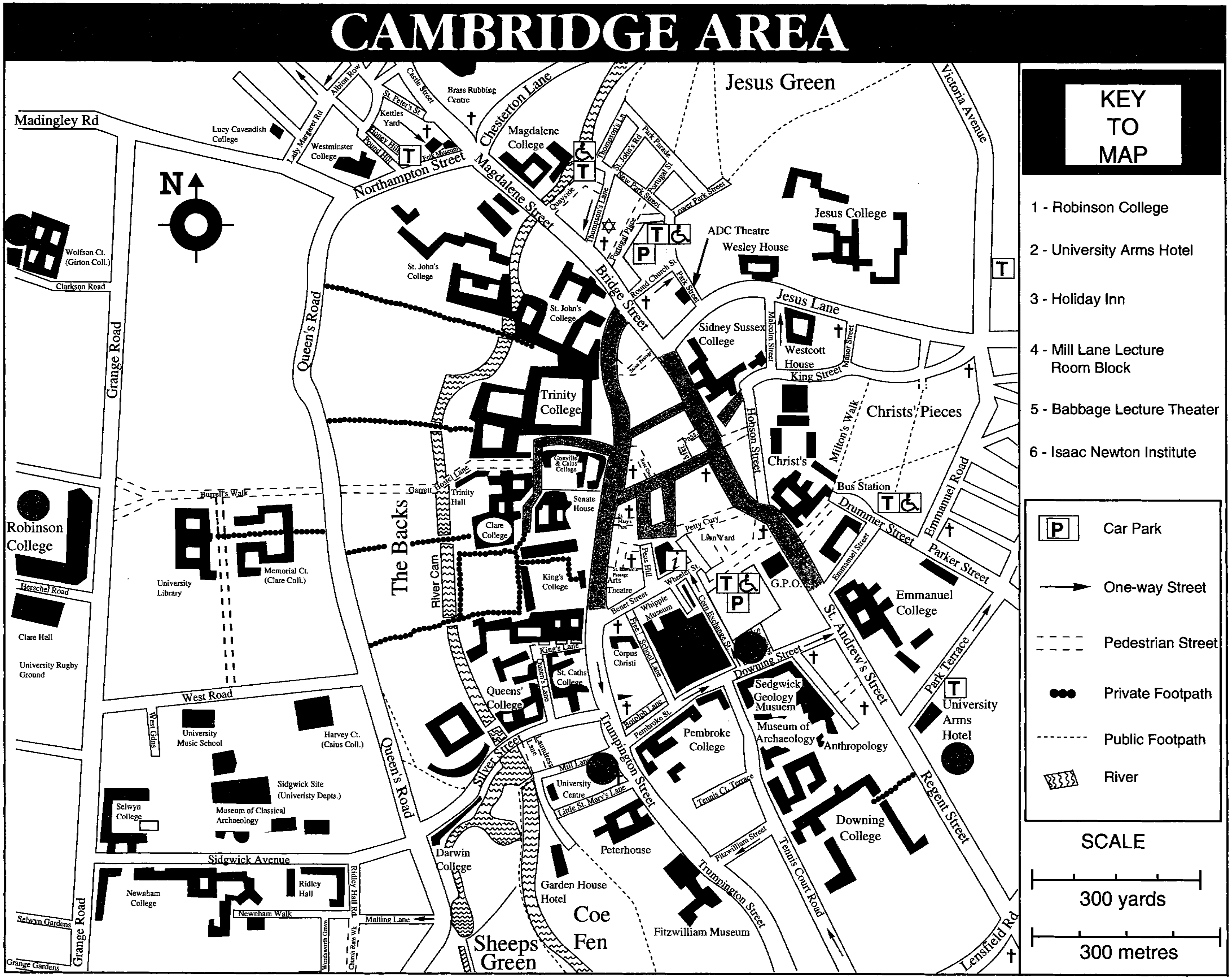
Travel and Local Information

TRAVCON, INC,. the official travel management firm for the meeting, has arranged for special discounts aboard Northwest Airlines (Northwest Airlines' London airport is Gatwick). If Northwest Airlines does not provide convenient service from your area, TRAVCON will be happy to inform you of the most convenient flights and lowest available airfare on other airlines. Each participant will receive $100,000 flight insurance with each ticket purchased through TRAVCON aboard any airline. For further information regarding these special airfares, contact TRAVCON, Inc at 1-800-999-9780 or 203-232-9939. Participants arriving at Gatwick, Heathrow, or Stansted airports are recommended to travel to Cambridge on Cambridge Coach Service #78 and 79. Coaches leave at hourly intervals. Alternatively, there is frequent train service from London King's Cross and Liverpool Street stations. If travelling from the airports by car, follow motorways M25 then M11. Parking space in Cambridge is very limited.

Participants in the meeting will have an opportunity to explore the historic city of Cambridge. The University consists of over thirty self-governing colleges spread around the city centre in beautiful surroundings. King's College Chapel, the Great Court of Trinity College, and the Bridge of Sighs at St. John's College will perhaps be well-known to everyone but there are many other buildings both medieval and modern that must be seen. There are many museums and galleries of which the most notable is the Fitzwilliam Museum. The Tourist Information Centre on Wheeler Street publishes a *Two Hour Guide to Cambridge* which describes a walking tour of the main sights. For those with more time to spare, the Tourist Centre has much more information on places to visit and things to see.

Other Conferences and Meetings

The European Congress of Mathematics (ECM) will be held from July 6-10, 1992, in Paris, France. This is the first Congress of the European Mathematical Society (EMS). There will be forty-one conferences on pure and applied mathematics and fifteen round tables on the general theme *Mathematics and Society*. For further information write to: ECM, College de France, 3 rue d'Ulm, F75005, Paris, France. A list of meetings and conferences being held in Europe after this meeting will be provided upon request.


CAMBRIDGE AREA
KEY TO MAP
1 - Robinson College
2 - University Arms Hotel
3 - Holiday Inn
4 - Mill Lane Lecture Room Block
5 - Babbage Lecture Theater
6 - Isaac Newton Institute
Car Park
One-way Street
Pedestrian Street
Private Footpath
Public Footpath
River
SCALE
300 yards
300 metres
Madingley Rd
Jesus Green
Jesus College
Jesus Lane
Victoria Avenue
Chesterton Lane
Magdalene College
Magdalene Street
Bridge Street
Northampton Street
Westminster College
Lucy Cavendish College
Brass Rubbing Centre
Kettles Yard
Folk Museum
ADC Theatre
Wesley House
St. John's College
Sidney Sussex College
Westcott House
King Street
Christs' Pieces
Christ's
Milton's Walk
Bus Station
Drummer Street
Parker Street
Emmanuel Road
Emmanuel Street
Emmanuel College
Park Terrace
University Arms Hotel
Regent Street
Lensfield Rd
Trinity College
Gonville & Caius College
Senate House
Trinity Hall
Garrett Hostel Lane
Clare College
King's College
The Backs
River Cam
Queen's Road
Grange Road
Clarkson Road
Wolfson Ct. (Girton Coll.)
Robinson College
Herschel Road
Clare Hall
University Rugby Ground
University Library
Burrell's Walk
Memorial Ct. (Clare Coll.)
West Road
University Music School
Harvey Ct. (Caius Coll.)
Sidgwick Site (Univeristy Depts.)
Museum of Classical Archaeology
Selwyn College
Sidgwick Avenue
Newnham College
Newnham Walk
Ridley Hall
Ridley Hall Rd.
Malting Lane
Selwyn Gardens
Grange Gardens
Darwin College
Sheeps Green
Coe Fen
Garden House Hotel
Peterhouse
Fitzwilliam Museum
Trumpington Street
Fitzwilliam Street
Tennis Court Road
Downing College
Pembroke College
Pembroke St.
Museum of Archaeology
Anthropology
Sedgwick Geology Museum
Downing Street
St. Andrew's Street
G.P.O.
Petty Cury
Lion Yard
Corn Exchange St.
Whipple Museum
Free School Lane
Corpus Christi
Bene't Street
Arts Theatre
Peas Hill
Wheeler St.
St. Caths College
Queens' College
Queen's Lane
King's Lane
Silver Street
Mill Lane
University Centre
Little St. Mary's Lane
Tennis Ct. Terrace
Hobson Street
Malcolm Street
Manor Street
Round Church St.
Park Street
Quayside
Thompson's Lane
Portugal Place
Park Parade
Lower Park Street
New Park Street
St. Peter's St.
Castle Street
Albion Row
Lady Margaret Rd
Honey Hill
Pound Hill
Laundress Lane
West Gdns
Wordsworth Grove
Church Rate Wk

Presenters of Papers

Numbers following the names indicate the speakers' positions on the program.
• Invited Lecturer * Special Session Speaker

Program of the Sessions

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

Abstracts of papers presented in the sessions at this meeting will be found in the June 1992 issue of *Abstracts of papers presented to the American Mathematical Society*, ordered according to the numbers in parentheses following the listings below.

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

Monday, June 29

Invited Address

19:45 –20:45 Babbage Lecture Theatre, New Museum Site

(1) *Energy minimization and microstructure.*
John M. Ball, Heriot-Watt University, United Kingdom (875-73-112)

Tuesday, June 30

Special Session on Discrete Group Actions, I

08:45 –11:05 Room 4, Mill Lane Lecture Room Block

08:45 (2) *Some inequalities for Kleinian groups.*
Bernard Maskit, State University of New York, Stony Brook (875-99-212)

09:15 (3) *Holomorphic motions and Teichmüller spaces.* Preliminary report.
Clifford J. Earle, Cornell University, **Irwin Kra***, State University of New York, Stony Brook, and **Samuel L. Krushkal**, Bar Ilan University, Israel (875-32-38)

09:45 (4) *Pleating coordinates for deformation spaces of Kleinian groups.* Preliminary report.
Linda Keen*, Herbert H. Lehman College, City University of New York, and **Caroline Series**, Warwick University, United Kingdom (875-30-108)

10:15 (5) *Geodesics in infinite dimensional Teichmüller spaces.* Preliminary report.
Clifford J. Earle*, Cornell University, **Irwin Kra**, State University of New York, Stony Brook, and **Samuel L. Krushkal**, Bar Ilan University, Israel (875-32-50)

10:45 (6) *Some examples of discrete two-generator subgroups of* $PSL(2, C)$. Preliminary report.
Jane Gilman, Institute for Advanced Study (875-35-31)

Special Session on Probabilistic Combinatorics, I

08:45 –11:15 Room 2, Mill Lane Lecture Room Block

08:45 (7) *Random walks supported on random points of* $\mathbf{Z}/n\mathbf{Z}$.
Martin V. Hildebrand, University of Michigan, Ann Arbor (875-60-59)

09:10 (8) *Independent process approximations for random combinatorial structures.*
R. Arratia and **S. Tavaré***, University of California, Los Angeles (875-05-170) (Sponsored by Bela Bollobas)

09:35 (9) *Cycles in random graphs and hypergraphs.*
V. F. Kolchin, Academy of Sciences of the USSR (875-05-202) (Sponsored by Bela Bollobas)

10:00 (10) *Keller's cube-tiling conjecture is false.*
Jeffrey C. Lagarias and **Peter W. Shor***, AT&T Bell Laboratories, Murray Hill, New Jersey (875-52-134)

10:30 (11) *Almost every graph can be covered by* $\lceil \Delta/2 \rceil$ *linear forests.*
Colin McDiarmid*, University of Oxford, England, and **Bruce Reed**, Rheinische Friedrich-Wilhelms-Universität, Germany (875-05-195)

10:55 (12) *The size of the last cycle in the random graph process.* Preliminary report.
Svante Janson, Uppsala University, Sweden, and **Tomasz Luczak***, Adam Mickiewicz University, Poland (875-05-131) (Sponsored by Bela Bollobas)

Special Session on Microstructure of Crystals, I

08:45 –10:35 Room 6, Mill Lane Lecture Room Block

08:45 (13) *Piezoelectricity in composite materials.*
Marco Avellaneda, Courant Institute of Mathematical Sciences, New York University (875-49-151)

09:15 (14) *Some problems in polycrystalline materials that undergo the Martensitic phase transformation.*
Kaushik Bhattacharya, Courant Institute of Mathematical Sciences, New York University (875-49-152)

09:45 (15) *Approximated convex envelope of a function.*
M. Chipot, University of Metz, France (875-49-153)

10:15 (16) *An investigation into small parameter limits of lattice convolutions and stored energies in magnetic materials.*
Nikan B. Firoozye, Heriot-Watt University, United Kingdom and University of Minnesota, Minneapolis (875-73-169)

Special Session on Operator Algebras, I

08:45 –11:15 Room 3, Mill Lane Lecture Room Block

08:45 (17) *Approximately homogeneous C^*-algebras.*
Bruce Blackadar, University of Nevada, Reno (875-99-208)

09:35 (18) *Lie superalgebras and product formulas for Siegel modular forms.*
Richard Borcherds, University of Cambridge, United Kingdom (875-81-197) (Sponsored by Vaughan F. Jones)

10:30 (19) *Non-commutative geometry.*
Alain Connes, IHES, Bures-sur-Yvette, France (875-46-200) (Sponsored by Vaughan F. Jones)

Special Session on Current Trends in Numerical Analysis of Nonlinear Problems, I

08:45 –11:05 Room 7, Mill Lane Lecture Room Block

08:45 (20) *Augmented Lagrangian methods for constrained optimization calculations.*
Michael J. D. Powell, University of Cambridge, United Kingdom (875-65-179)

09:15 (21) *Numerical approximation of the Vlasov-Maxwell equations.*
P. A. Raviart, Ecole Polytechnique, France (875-65-186) (Sponsored by Rangachary Kannan)

09:45 (22) *Covolume methods for viscous flows.*
Roy A. Nicolaides, Carnegie Mellon University (875-65-185) (Sponsored by Rangachary Kannan)

10:15 (23) *Numerically capturing subscale behavior.*
Stanley Osher, University of California, Los Angeles and Cognitech, Inc., Santa Monica, California (875-65-189)

10:45 (24) *Wavelets and turbulence.*
Katepalli R. Sreenivasan, Yale University (875-65-201)

Special Session on Groups: Finite and Algebraic, I

08:45 –11:05 Room 1, Mill Lane Lecture Room Block

08:45 (25) *Imprimitive group actions on graphs and designs.*
Cheryl E. Praeger, University of Western Australia, Australia (875-20-13)

09:15 (26) *Linear algebraic groups with finitely many orbits.*
M. W. Liebeck, Imperial College, United Kingdom (875-20-174) (Sponsored by William M. Kantor)

09:45 (27) *Questions provoked by a theorem on latin squares.*
Peter J. Cameron, Queen Mary and Westfield College, University of London, United Kingdom (875-20-192) (Sponsored by William M. Kantor)

10:15 (28) *Counting congruence subgroups.* Preliminary report.
Alex Lubotzky, Hebrew University, Israel (875-20-55) (Sponsored by William M. Kantor)

10:45 (29) *Transitive permutation modules.* Preliminary report.
Robert M. Guralnick, University of Southern California (875-20-43)

Special Session on Geometric Topology in Low Dimensions, I

08:45 –11:05 Room 9, Mill Lane Lecture Room Block

08:45 (30) *Recognizing nonorientable Seifert bundles.*
Wilbur Whitten, University of Southwestern Louisiana (875-57-11)

09:15 (31) *Exceptional Dehn fillings.*
Steven Bleiler*, Portland State University, and **Craig Hodgson**, University of Melbourne, Australia (875-57-12)

09:45 (32) *Title to be announced.*
Yves E. Mathieu, University of Provence, France (875-99-217)

10:15 (33) *Representations of the groups of skew triple unions of knots.*
Robert Riley, State University of New York, Binghamton (875-57-88)

10:45 (34) *When is an incompressible torus created by Dehn surgery on a knot?*
Cameron Gordon* and **John Luecke**, University of Texas, Austin (875-57-95)

Session on Analysis and Probability

08:45 –10:40 Room 8, Mill Lane Lecture Room Block

08:45 (35) *Some mapping properties of the radial-limit function of an inner function.* Preliminary report.
Robert Berman* and **Togo Nishiura**, Wayne State University (875-30-101)

09:00 (36) *The determinant of the Laplacian on moduli space.*
J. R. Quine* and **Mark Hughes**, Florida State University (875-30-121)

09:15 (37) *Uniform algebras generated by holomorphic and pluriharmonic functions.* Preliminary report.
Alexander J. Izzo, University of Michigan, Ann Arbor (875-32-57)

09:30 (38) *Mutual independence.*
Gary L. Wise*, University of Texas, Austin, and **Eric B. Hall**, Southern Methodist University (875-60-168)

09:45 (39) *R numbers and queues.* Preliminary report.
Mei Ling Huang*, Brock University, and **Percy Brill**, University of Windsor (875-62-143)

10:00 (40) *From sample-values to zeros and poles.*
Philip G. Spain, University of Glasgow, United Kingdom (875-65-130)

Tuesday, June 30 (cont'd)

10:15 (41) *Sobolev gradients and differential equations.*
J. W. Neuberger, University of North Texas (875-65-17)

10:30 (42) *An expanded set of correlation tests for random number generators.*
Ora Engelberg Percus and **J. K. Percus***, Courant Institute of Mathematical Sciences, New York University (875-65-99)

Session on Number Theory

08:45 –11:25 Seminar Room A, Department of Applied Mathematics and Theoretical Physics

08:45 (43) *The use of infinite numbers to make explicit the poles of the factorial function.*
C. Muses, Mathematics and Morphology Research Centre (875-11-111)

09:00 (44) *Hecke operators on ternary cusp forms.*
J. Larry Lehman, Mary Washington College (875-11-145)

09:15 (45) *Upper bounds for frequencies of elements in second-order recurrences over a finite field.*
Lawrence Somer, Catholic University of America (875-11-16)

09:30 (46) *Gelfond's theorem for Drinfeld modules.*
Paul Georg Becker, Math Institut der Universitat, Germany, **W. Dale Brownawell**, Pennsylvania State University, University Park, and **Robert Tubbs***, University of Colorado, Boulder (875-11-175)

09:45 (47) *Primitive divisors of Lucas and Lehmer sequences.*
Paul M. Voutier, University of Colorado, Boulder (875-11-193)

10:00 (48) *On the stable Shimura correspondence for $SL(2)$.*
David Joyner, United States Naval Academy (875-11-21)

10:15 (49) *On $\sigma \circ \phi(n)$.* Preliminary report.
S. W. Graham*, Michigan Technical University, **M. Filaseta** and **C. Nicol**, University of South Carolina, Columbia (875-11-26)

10:30 (50) *The computational dynamics of Pollard's rho method.* Preliminary report.
Christopher S. Cotter, University of Northern Colorado (875-11-42)

10:45 (51) *Configurations of lines which determine modular families of $K3$ surfaces.* Preliminary report.
W. L. Hoyt*, Rutgers University, New Brunswick, and **C. F. Schwartz**, Rider College (875-11-53)

11:00 (52) *Dihedral perfect numbers.*
David W. Jensen* and **Eric R. Bussian**, United States Air Force Academy (875-11-93)

11:15 (53) *Ideal class group structure.*
Ruth I. Berger, Memphis State University (875-11-218)

Invited Address

11:30 –12:30 Babbage Lecture Theatre, New Museum Site

(54) *Langlands parameters in representation theory and number theory.*
Benedict H. Gross, Harvard University (875-11-25)

Special Session on Probabilistic Combinatorics, II

14:00 –16:20 Room 2, Mill Lane Lecture Room Block

14:00 (55) *Percolation in the cube.*
Béla Bollobás, University of Cambridge, United Kingdom (875-05-172)

14:30 (56) *Collisions among random walks on a graph.*
Don Coppersmith, IBM T. J. Watson Research Center, Yorktown Heights, New York, **Prasad Tetali**, Rutgers University, Piscataway, and **Peter Winkler***, Bellcore, Morristown, New Jersey (875-05-135)

15:00 (57) *Limit theorems using associated variables.*
Svante Janson, Uppsala University, Sweden (875-99-205)

15:30 (58) *Asymptotically good list-colorings.*
Jeff Kahn, Rutgers University, New Brunswick (875-05-87)

16:00 (59) *The Potts model.*
D. J. A. Welsh, Merton College, United Kingdom (875-05-98)

Special Session on Number Theory, I

14:00 –16:30 Room 4, Mill Lane Lecture Room Block

14:00 (60) *L-functions and extensions of motives.*
Anthony J. Scholl, University of Durham, United Kingdom (875-11-176)

14:50 (61) *Representations of Galois groups associated to automorphic forms.*
Richard Taylor, University of Cambridge, United Kingdom (875-11-03)

15:45 (62) *More on Serre's conjectures.*
Kenneth A. Ribet, University of California, Berkeley (875-11-138)

Special Session on Discrete Geometry and Convexity, I

14:00 –16:20 Room 1, Mill Lane Lecture Room Block

14:00 (63) *On the number of convex lattice polytopes.* Preliminary report.
Imre Bárány, Mathematical Institute, Hungary (875-52-78)

14:30 (64) *Two aspects of the regular 24-cell in four dimensions.*
H. S. M. Coxeter, University of Toronto (875-52-73)

15:00 (65) *Strategies for the generation of Penrose tilings with defects, which (hopefully) will not lead to dead ends.* **L. Danzer**, Universität Dortmund, Germany (875-52-66) (Sponsored by Jacob E. Goodman)

15:30 (66) *A class of convex programs with applications to computational geometry.* **Martin Dyer**, University of Leeds, United Kingdom (875-90-67) (Sponsored by Jacob E. Goodman)

16:00 (67) *Betti numbers for convex polytopes.* **Jonathan Fine**, Cambridge, United Kingdom (875-52-39)

Special Session on Microstructure of Crystals, II

14:00 –16:20 Room 6, Mill Lane Lecture Room Block

14:00 (68) *Numerical methods for computing microstructure.* **Roy Nicolaides**, Carnegie Mellon University (875-49-159)

14:30 (69) *Numerical computation for a variational problem in micromagnetics.* **Mitchell Luskin**, University of Minnesota, Minneapolis, and **Ling Ma***, Carnegie Mellon University (875-65-44)

15:00 (70) *Young measures supported on a given set.* **João P. Matos**, Instituto Superior Técico, Portugal (875-49-157)

15:30 (71) *Surface energy and microstructure in coherent phase transitions.* **Stefan Müller**, Institut für Angewandte Mathematik, Germany (875-49-156)

16:00 (72) *Piezoelectric polycrystals: Effective medium approximation and bounds.* **Tamara Olson**, Yale University (875-49-160)

Special Session on Operator Algebras, II

14:00 –16:30 Room 3, Mill Lane Lecture Room Block

14:00 (73) *Quantized differential forms in non-commutative geometry.* **Joachim Cuntz**, University of Heidelberg, Germany (875-99-213)

14:50 (74) *Operator algebras tensor categories and conformal field theory.* Preliminary report. **Jörg Fröhlich**, Eidgen Technological Hochschule, Switzerland (875-99-214) (Sponsored by Vaughan F. Jones)

15:45 (75) *Vertex operator algebras.* **Peter Goddard**, University of Cambrige, United Kingdom (875-81-196) (Sponsored by Vaughan F. Jones)

Special Session on Current Trends in Numerical Analysis of Nonlinear Problems, II

14:00 –16:20 Room 7, Mill Lane Lecture Room Block

14:00 (76) *A mixed-characteristic method for contaminant transport.* **Mary Wheeler**, Rice University (875-65-183)

14:30 (77) *Applications of inertial manifolds to scientific computing.* **Roger Temam**, University of Paris XI, France (875-65-190)

15:00 (78) *Numerical analysis for ULSI simulation.* **Donald J. Rose**, Duke University (875-65-182)

15:30 (79) *Application of decomposition methods to some class of nonlinear partial differential equations.* **Roland Glowinski**, University of Houston, University Park (875-65-181)

16:00 (80) *Multi-scale computational methods.* **Achi Brandt**, Weizmann Institute of Science, Israel (875-65-188) (Sponsored by Rangachary Kannan)

Special Session on Groups: Finite and Algebraic, II

14:00 –16:20 Room 9, Mill Lane Lecture Room Block

14:00 (81) *A_1 type subgroups in semisimple algebraic groups and the finite groups of Lie type.* Preliminary report. **Donna M. Testerman**, Wesleyan University (875-20-204)

14:30 (82) *Large subgroups of finite groups.* Preliminary report. **Laszlo Pyber**, Rutgers University, Piscataway (875-20-94) (Sponsored by William M. Kantor)

15:00 (83) *Quasithin groups.* **Michael Aschbacher**, California Institute of Technology (875-20-100)

15:30 (84) *Revising the classification of the finite simple groups.* **Daniel Gorenstein*** and **Richard Lyons**, Rutgers University, New Brunswick (875-20-118)

16:00 (85) *A local characterization of sporadic groups.* **Richard Lyons*** and **Daniel Gorenstein**, Rutgers University, New Brunswick (875-20-102)

Special Session on Classical Analysis, I

14:00 –16:30 Cockcroft Lecture Theatre, New Museum Site

14:00 (86) *A solution to an old problem of Hopf in ergodic theory.* **Alexandra Bellow***, Northwestern University, and **A. P. Calderon**, University of Chicago (875-46-203)

14:25 (87) *Analogues of classical L^p inequalities.* Preliminary report. **T. A. Gillespie**, University of Edinburgh, United Kingdom (875-42-82)

Tuesday, June 30 (cont'd)

14:50 (88) *Stieltjes operator measures, evolution equations and univalent functions.*
N. Nikolskii*, University of Bordeaux I, France and Steklov Mathematics Institute, USSR, and **V. Vasyunin**, Steklov Mathematics Institute, USSR (875-47-81)

15:20 (89) *H^p spaces and elliptic boundary value problems.*
Der-Chen Chang*, University of Maryland, College Park, **Eli Stein**, Princeton University, and **Steven Krantz**, Washington University (875-42-80)

15:45 (90) *Restriction implies Bochner-Riesz for paraboloids.*
Anthony Carbery, University of Sussex, United Kingdom (875-42-123)

16:10 (91) *Oscillatory integrals and radon transforms.*
Elias M. Stein, Princeton University (875-42-124)

Session on Differential Equations

14:00 –15:40 Room 8, Mill Lane Lecture Room Block

14:00 (92) *Critical elements of quadratic systems.*
Arthur Sagle*, University of Hawaii, Hilo, and **Michael Kinyon**, University of Utah (875-34-04)

14:15 (93) *Asymptotic behavior of solutions of functionally perturbed nonoscillatory second order differential equations.*
William F. Trench, Trinity University (875-34-08)

14:30 (94) *A deterministic model for arms growth.* Preliminary report.
Carey B. Joynt and **Jerry P. King***, Lehigh University (875-34-19)

14:45 (95) *Extension of Riemann P-function.*
M. A. Al-Bassam, University of Cambridge, United Kingdom (875-34-37)

15:00 (96) *Nonlinear neutral delay differential equations of a higher order.*
R. S. Dahiya* and **A. Zafer**, Iowa State University (875-34-51)

15:15 (97) *Schroedinger conditions.* Preliminary report.
H. A. Venables, Portsmouth Polytechnic, United Kingdom (875-35-136)

15:30 (98) *Abstract Volterra equations: Stability and boundedness.* Preliminary report.
C. Corduneanu, University of Texas, Arlington (875-45-92)

Session on Geometry

14:00 –15:55 Seminar Room A, Department of Applied Mathematics and Theoretical Physics

14:00 (99) *Calculating the extrinsic geometry of a tube.*
Michael H. Vernon, Lewis-Clark State College (875-53-144)

14:15 (100) *Monopoles on 3-manifolds with ends.*
L. M. Sibner, Polytechnic Institute of New York, and **R. J. Sibner***, Brooklyn College, City University of New York (875-53-178)

14:30 (101) *New diagonal properties and metrization* II. Preliminary report.
G. R. Hiremath, Talladega College (875-54-146)

14:45 (102) *A census of positive knots.*
James M. Van Buskirk, University of Oregon (875-57-150)

15:00 (103) *Morse flows on* SO(n) *and* spin(n). Preliminary report.
Jay A. Wood, Purdue University, Calumet Campus (875-57-194)

15:15 (104) *A topological quantum theory approach to the Andrews-Curtis conjecture.*
Frank Quinn, Virginia Polytechnic Institute and State University (875-57-47)

15:30 (105) *Stochastic calculus on supermanifolds and the Atiyah-Singer index theorem.*
Alice Rogers, King's College, United Kingdom (875-58-164)

15:45 (106) *Continuity of hyperbolic spectral theory for degenerating Riemann surfaces of finite volume.*
Jay Jorgenson, Yale University, and **Rolf Lundelius***, University of Southern California (875-58-48)

Invited Address

16:45 –17:45 Babbage Lecture Theatre, New Museum Site

(107) *Einstein metrics and algebraic geometry.*
Nigel J. Hitchin, University of Warwick, United Kingdom (875-53-90)

Wednesday, July 1

Special Session on Discrete Group Actions, II

08:45 –11:05 Room 1, Mill Lane Lecture Room Block

08:45 (108) *Nilpotent groups of automorphisms of Riemann surfaces.*
A. M. Macbeath, Tayport, United Kingdom (875-20-56)

09:15 (109) *p-groups of symmetries of surfaces.*
Colin Maclachlan* and **Yasemin Talu**, Aberdeen University, United Kingdom (875-57-40)

09:45 (110) *Computation of a period matrix of a compact and symmetric Riemann surface.*
Mika Seppälä, University of Helsinki, Finland (875-32-122)

10:15 (111) *Certain Seifert 3-manifold groups are automatic.*
D. B. A. Epstein, University of Warwick, United Kingdom (875-99-209)

10:45 (112) *Convergence groups are Fuchsian groups.*
David Gabai, California Institute of Technology (875-30-129)

Special Session on Discrete Geometry and Convexity, II

08:45 –11:05 Room 4, Mill Lane Lecture Room Block

08:45 (113) *Arrangements, spreads, and topological planes.* **Jacob E. Goodman***, City College, City University of New York, **Richard Pollack**, Courant Institute of Mathematical Sciences, New York University, **Rephael Wenger**, Ohio State University, Columbus, and **Tudor Zamfirescu**, Universität Dortmund, Germany (875-52-69)

09:15 (114) *Deciding uniqueness in norm-maximization.* Preliminary report. **Peter Gritzmann***, University of Trier, Germany, and **Victor Klee**, University of Washington (875-52-76)

09:45 (115) *Paths on polyhedra and their importance in optimization.* Preliminary report. **Peter Kleinschmidt**, Universität Passau, Germany (875-52-77) (Sponsored by Jacob E. Goodman)

10:15 (116) *On a conjecture of Firey.* Preliminary report. **Erwin Lutwak**, Polytechnic Institute of New York (875-52-79)

10:45 (117) *Between combinatorial and smooth manifolds.* Preliminary report. **Peter Mani-Levitska**, University of Bern, Switzerland (875-52-75) (Sponsored by Jacob E. Goodman)

Special Session on Microstructure of Crystals, III

08:45 –11:15 Room 6, Mill Lane Lecture Room Block

08:45 (118) *An existence theory for nonlinear elasticity that allows for cavitation.* Preliminary report. **Stefan Müller**, Institut für Angewandte Mathematik der Universität Bonn, Germany, and **Scott Spector***, Southern Illinois University (875-73-96)

09:10 (119) *The kinematics of continuously defective crystals.* **G. P. Parry**, University of Bath, United Kingdom (875-49-161)

09:35 (120) *Extreme measures for the two-well problem.* **Pablo Pedregal**, Carnegie Mellon University (875-49-162)

10:00 (121) *Relaxation of multiple integrals in the space of functions of bounded variation.* **Irene Fonseca**, Carnegie Mellon University, and **Piotr Rybka***, Warsaw University, Poland (875-49-163)

10:30 (122) *Nonlocal penalties on microstructure.* **Robert C. Rogers**, Virginia Polytechnic Institute and State University (875-49-158)

10:55 (123) *Microstructures and regularity for variational integrals.* **Vladimir Šverák**, Heriot-Watt University, United Kingdom (875-49-154)

Special Session on Operator Algebras, III

08:45 –11:15 Room 3, Mill Lane Lecture Room Block

08:45 (124) *The structure of subfactors.* **Sorin Popa**, University of California Los Angeles (875-99-215) (Sponsored by Vaughan F. Jones)

09:35 (125) *Gaussian random matrices and free product operator algebras.* Preliminary report. **Dan Voiculescu**, University of California, Berkeley (875-46-109)

10:30 (126) *Operator algebras and conformal field theory.* **Antony Wassermann**, University of Cambridge, United Kingdom (875-46-198) (Sponsored by Vaughan F. Jones)

Special Session on Geometric Topology in Low Dimensions, II

08:45 –10:35 Room 9, Mill Lane Lecture Room Block

08:45 (127) *Symplectic structures on T^2-bundles over T^2.* **Hansjörg Geiges**, University of Cambridge, United Kingdom (875-53-22) (Sponsored by W. B. Lickorish)

09:15 (128) *Surgery on cusp fibers.* **Ronald Fintushel**, Michigan State University, and **Ronald J. Stern***, University of California, Irvine (875-57-58)

09:45 (129) *On the fundamental groups of manifolds with distributions.* **N. A'Campo**, University of Basel, Switzerland, and **D. Kotschick***, University of Basel, Switzerland and Queen's College, United Kingdom (875-58-91)

10:15 (130) *Convex real projective structures on closed surfaces are closed.* **Suhyoung Choi***, Kyungpook National University, Korea, and **William M. Goldman**, University of Maryland, College Park (875-51-18)

Special Session on Classical Analysis, II

08:45 –11:15 Cockcroft Lecture Theatre, New Museum Site

08:45 (131) *Superoptimal approximation by analytic functions.* **N. J. Young*** and **V. V. Peller**, Lancaster University, United Kingdom (875-30-65)

09:10 (132) *Spectral properties of selfadjoint Hankel operators.* **A. V. Megretskii**, Royal Institute of Technology, Sweden, **V. V. Peller***, University of Lancaster, United Kingdom, and **S. R. Treil**, Michigan State University (875-47-127)

09:35 (133) *Interplolation of analytic functions in the polydisk.* **Mischa Cotlar**, Universidad Central de Venezuela, Venezuela, and **Cora Sadosky***, Howard University (875-42-177)

10:00 (134) *Weighted norm estimates for potential operators and eigenvalue estimates for Schrodinger operators.* **Richard Rochberg**, Washington University (875-46-23)

Wednesday, July 1 (cont'd)

10:30 (135) *On tangents to curves.* Preliminary report.
J. M. Anderson*, University College, United Kingdom, and **F. D. Lesley**, San Diego State University (875-99-207)

10:55 (136) *Besov and Triebel-Lysorkin spaces on spaces of homogeneous type.*
Yongsheng Han, University of Windsor, and **Guido Weiss***, Washington University (875-42-46)

Session on Algebra

08:45 –10:40 Room 8, Mill Lane Lecture Room Block

08:45 (137) *The stabilizer of a Schubert variety.*
Steven B. Tesser, Indiana State University (875-16-167)

09:00 (138) *Simple Lie algebras in characteristic 2, graphs, and Fisher's theorem.* Preliminary report.
Joseph Rotman* and **Paul Weichsel**, University of Illinois, Urbana-Champaign (875-17-10)

09:15 (139) *Semidirect products, derivations and reduced cyclic cohomology.*
Jacek Brodzki, University of Texas, Austin and Mathematical Institute, United Kingdom (875-18-29)

09:30 (140) *Universal algebras having canonical function spaces.*
Vijaya L. Gompa, Ball State University (875-18-62)

09:45 (141) *Operator K-theory and p-adic algebraic groups.* Preliminary report.
Roger Plymen, University of Manchester, United Kingdom (875-19-34)

10:00 (142) *Some new proofs of the "Monstrous Moonshine" conjectures.*
Charles R. Ferenbaugh, Princeton University (875-20-09)

10:15 (143) *Universal example for proper actions.*
Paul Baum, Pennsylvania State University, University Park (875-20-28)

10:30 (144) *Direct product ring representations of digital signal processing algorithm.*
Neil M. Wigley, University of Windsor (875-94-116) (Sponsored by Tim Traynor)

Session on Graphs and Combinatorics

08:45 –10:55 Seminar Room A, Department of Applied Mathematics and Theoretical Physics

08:45 (145) *Saunderson's algorithm.*
J. J. Tattersall, Providence College (875-01-15)

09:00 (146) *An intuitive and minimal axiomatic system for m-valued logic.* Preliminary report.
Atwell Turquette, University of Illinois, Urbana-Champaign (875-03-30)

09:15 (147) *The non-linear universal wave-function, and complete multifold ordered universe.*
W. S. Leng, Birkbeck College, Univeristy of London, United Kingdom (875-03-52)

09:30 (148) *Liftings for Lebesgue measure.*
Maxim R. Burke, University of Prince Edward Island (875-04-165)

09:45 (149) *Correlation of sequences from cyclic difference sets.*
Solomon W. Golomb, University of Southern California (875-05-113)

10:00 (150) *Probabilistic proofs of hypergeometric identities.*
Roberta Wenocur, West Chester University (875-05-20)

10:15 (151) *Genus imbeddings of $(3m, 6)$-cages.* Preliminary report.
John B. Fink, Kalamazoo College, and **Arthur T. White***, Western Michigan University (875-05-60)

10:30 (152) *A theory of quasi-uniformities for completely regular frames.* Preliminary report.
Peter Fletcher, Virginia Polytechnic Institute, **Worthen Hunsaker**, Southern Illinois University, Carbondale, and **William Lindgren***, Slippery Rock University of Pennsylvania (875-06-107) (Sponsored by Michael E. Detlefsen)

10:45 (153) *Countable games and monotone cores.*
John Sorenson, Valparaiso University (875-90-126)

Special Session on Number Theory, II

09:00 –10:45 Room 2, Mill Lane Lecture Room Block

09:00 (154) *Deformation spaces of Galois representations.*
Nigel Boston, University of Illinois, Urbana-Champaign (875-11-133)

10:00 (155) *Zeta-functions of orders.*
Stephen Lichtenbaum, Brown University (875-11-106)

Special Session on Current Trends in Numerical Analysis of Nonlinear Problems, III

09:15 –11:05 Room 7, Mill Lane Lecture Room Block

09:15 (156) *Numerical modelling of the compressible Navier-Stokes equations.*
K. W. Morton, University of Oxford, United Kingdom (875-65-184)

09:45 (157) *Instability of solitary waves.*
Jerry Bona*, Pennsylvania State University, University Park, **Vassilios Dougalis**, National Technical University of Athens, Greece, **Ohannes Karakashian**, University of Tennessee, Knoxville, and **William McKinney**, North Carolina State University (875-65-139)

10:15 (158) *Geometric algorithms for cyclides, developables, and related surfaces.*
George J. Fix, University of Texas, Arlington (875-65-187)

10:45 (159) *Analysis and approximation of control problems for nonlinear partial differential equations.*
Max D. Gunzburger, Virginia Polytechnic Institute and State University (875-65-180) (Sponsored by Rangachary Kannan)

Invited Address

11:30 –12:30 Babbage Lecture Theatre, New Museum Site

(160) *Localization and Gauge Theories.*
Edward Witten, Institute for Advanced Study (875-81-85)

Special Session on Discrete Group Actions, III

14:00 –16:20 Room 1, Mill Lane Lecture Room Block

14:00 (161) *The growth series of a graph product.*
I. M. Chiswell, Queen Mary and Westfield College, University of London, United Kingdom (875-20-125)

14:30 (162) *Pseudogroups of isometries and Rips' theorem on free actions on R-trees.*
Frédéric Paulin, Ecole Normale Super de Lyon, France (875-99-211)

15:00 (163) *Uniform tree lattices.*
Ravi S. Kulkarni, Graduate School and University Center, City University of New York (875-30-141)

15:30 (164) *On the ergodicity of the geodesic flow associated to a discrete group of isometries of a tree.*
Athanase Papadopoulos, University Louis Pasteur, France (875-99-210)

16:00 (165) *Limit sets of correspondences.* Preliminary report.
Shaun Bullett* and **Christopher Penrose**, Queen Mary and Westfield College, University of London, United Kingdom (875-30-97) (Sponsored by Alan F. Beardon)

Special Session on Probabilistic Combinatorics, III

14:00 –16:20 Room 2, Mill Lane Lecture Room Block

14:00 (166) *Random liars.*
Joel Spencer, Courant Institute of Mathematical Sciences, New York University (875-05-02)

14:30 (167) *Laplacian and vibrational spectra for homogeneous graphs.*
Fan R. K. Chung*, Bellcore, Morristown, New Jersey and Harvard University, and **Shlomo Sternberg**, Harvard University (875-05-105)

15:00 (168) *An affine walk on the hypercube.* Preliminary report.
Persi Diaconis, Harvard University, and **Ron Graham***, AT&T Bell Laboratories, Murray Hill, New Jersey (875-05-103)

15:30 (169) *Random Ramsey problems.*
Vera T. Sós, Hungarian Academy of Science, Hungary (875-05-171) (Sponsored by Bela Bollobas)

16:00 (170) *Problems in probabilistic number theory and combinatorics.*
Paul Erdos, Hungarian Academy of Sciences, Hungary (875-05-104)

Special Session on Number Theory, III

14:00 –16:30 Room 4, Mill Lane Lecture Room Block

14:00 (171) *Galois module structure of principal homogeneous spaces.*
Martin Taylor, University of Manchester, United Kingdom (875-11-137)

14:50 (172) *An almost pure sieve and its applications.*
C. Hooley, Wales University, United Kingdom (875-99-216)

15:45 (173) *The size of Selmer groups for the congruent number problem.*
D. R. Heath-Brown, Magdelen College, United Kingdom (875-99-206)

Special Session on Discrete Geometry and Convexity, III

14:00 –16:20 Room 6, Mill Lane Lecture Room Block

14:00 (174) *On simple polytopes.* Preliminary report.
Peter McMullen, University College of London, United Kingdom (875-52-72)

14:30 (175) *Towards a geometric graph theory.*
János Pach, Mathematical Institute Hungarian Academy, Hungary and Courant Institute of Mathematical Sciences, New York University (875-52-68) (Sponsored by Jacob E. Goodman)

15:00 (176) *Stability results for convex bodies.* Preliminary report.
Rolf Schneider, Albert-Ludwigs-Universität, Germany (875-52-70) (Sponsored by Jacob E. Goodman)

15:30 (177) *Pick's theorem for lattice polygons.*
G. C. Shephard*, University of East Anglia, United Kingdom, and **B. Grünbaum**, University of Washington (875-52-74) (Sponsored by Jacob E. Goodman)

16:00 (178) *Quermassintegrals, successive minima, and minimal determinants.*
Jörg M. Wills, University of Siegen, Germany (875-52-71)

Special Session on Groups: Finite and Algebraic, III

14:00 –16:30 Room 3, Mill Lane Lecture Room Block

14:00 (179) *A proof of a conjecture of Garrett Birkhoff and Philip Hall.*
Peter M. Neumann, Queen's University, United Kingdom (875-20-07)

14:25 (180) *Computing in solvable linear groups.*
Eugene M. Luks, University of Oregon (875-20-120)

14:50 (181) *Topics in asymptotic group theory.*
László Babai, University of Chicago and Eötvös University, Hungary (875-20-191)

Wednesday, July 1 (cont'd)

15:20 (182) *On Y-presentations for the monster and related groups.*
A. A. Ivanov, Institute for System Studies, Russia (875-20-119)

15:45 (183) *Epimorphic subgroups of affine algebraic groups.*
Frederic Bien, Princeton University (875-20-173)

17:10 (184) *Standard bases related to minuscule weight modules.*
Arjeh M. Cohen*, CWI, The Netherlands, and **Richard H. Cushman**, University of Utrecht, The Netherlands (875-14-132)

Special Session on Geometric Topology in Low Dimensions, III

14:00 –16:20 Room 9, Mill Lane Lecture Room Block

14:00 (185) *Racks and links in codimension two: Abstract.*
Roger Fenn, Sussex University, United kingdom (875-57-63)

14:30 (186) *Signature defects and quantum invariants.*
Paul Melvin, Bryn Mawr College (875-57-27)

15:00 (187) *Temperley-Lieb recoupling and 3-manifold invariants.* Preliminary report.
Louis H. Kauffman, University of Illinois, Chicago (875-55-128)

15:30 (188) *Topological imitations of 3-manifolds and the quantum invariants.* Preliminary report.
Akio Kawauchi, Osaka City University, Japan (875-57-33) (Sponsored by W. B. Lickorish)

16:00 (189) *On the homotopy invariance of Casson's invariant.* Preliminary report.
Daniel Ruberman, Brandeis University (875-57-140)

Special Session on Classical Analysis, III

14:00 –16:20 Cockcroft Lecture Theatre, New Museum Site

14:00 (190) *The collapse of the inverse function theorem.*
Thomas William Körner, University of Cambridge, United Kingdom (875-26-84)

14:30 (191) *The Pompeiu problem in the Heisenberg group.*
Carlos A. Berenstein, University of Maryland, College Park (875-42-89)

15:00 (192) *Large analytic functions.*
Henry Helson, University of California, Berkeley (875-30-83)

15:30 (193) *Two remarks on porous sets.*
Casper Goffman, Purdue University, West Lafayette (875-26-35)

16:00 (194) *An inequality for bounded Fourier series, related to an isoperimetric problem.*
W. K. Hayman, University of York, United Kingdom (875-42-149)

Session on Function Algebras

14:00 –16:25 Seminar Room A, Department of Applied Mathematics and Theoretical Physics

14:00 (195) *On the extension of linear operators.*
John J. Saccoman, Seton Hall University (875-46-01)

14:15 (196) *Smooth points of unit balls of operator and function spaces.*
Roshdi Khalil, Bahrain University, Bahrain (875-46-05) (Sponsored by Robert M. Fossum)

14:30 (197) *Continuous approximation of set-valued maps and coincidence theorems.*
Hichem Ben-El-Mechaiekh, Brock University (875-46-114) (Sponsored by Mei L. Huang)

14:45 (198) *On extreme normal completely positive linear maps.* Preliminary report.
Sze-Kai Tsui, Oakland University (875-46-115)

15:00 (199) *New convexity and fixed point properties in Hardy and Lebesque-Bochner spaces.*
M. Besbes, University of Paris, France, **S. J. Dilworth***, University of South Carolina, Columbia, **P. N. Dowling**, Miami University, and **C. J. Lennard**, University of Pittsburgh, Pittsburgh (875-46-14)

15:15 (200) *A quantitative generalization of a theorem of Hille.*
Gregory F. Bachelis*, Wayne State University, and **Sadahiro Saeki**, Kansas State University (875-46-148)

15:30 (201) *Convergence of random products of operators.* Preliminary report.
Robert Sine, University of Rhode Island (875-46-64)

15:45 (202) *Relatively open operators and the ubiquitous concept.*
Ronald Cross, University of Cape Town, Republic of South Africa (875-47-06)

16:00 (203) *Commutator approximants.*
P. J. Maher, Middlesex Polytechnic, United Kingdom (875-47-54)

16:15 (204) *Young measures as optimal controls for Navier-Stokes equations.*
S. S. Sritharan, University of Colorado Boulder (875-49-32)

Session on Special Functions and Applied Mathematics

14:00 –16:10 Room 8, Mill Lane Lecture Room Block

14:00 (205) *The generalized Leibniz rule and its consequences.*
R. N. Kalia, Saint Cloud State University (875-26-142)

14:15 (206) *Rotation invariant separable functions are Gaussian.*
PI Kannappan, University of Waterloo (875-39-45)

14:30 (207) *Approximation of control and optimal control problems using neural nets.*
M. Nouri-Moghadam* and **M. Ermish**, Pennsylvania State University, Lehman (875-41-110)

14:45 (208) *A generalization of the Cantor-Lebesgue theorem.*
J. Marshall Ash, DePaul University, **Robert P. Kaufman**, University of Illinois, Urbana-Champaign, and **Eric Rieders***, DePaul University (875-42-117)

15:00 (209) *Wavelet transform of periodic generalized functions.*
Ahmed I. Zayed, University of Central Florida (875-42-147)

15:15 (210) *Construction of numerical solutions of permanent capillar-heavy waves of two liquids.*
Nabil Moussa, American University in Cairo, Egypt (875-76-199)

15:30 (211) *Chern-Simons theory via path integrals.*
Dana S. Fine, University of Massachusetts, Dartmouth (875-81-41)

15:45 (212) *Quasiperiodic perturbations and normal forms.*
Raghu R. Gompa, Indiana University, Kokomo (875-81-61) (Sponsored by Vijaya L. Gompa)

16:00 (213) *Global interfacial instability and micro-structure formation in dendritic crystal growth.*
Jian-Jun Xu, McGill University (875-82-24)

Invited Address

16:45 –17:45 Babbage Lecture Theatre, New Museum Site

(214) *Harmonic maps and Hardy spaces.*
Lawrence C. Evans, University of California, Berkeley (875-35-86)

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.

Dayton, OH, October 1992

Martin Golubitsky
Jonathan I. Hall
Louis H. Kauffman
J. T. Stafford

Los Angeles, CA, November 1992

Robert K. Lazarsfeld
Tomasz S. Mrowka
Thomas C. Sideris

San Antonio, TX, January 1993

Richard A. Brualdi (AMS-MAA)
Luis A. Caffarelli (Colloquium Lectures)
Subrahamanyan Chandrasekhar (AMS-MAA)
James Douglas, Jr.
Carolyn S. Gordon
Wu-Yi Hsiang
Bernd Sturmfels
Leon Takhtajan
Alexander Varchenko
Mary F. Wheeler (AMS-MAA)

Knoxville, TN, March 1993

Paul R. Blanchard
Olav Kallenberg
Richard A. Tapia
Michelle L. Wachs

Washington, DC, April 1993

Fan R. K. Chung
Leopold Flatto
Joel Spruck
A. Zamolodchikov

Vancouver, British Columbia, Canada August 1993

Louis Nirenberg (AMS-CMS)
Jill Pipher (AMS-CMS)

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 1992 Meeting in Dayton, Ohio
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: Expired
Deadline for consideration: July 13, 1992

Colin C. Adams and Ara S. Basmajian, *Hyperbolic manifolds*
Carolyn A. Dean, Timothy J. Hodges, and J. Toby Stafford, *Quantum groups and regular algebras*
Joanne M. Dombrowski and Richard Mercer, *Operator theory and operator algebras*
Anthony B. Evans and Terry A. McKee, *Combinatorics and graph theory*
Daniel E. Frohardt, *Groups and geometries*
Lop Fat Ho, Srdjan D. Stojanovic and Thomas Svobody, *Control theory and partial differential equations*
Muhammud N. Islam and Lawrence Turyn, *Differential and integral equations*
Louis H. Kauffman, *Knots and topological quantum field theory*
Hendrik J. Kuiper and Tapas Mazumdar, *Ricatti equations and transport theory*
Anatoly S. Libgober and Stephen Sperber, *Topology of affine hypersurfaces and related number theory*
Joe D. Mashburn, *Set-theoretic topology*
C. David Minda, *Function theory*

November 1992 Meeting in Los Angeles, California
Western Section
Associate Secretary: Lance W. Small
Deadline for organizers: Expired
Deadline for consideration: July 13, 1992

Michael Aschbacher, Robert M. Guralnick, and David B. Wales, *Finite and algebraic groups*
Francis Bonahon and Robert L. Meyer, *Hyperbolic geometry*
Robert Brooks and Peter A. Perry, *Spectral geometry*
Lawrence Ein, *Algebraic and complex geometry*
Eugene Gutkin and Nicolai T. A. Haydn, *Dynamical systems*

Robert C. Penner and Edward Witten, *Topics in geometry and physics*

January 1993 Meeting in San Antonio, Texas
Associate Secretary: W. Wistar Comfort
Deadline for organizers: April 13, 1992
Deadline for consideration: September 17, 1992

Kathleen T. Alligood and Judy A. Kennedy, *Continuum theory and dynamical systems*
Thomas Archibald and Victor Katz, *History of mathematics*
Alvaro Arias, *Banach space theory*
Charles E. Aull, *History of general topology*
Melvyn S. Berger, *Small divisor problems in analysis*
Scott T. Chapman, *Commutative algebra*
William J. Coles and B. A. Fusaro, *Environmental modeling*
David Cox and Bernd Sturmfels, *Combinatorial methods in computational algebraic geometry*
Raúl Curto and David R. Larson, *Operator theory and triangular operator algebras*
Michael R. Darnel, *Ordered algebraic structures*
Robert S. Doran, *C*-algebras: 1943-1993 (a 50-year celebration)*
K. L. Duggal, *Differential geometry*
Saber N. Elaydi, John R. Graef, and William F. Trench, *Stability and asymptotic behavior of difference equations*
Dennis R. Estes and Donald James, *Quadratic forms*
Naomi Fisher, Harvey B. Keynes, and Philip D. Wagreich, *Research in undergraduate education*
Robin Forman and John E. Luecke, *Topology and geometry*
Dennis DeTurck and Carolyn S. Gordon, *Eigenvalues in Riemannian geometry*
Morris W. Hirsch and Halbert White, *Dynamics and computation in neural networks*
Hans A. Koch, Rafael de la Llave, and Charles Radin, *Infinitely many degrees of freedom*
Xinzhi Liu and Seenith Sivasundaram, *Integro-differential equations: stability and control*
David E. Marker and Philip H. Scowcroft, *Model theory and algebra*
John E. McCarthy, *Holomorphic spaces*
Alec Norton and Mary Lou Zeeman, *Low dimensional geometric dynamical systems*
L. Alayne Parson and Mark Sheingorn, *Modular forms and related topics*
Nikolay Reshetikhin, Leon Takhtajan, and Alexander Varchenko, *Quantum groups*

March 1993 Meeting in Knoxville, Tennessee
Southeastern Section
Associate Secretary:
Joseph A. Cima (until 1/31/93)
Robert J. Daverman (after 1/31/93)
Deadline for organizers: June 26, 1992
Deadline for consideration: December 15, 1992

David F. Anderson and David E. Dobbs, *Commutative ring theory*
Ben G. Fitzpatrick and Suzanne M. Lenhart, *Optimal control and applications*
Alexandre S. Freire, *Variational problems in geometry*
Don B. Hinton and Kenneth Shaw, *Sturm-Liouville operators, applications, and extensions*
Tim Kelley, *Numerical methods in optimization*
John C. Mayer, *Continua theory and dynamical systems*
Balram S. Rajput and Jan Rosinski, *Stochastic processes*
Michelle L. Wachs, *Algebraic combinatorics*

April 1993 Meeting in Salt Lake City, Utah
Western Section
Associate Secretary: Lance W. Small
Deadline for organizers: July 9, 1992
Deadline for consideration: January 6, 1993

April 1993 Meeting in Washington, DC
Eastern Section
Associate Secretary:
W. Wistar Comfort (until 1/31/93)
Lesley M. Sibner (after 1/31/93)
Deadline for organizers: July 17, 1992
Deadline for consideration: January 6, 1993

John J. Benedetto and Rodney B. Kerby, *Waveletes in sampling theory and signal processing*
Kevin G. Hockett and E. Arthur Robinson, *Ergodic theory, dynamical systems and applications*
Joel Spruck, *Nonlinear elliptic problems in geometry and physics*

May 1993 Meeting in DeKalb, Illinois
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: August 21, 1992
Deadline for consideration: February 3, 1993

Michael A. Filaseta, *Number theory*
Zoltan Furedi, *Combinatorics*
Andrew J. Granville, *Analytic number theory*
Frank Harary, *Graph theory*
Steffen Lempp, *Recursion theory*
Mohsen Pourahmadi, *Stochastic processes*
Linda R. Sons, *Function theory*
Joel H. Spencer, *Probabilistic methods*
Peter Weaterman, *Discrete groups*

August 1993 Meeting in Vancouver, British Columbia, Canada
Associate Secretary: Lance W. Small
Deadline for organizers: November 11, 1992
Deadline for consideration: April 27, 1993

October 1993 Meeting in College Station, Texas
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: January 22, 1993
Deadline for consideration: July 14, 1993

January 1994 Meeting in Cincinnati, Ohio
Associate Secretary:
Joseph A. Cima (until 1/31/93)
Robert J. Daverman (after 1/31/93)
Deadline for organizers: April 5, 1993
Deadline for consideration: September 23, 1993

March 1994 Meeting in Lexington, Kentucky
Southeastern Section
Associate Secretary:
Joseph A. Cima (until 1/31/93)
Robert J. Daverman (after 1/31/93)
Deadline for organizers: June 18, 1993
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

June 1994 Meeting in Eugene, Oregon
Western Section
Associate Secretary: Lance W. Small
Deadline for organizers: September 7, 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

March 1995 Meeting in Chicago, Illinois
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: June 24, 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 Department 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 (until January 31, 1993)
Department of Mathematics
Wesleyan University
Middletown, CT 06457
Electronic mail: g_comfort@math.ams.com
(Telephone 203-347-9411)

Lesley M. Sibner, Associate Secretary (beginning February 1, 1993)
Department of Mathematics
Polytech University of New York
Brooklyn, NY 11201-2990
(Telephone 718-260-3505)

Southeastern Section

Joseph A. Cima, Associate Secretary (until January 31, 1993)
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)

Robert J. Daverman, Associate Secretary (beginning February 1, 1993)
Department of Mathematics
University of Tennessee
Knoxville, TN 37996-1300
(Telephone 615-974-6577)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

Information for Speakers

A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special Session has been scheduled. Contributors should know that there is a limitation in size of a single Special Session, so that it is sometimes true that all places are filled by invitation. Papers not accepted for a Special Session are considered as ten-minute contributed papers.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Meetings Department, American Mathematical Society, P. O. Box 6887, 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, Meetings Department, P.O. Box 6887, 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.

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 1994 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 1994. 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; or by telephone: 401-455-4146; FAX 401-455-4004; email: 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 chair 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 staff in their selection of an appropriate site.

1994 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 Newmann 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, 1992

1994 AMS Summer Research 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. 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:

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 – *Quadratic forms and division algebras: Connections with algebraic K – theory and algebraic geometry*, **William Jacob** and **Alex Rosenberg**, University of California, Santa Barbara.

1993 – *Stochastic analysis*, **Michael Cranston**, University of Rochester; **Richard T. Durrett**, Cornell University; and **Mark A. Pinsky**, Northwestern University.

Deadline For Suggestions: September 1, 1992

1994 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:

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 – *Mathematical models in cell biology*, organized by **Byron Goldstein**, Los Alamos National Laboratory, and **Carla Wofsy**, University of New Mexico.
1993 – Proposal not yet selected.

Deadline For Suggestions: September 1, 1992

1994 AMS-SIAM Summer Seminar in Applied Mathematics

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:
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 – *Exploiting symmetry in applied and numerical analysis*, organized by **Eugene L. Allgower**, **Kurt Georg**, and **Rick Miranda**, Colorado State University.
1993 – Proposal not yet selected.

Deadline For Suggestions: September 1, 1992

1994 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 eleventh series of one-week conferences being held in 1992 are: *Conformal field theory, topological field theory, and quantum groups*; *Cohomology, representations, and actions of finite groups*; *Nielsen theory and dynamical systems*; *The Penrose transform and analytic cohomology in representation theory*; *Wavelets and applications*; *Commutative algebra: syzygies, multiplicities and birational algebra*; *Change-point problems*; *Control and identification of partial differential equations*; and *Adaptive designs*.

If proceedings are published by the AMS, they appear as volumes in the series *Contemporary Mathematics*.

Deadline For Suggestions: February 1, 1993

Call for Topics for 1994 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:
Wavelets and applications (January 1993), *New scientific applications of geometry and topology* (January 1992), *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), and *Matrix theory and applications* (January 1989). 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 should be submitted by **December 1, 1992**.

Submit suggestions to: AMS Meetings Department, P.O. Box 6887, Providence, RI 02940; FAX: 401-455-4004; email: MEET@MATH.AMS.COM.

Joint Mathematics Meetings in San Antonio
AMS Special Sessions and Contributed Papers
MAA Contributed Papers

The Joint Mathematics Meetings in San Antonio will be held January 6–9 (Wednesday–Saturday), 1993. The first full announcement of the meetings will appear in the October 1992 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 18, 1992, 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, Meetings Department, American Mathematical Society, Post Office Box 6887, Providence, RI 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, Meetings Department, American Mathematical Society, Post Office Box 6887, Providence, RI 02940, **so as to arrive by the abstract deadline of October 8, 1992.** A charge of $16 is imposed for retyping abstracts that are not in camera-ready form. **Late papers will not be accepted.**

Electronic Submission of AMS 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 in AMS sessions only. 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: Director of Meetings, American Mathematical Society, P.O. Box 6887, Providence, RI 02940. When requesting the abstracts package, users should be sure to specify whether they want the plain TEX, AMS-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.

MAA Contributed Papers

Contributed papers are being accepted on several topics in collegiate mathematics for presentation in contributed paper sessions at the meeting. The organizers listed below solicit contributed papers pertinent to their sessions' interests and concerns; material should be sent to the organizer whose name is followed by an asterisk (*). Please note that any days scheduled for any session are tentative. The topics, organizers, and their affiliations are:

- *Assessment programs for the undergraduate major*, Friday morning and Saturday afternoon

Charles F. Peltier*
Department of Mathematics
Saint Mary's College
Notre Dame, IN 46556
email: cpeltier@bach.helios.nd.edu
fax: 219-284-4492

James W. Stepp, University of Houston

This session sponsored by the CUPM Subcommittee on Assessment, seeks papers on use of assessment of student achievement in evaluation of undergraduate programs in mathematics. Contributors may address program evaluation (as related to assessment of student achievement), methods of assessment of individual student achievement, development of goals and criteria for assessment, or the effects of assessment on the development of programs. Contributions addressing methods of assessment or describing experience with programs for assessment are particularly encouraged.

- *"Capstone" courses for senior mathematics majors*, Wednesday and Thursday mornings

Christopher E. Barat and **Pamela Crawford***
Department of Mathematics
Randolph-Macon College
Ashland, VA 23005

In recent years, there has been a dramatic increase in the number and variety of "capstone" courses designed to provide senior mathematics majors with a "summation" of their undergraduate experiences and to sharpen fundamental skills such as reading and writing mathematics, problem solving, and research techniques. This session welcomes papers describing courses of this type, as well as those discussing how such courses might be developed. Topics may include the choice of a "capstone" theme, course organization, innovative student assignments, evaluation of student performance, and the integration of "capstone" courses into existing major sequences.

• *Empowering the mathematical community*, Wednesday morning and Thursday afternoon

Gloria F. Gilmer*
Math-Tech, Inc.
9155 N. 70 St.
Milwaukee, WI 53223

Marilyn Frankenstein, University of Massachusetts, Boston
Patricia C. Kenschaft, Montclair State College
Alvin M. White, Harvey Mudd College

This session is organizer by the Joint AMS-MAA-AAAS Committee on Opportunities in Mathematics for Underrepresented Minorities (COMUM) in cooperation with the MAA Committee on the Participation of Women, The Cricical Math Network, and the Humanistic Math Network.

Student empowerment refers to an internal state in which students see themselves as responsible for, in control of, or the source of their own learning. When students control few elements in the learning environment, their empowerment is low; when they control many elements, it is high. Mathematically **powerful** students think and communicate, drawing on mathematical ideas and using mathematical tools and techniques. Mathematically powerful work is purposeful. Thus, papers are sought which respond to questions such as the following: What are we doing to empower students? What must the profession do to empower others at all educational levels and interests? What must the profession do to empower others at all educational levels and interests? Why are some instructional models more empowering for students than others?

• *Impact of non-traditional instructional methods on testing and evaluation*, Wednesday and Thursday afternoons

Linda H. Boyd*
Mathematics Department
DeKalb College
555 North Indian Creek Dr.
Clarkston, GA 30021

Elizabeth Teles, Montgomery College, Maryland

The session is organized by the Committee on Two-Year Colleges. Papers are requested describing the impact of non-traditional methods of instruction on testing and evaluation. These methods include but are not limited to laboratory exercises or experiments, group projects, and student presentations.

• *Interactive learning environments*, Wednesday and Thursday mornings

Katherine Pedersen*
NSF Statewide Systemic Initiative
435 S. Chapelle
Pierre, SD 57501

Sandra Z. Keith, St. Cloud State University

Interactive learning environments in undergraduate mathematics have been a topic of growing interest in the last few years. Interactive modes of teaching include collaborative learning and cooperative learning as well as teaching/learning strategies that enable students to interact not only with each other and the instructor but with materials and technology. Typically, the student interactions are structured by the instructor for maximum benefit to the students. Technology often plays a role as group study and group assignments have been a natural outgrowth of environments that use computers and calculators. Papers for this session, sponsored by the Committee on Computers in Mathematics Education, will not be limited to those using technology. Preference will be given to papers describing, with appropriate data, the author's own experiences in promoting interactive learning environments, especially collaborative learning and cooperative learning.

• *Linear algebra*, Wednesday and Friday afternoons, and Thursday evening

Donald R. LaTorre*
Department of Mathematical Sciences
Clemson University
Clemson, SC 29634-1907

Steven J. Leon, University of Massachusetts, Dartmouth
A. Duane Porter (for the LACSG), University of Wyoming

This session invites papers on innovations in teaching linear algebra, including: (1) the use of computer algebra systems, supercalculators, or computer software; (2) experiences with materials from the ATLAST summer workshops; (3) experiences with the Core Curriculum recommended by the Linear Algebra Curriculum Study Group; and (4) "Gems" of exposition in linear algebra; and (5) other innovative teaching or curriculum ideas in linear algebra.

• *Mathematics and the arts*, Thursday afternoon and Saturday morning

JoAnne S. Growney*
Department of Mathematics and Computer Science
Bloomsburg University
Bloomsburg, PA 17815

This session invites submissions on the follwing themes: (1) Application of mathematical methods of thought and design to another art form. (2) Examination of artworks/artforms in which mathematics is included in the content or in the construction. (3) Strategies/examples for teaching and learning mathematics by exploring its links with other arts.

• *Recreational mathemagical computing*, Friday morning and Saturday afternoon

Dr. Michael W. Ecker*
Editor/Publisher
Recreational & Educational Computing
909 Violet Terrace
Clarks Summit, PA 18411

This session plans to present diverse recreations in which computer programming plays a supplementary but essential role. Though the computer languages and topics are open, some preference will be given to recreations and/or recreational problem-solving with widest appeal for maximum accessibility. Thus papers at a more elementary or intermediate level are particularly sought, perhaps using BASIC, QuickBASIC, or Pascal. Papers presenting recreations off the beaten path or that unify seemingly diverse themes are also most welcome. Utility software for aiding such investigations will be welcome, but more so to the extent that it is connected to particular problems. Since it is impossible to anticipate the range of topics and papers of interest, all proposals and suggestions are encouraged and will be given serious consideration.

• *Recruitment and retention of women in mathematics revisited*, Saturday morning and afternoon

Marcelle Bessman*
328 Braddock, #212
Frostberg, MD 21532
email: R2NKBES@FRE.TOWSON.EDU
fax: 813-872-9342
(May 10–Aug. 20, mailing address will be 644 Geneva Place, Tampa, FL 33606)

This session, sponsored by the Committee on Participation of Women in Mathematics, is a sequel to the 1987 contributed paper session "Recruitment and Retention of Women in Mathematics", which focused on the factors affecting the participation of women in mathematics. Since that time the Committee on Participation of Women in Mathematics was formed to assess the problem and develop or encourage projects designed to improve recruitment and retention of women. One such project is the recent committee publication "Winning Women into Mathematics." The purpose of this session is to learn about projects undertaken at educational institutions and agencies that employ mathematicians to encourage participation of women in mathematics. Of particular interest are presentations that describe such a project, the obstacles encountered, proposed or accomplished solutions, and projections for the future.

• *Teaching mathematics to multicultural and multilingual students*, Friday morning and afternoon

Richard O'Lander*
Division of Computer Science, Mathematics & Science
St. John's University
St. Vincent's College
Grand Central & Utopia Parkways
Jamaica, NY 11439

Demographic changes have meant that educators are now required to teach mathematics to students from a wide variety of multicultural and multilingual backgrounds. This session welcomes papers which describe research on student learning as well as methods of teaching mathematics to these students. Descriptions of courses taught should address how these students learn mathematics, teaching methods used, and the effectiveness of these methods.

• *Use of visualization in the teaching of mathematics*, Friday morning and Saturday afternoon

Howard Lewis Penn*
Mathematics Department
572 Holloway Rd.
United States Naval Academy
Annapolis, MD 21402-5002
email: hlp@math2.sma.usna.navy.mil

James R. King, University of Washington

This session, organized by the Committee on Computers in Mathematics Education, invites presentations that illustrate the use of visualization in mathematics teaching. Authors should send an abstract which includes a description of how visualization will be used in the presentation. In particular, if the use of computers or other technology is contemplated, include a very precise description of what is needed (it is expected that a MacIntosh and an MS-DOS-PC with overhead projection panels will be available).

• *Using data and computers in teaching statistics*, Wednesday morning and Thursday afternoon

Mary Parker*
Department of Mathematics
Austin Community College
11928 Stonehollow Drive
Austin, TX 78758-3101

George Cobb, Mount Holyoke College

The MAA/ASA Joint Committee on Undergraduate Statistics organized this session to explore the use of data and computers in undergraduate statistics courses. Contributions are specifically invited which discuss how the use of data and/or computer simulations can be used to strengthen the teaching of important concepts, to emphasize statistical thinking, and to foster active learning. Papers on upper division mathematical statistics courses are welcome as well as papers on more elementary courses.

Presentations are normally limited to ten minutes, although selected contributors may be given up to twenty minutes. Individuals wishing to submit a paper 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 whose address is given**. The purpose of this summary is to enable the organizer(s) to evaluate the appropriateness of the paper for the session, so this summary should be as detailed and informative as possible within the

one-page limitation. This summary must reach the organizer by **September 10, 1992. Summaries should NOT be sent to the MAA Washington office.**

The organizer will acknowledge receipt of the summary. If the paper is accepted for presentation, the organizer will send the author(s) a standardized abstract form. to be used to prepare a brief abstract, which will be published in the journal *Abstracts* (copies will be available in the registration area).

Completed abstract forms must be returned to the organizer promptly and **no later than September 24. Do not send the abstracts to the AMS, and do not submit them electronically**. Abstracts not received by that date cannot be published. If desired, an abstract form may be obtained in advance from either the AMS office or the MAA Washington office and the abstract may be submitted along with the summary.

Rooms where MAA contributed paper sessions 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 $\frac{1}{2}''$ or $\frac{3}{4}''$ VHS video cassette recorder with one color monitor.

1992 Symposium on Some Mathematical Questions in Biology

Cell Biology

Denver, Colorado, November 1992

The twenty-sixth annual Symposium on Some Mathematical Questions in Biology, focusing on *Cell Biology*, will be held during the annual meeting of the American Society for Cell Biology, November 15–19, 1992, at the Colorado Convention Center in Denver, Colorado. 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 members are Jack D. Cowan, James W. Curren, Marcus W. Feldman, Eric S. Lander, Marc Mangel (Chair), and James D. Murray. Byron Goldstein and Carla Wofsy serve as organizers.

There will be two afternoon sessions, each including three invited lectures on mathematical and biophysical approaches to problems in cell biology. The dates will appear in the next issue of the *Notices*. The speakers and their topics are: **Micah Dembo** (Los Alamos National Laboratory), *Modeling cell adhesion*; **Elliot Elson** (Washington University School of Medicine, St. Louis), *Interpretation of measurements of cellular deformability*; **Byron Goldstein** (Los Alamos National Laboratory), *Cell activation through the aggregation of cell surface receptors*; **Jennifer Linderman** (University of Michigan, Ann Arbor), *Cell-cell interactions and the activation of T cells in an immune response*; **George Oster** (University of California, Berkeley), *The dynamics of single-motor molecules*; and **Michael Reed** (Duke University), *The transport of organelles in axons*.

Proceedings of the symposium will be published by the AMS in the series *Lectures on Mathematics in the Life Sciences*.

The SMB has funds for partial support of graduate students attending the symposium. To request support, contact John Rinzel, Chief, Mathematical Research Branch, NIADDKD, Bldg. 31, Room 4B-54, NIH, Bethesda, MD 20892, by June 15, 1992. The application should include a one-page research summary and one letter from a faculty sponsor.

Discount airfares are available from United Airlines for travel November 12–22, 1992. Call 1-800-521-4041 and refer to file number 524YM.

For further information on the symposium, contact the Symposium Conference Coordinator, AMS, P.O. Box 6887, Providence, RI 02940, or DLS@MATH.AMS.COM by electronic mail.

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 the *Notices* if it contains a call for papers, and specifies the place, date, subject (when applicable), and the speakers; a second 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 the *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 the *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 the *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.

1992

1992. **IMACS Symposium on Symbolic Computation in Engineering Design**, IDN, Lille, France. (Jul./Aug. 1990, p. 746)

1992. **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. **Third IMACS International Conference on Expert Systems in Numerical Computing**, Purdue University, West Lafayette, IN. (May/Jun. 1991, p. 475)

Spring 1992. **DIMACS Workshop on Expander Graphs: Theory and Applications**, Center for Discrete Mathematics, Rutgers, The State University of New Jersey, New Brunswick, NJ. (Oct. 1991, p. 1007)

June 1992

June 1992. **IMACS Symposium on Numerical Computing and Mathematical Modelling**, Bangalore, India. (Oct. 1990, p. 1141)

June 1992. **Continuum Models for the Microstructure of Crystals**, International Centre for Mathematical Sciences, Edinburgh, Scotland. (Oct. 1991, p. 1009)

1-3. **Logical Analysis and Computer Science in Honor of the 60th Birthday of MSI Director A. Nerode**, Mathematical Sciences Institute, Ithaca, NY. (Apr. 1992, p. 343)

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)

1-5. **Third International Conference on Mathematical Population Dynamics**, University of Pau, France. (Dec. 1991, p. 1336)

1-5. **Calcul Formel et Équations Différentielles**, Marseille, France. (Jan. 1992, p. 49)

1-5. **NSF-CBMS Regional Research Conferences in the Mathematical Sciences: Number Theory and Dynamical Systems**, California State University, Fresno, California. (Jan. 1992, p. 49)

4-6. **AT LAST: An NSF-ILAS Project to Augment the Teaching of Linear Algebra through the use of Software Tools**, West Valley College, Saratoga, CA. (Feb. 1992, p. 142)

*4-11. **III Week on Algebra and Algebraic Geometry**, Puerto de la Cruz (Tenerife).

INVITED SPEAKERS: *Tentative*: A. Bak (U. Bielefeld), G. Elencwajg (U. Nice), A. Facchini, A. Fröhlich (Queen's College), Hermann (U. Köln), M. Knus, Lipman (Purdue U.), M.P. Malliavin (U. Paris VI), McConnell (U. Leeds), Robiano (U. Genova), Spivakosky (Hravard U.), Villamayor (Buenos Aires).

INFORMATION: Victoria Reyes Sánchez, Dept. de Matemática Fundamental, Univ. de La Laguna, 38206, La Laguna, Tenerife, Canary Island, Spain.

7-11. **International Joint Conference on Neural Networks "IJCNN '92"**, Baltimore, MD. (Dec. 1991, p. 1337)

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)

8-12. **Séminaire Sud-Rhodanien de Géométrie**, Marseille, France. (Jan. 1992, p. 49)

8-12. **NSF Undergraduate Faculty Enhancement Workshop: Algorithmic Number Theory**, California State University, Fresno, CA. (Jan. 1992, p. 50)

8-12. **Gordon Research Conferences "Frontiers of Science"**, Tilton, NH. (Apr. 1992, p. 344)

8-13. **Zero-dimensional Schemes**, Ravello, Italy. (Sep. 1991, p. 837)

8-13. **Continuum Models for the Mi-**

crostructure of Crystals, Edinburgh, Scotland. (Jan. 1992, p. 50)

8–19. **Dirichlet Forms**, Villa Monastero, Varenna, Italy. (Dec. 1991, p. 1337)

8–19. **Workshop on Dynamical Systems**, International Centre for Theoretical Physics, Trieste, Italy. (Jan. 1992, p. 50)

9–11. **International Conference on Art and Mathematics**, SUNY Albany, NY. (Feb. 1992, p. 142)

9–14. **International Conference on Differential Geometry and Global Analysis**, Münster, Federal Republic of Germany. (Apr. 1992, p. 344)

10–16. **Geometric Topology Workshop**, Technion, Haifa, Israel. (Nov. 1991, p. 1168)

11–13. **AT LAST: An NSF-ILAS Project to Augment the Teaching of Linear Algebra through the use of Software Tools**, Auburn University, Auburn, AL. (Feb. 1992, p. 142)

11–13. **Ninth Annual Western Workshop in Geometric Topology**, Colorado College, Colorado Springs, Colorado. (Mar. 1992, p. 244)

11–13. **Logical Methods in Mathematics and Computer Science**, Cornell University, Ithaca, NY. (Mar. 1992, p. 244)

12–13. **Conference on the Teaching of Calculus**, Harvard University, Cambridge, MA. (Apr. 1992, p. 344)

12–14. **Canadian Mathematical Society Summer Meeting**, York University, North York, Ontario, Canada. (Nov. 1990, p. 1289)

12–20. **D-moduli and Representation Theory**, Ca' Foscari, Venezia, Italy. (Dec. 1991, p. 1337)

13–16. **Conference in Geometric Group Theory**, Ohio State University, Columbus, OH. (Nov. 1991, p. 1168)

13–18. **Inverse Problems in Engineering: Theory and Practice**, Palm Coast, FL. (Mar. 1992, p. 244)

14–17. **Third Symposium on "Chaotic Dynamical Systems"**, Conference Center "Woudschoten", The Netherlands. (Mar. 1992, p. 244)

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)

15–18. **Wave Phenomena II: Modern Theory and Applications**, Edmonton, Alberta, Canada. (Nov. 1991, p. 1169)

15–18. **Computer Vision and Pattern Recognition**, Champaign, IL. (Dec. 1991, p. 1337)

15–19. **Twenty-first International Conference on Stochastic Processes and their Applications**, Toronto, Canada. (May/Jun. 1990, p. 613)

15–19. **Fourth Conference on Formal Power Series and Algebraic Combinatorics**, Université du Quebec a Montréal. (Sep. 1991, p. 837)

15–19. **Sixth International Conference on Domain Decomposition Methods in Science and Engineering**, Como, Italy. (Nov. 1991, p. 1169)

15–19. **Tire a Préciser**, Marseille, France. (Jan. 1992, p. 50)

* 15–19. **Logic and Computer Science**, Centre International de Recontres Mathématiques, Luminy, France.

ORGANIZER: M.R. Donnadieu.
CONFERENCE TOPICS: λ-calculus, functional programming, nonclassical logics, proof theory, logic programming, categorical logic.
INVITED SPEAKERS: S. Abramsky (London), S. Artemov (Moscou), M. Bezem (Utrecht), E. Börger (Pise), V. Danos (Paris VII), R. Dyckhoff (St. Andrew), J.Y. Girard (CNRS Paris), K. Mac Aloon (NY), F. Montagna (Siene), H. Ono (Hiroshima), M. Parigot (Paris), V. Ribakov (Krasnoyarsk), K. Segerberg (Uppsala), J. Smith (Göteberg), P. Aczel (Manchester), H.P. Barendregt (Nijmegen), G. Boolos (MIT), B. Courcelle (Bordeaux), J.P. Delahaye (Lille), Y. Gurevich (Ann Arbor), G. Japaridze (Tbilissi), I. Moerdijk (Utrecht), Y. Moschovakis (Los Angeles), E. Palmgren (Uppsala), A.M. Pitts (Cambridge), U. Schmerl (Munich), Ph. Scott (Edimbourg), S. Solovëv (St. Petersburg).
INFORMATION: M.R. Donnadieu, Dept. de Math.-Informatique, Faculté des Sciences de Luminy, Case 901, 13288 MARSEILLE Cedex 9, Tel: 91 26 90 47 or 91 26 90 80; Fax: 91 26 90 38; email: mrd@lumimath.univ-mrs.fr.

15–20. **International Conference and Summer School on the Theory and Applications of Dynamical Systems**, Huddinge (Stockholm), Sweden. (Mar. 1992, p. 245)

15–20. **Fourier Analysis and Partial Differential Equations**, Miraflores de la Sierra, near Madrid, Spain. (Mar. 1992, p. 245)

* 15–20. **Interactive Mathematics Text Project: Mathcad 3.1**, University of Pennsylvania.

INSTRUCTOR: L. Senechal.
COST: $500.
INFORMATION: E. Deeba, Dept. of Applied Math. Sciences, Univ. of Houston-Downtown, One Main St., Houston, TX 77002; 713-221-8550.

15–27. **Nonequilibrium problems in many-particle systems**, Montecatini Terme, Italy. (Dec. 1991, p. 1337)

16–18. **1992 IFAC/IFIP/IMACS International Symposium on Artificial Intelligence in Real-Time Control**, Delph University of Technology, Delph, The Netherlands. (Jan. 1992, p. 50)

* 16–19. **Tenth U.S. Army Mathematics Conference**, West Point, NY.

ORGANIZER: U.S. Army Research Office.
INFORMATION: J. Chiment, Mathematical Sciences Institute, 409 College Ave., Ithaca, NY 14850; 607-255-8005; Fax: 607-255-9003; jjc@cornellc.cit.cornell.edu.

17–20. **Fourth International Conference on Computers and Learning, ICCAL '92**, Acadia University, Nova Scotia, Canada. (Feb. 1991, p. 147)

17–20. **Second Geoffrey J. Butler Memorial Conference on Differential Equations and Population Biology**, University of Alberta, Edmonton, Alberta, Canada. (Feb. 1992, p. 143)

18–20. **Eighteenth International Workshop on Graph-Theoretic Concepts in Computer Science "WG '92"**, Wiesbaden-Naurod, Federal Republic of Germany. (Jan. 1992, p. 50)

18–20. **Problem Solving Across the Curriculum**, Wells College, Aurora, NY. (Jan. 1992, p. 50)

18–20. **AT LAST: An NSF-ILAS Project to Augment the Teaching of Linear Algebra through the use of Software Tools**, University of Wisconsin, Madison, WI. (Feb. 1992, p. 143)

18–20. **Eighth Summer Conference on General Topology and Applications**, Queens College, CUNY, New York City. (Mar. 1992, p. 245)

19–23. **International Conference on Complex Analysis**, Nankai Institute of Mathematics, Tianjin, China. (Feb. 1992, p. 143)

21–27. **Porous Media**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

21–July 10. **Summer Geometry Institute**, Park City, Utah. (Nov. 1991, p. 1169)

22–24. **Seventh IMACS International Conference on Computer Methods for Partial Differential Equations**, Rutgers University, New Brunswick, NJ. (Dec. 1991, p. 1337)

22–25. **Seventh Annual IEEE Symposium on Logic in Computer Science**, Santa Cruz, CA. (Sep. 1991, p. 838)

22–25. **Seventh Annual Conference on Structure in Complexity Theory**, Boston University, Boston, MA. (Nov. 1991, p. 1169)

22–26. **Fifth International Meeting on Statistical Climatology (5IMSC)**, Toronto, Canada. (Nov. 1991, p. 1169)

22–26. **Twelfth Conference on Probability and Statistics in the Atmospheric Sciences**, Toronto, Canada. (Nov. 1991, p. 1169)

22–26. **The Twelfth Dundee Conference on Ordinary and Partial Differential Equations**, Dundee, Scotland. (Nov. 1991, p. 1170)

22–26. **International Conference on Spec-**

tral and High Order Methods, Montpellier, France. (Jan. 1992, p. 50)

22–26. **Convergences en Analyse Multivoque et Optimisation**, Marseille, France. (Jan. 1992, p. 50)

22–26. **International Conference on Nonlinear Evolution Problems**, Rome, Italy. (Jan. 1992, p. 50)

22–26. **Convergences en Analyse Multivoque et Unilatérale**, CIRM, Luminy, France. (Mar. 1992, p. 245)

* 22–26. **Coxeter Groups and Algorithmic Representation Theory**, Lyon, France.

PROGRAM: The conference will focus on the algorithmic aspects of coxeter groups and Hecke algebras, with a view towards their applications in representation theory of reductive Lie groups and in geometry. Contributions of a computer science nature and reports from users of the theory working in other fields are also invited.
ORGANIZING COMMITTEE: F. Bien (Princeton U.), Fokko du Cloux and T. Fack (U. Claude Bernard, Lyon).
INVITED SPEAKERS: J. Carrell, W. Casselman, A. Cohen, V. Deodhar, F. Digne, M. Dyer, A. Garsia, Lehrer, T. Springer, J. Tits, N. Wallach.
INFORMATION: F. du Cloux, Inst. de Math et Informatique, Universite Claude Bernard, F-69622 Villeurbanne Cedex, France; ducloux@lan1.univ-lyon1.fr; Fax: +33-72.44.80.65.

* 22–26. **Waterloo '92: An International Conference on Combinatorics and Optimization**, University of Waterloo, Waterloo, Ontario, Canada.

PLENARY SPEAKERS: G. Andrews (Penn State), V. Chával (Rutgers), T. Coleman (Cornell), W. Cook (Bellcore), J. Dennis (Rice), L. Lovász (Eötvös, Hungary), P. Seymour (Bellcore), D. Stinson (Nebraska), L. Teirlinck (Auburn), C. Thomassen (Technical U., Denmark).
SPECIAL SESSIONS/WORKSHOPS: **Algebraic combinatorics**: D. de Caen, H. Barcelo, A. Brouwer, M. Conder, S. Fomin, C. Greene, M. Haiman, J. Hall, P. Hanlon, D. Leonard, I. Macdonald, P. Terwilliger, T. Visentin, R. Weiss; **Codes, designs, and cryptography**: I. Blake, D. Jungnickel, K. Heinrich, C. Lindner, B. Mills, A. Rosa, G. Simmons, N. Sloane, R. Stanton, A. Street, R. Wilson; **Combinatorial optimization**: R. Kannan, B. Korte, J. Orlin, W. Pulleyblank, A. Schrijver, E. Tardos, K. Truemper; **Graph theory**: N. Alon, R. Häggkvist, F. Jaeger, C.St.J.A. Nash-Williams; **Nonlinear optimization**: J. Birge, A. Conn, A. Dontchev, C. Lemarechal, P. Loewen, B. Mordukhovich, M. Overton, D. Shanno.
INFORMATION: Waterloo '92, Dept. of C&O, Univ. of Waterloo, Waterloo, Ontario, Canada N2L 3G1; 519-885-1211; Fax: 519-746-6530; email: combot@math.uwaterloo.ca.

22–July 17. **Patch Dynamics II**, Mathematical Sciences Institute, Ithaca, NY. (Apr. 1992, p. 345)

23–27. **Workshop on Computational Geometry**, Turin, Italy. (Dec. 1991, p. 1338)

25–27. **AT LAST: An NSF-ILAS Project to Augment the Teaching of Linear Algebra through the use of Software Tools**, University of Wyoming, Laramie, WY. (Feb. 1992, p. 143)

28–July 4. **Hyperbolic Systems of Conservation Laws**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

29–30. **International Conference on the Development of Mathematics from 1900 to 1950**, Luxembourg. (Mar. 1992, p. 245)

29–July 1. **Joint Meeting with the London Mathematical Society**, Cambridge, England.

INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6887, Providence, Rhode Island 02940.

29–July 3. **International Conference on K-Theory**, Strasbourg, France. (Dec. 1991, p. 1338)

29–July 3. **Workshop on Data Analysis and Robustness**, Ascona, Switzerland. (Jan. 1992, p. 51)

29–July 3. **Greco Calcul Formel**, Marseille, France. (Jan. 1992, p. 51)

29–July 5. **Nineteenth International Colloquium on "Group Theoretical Methods in Physics"**, Salamance, Spain. (May/Jun. 1991, p. 476)

July 1992

1–4. **Algèbres d'Operateurs 1992 (a satellite conference of the European Congress of Mathematics)**, University of Orléans, France. (Jan. 1992, p. 51)

* 2–4. **Banach Space Theory, Miniconference**, Perth, Western Australia.

INFORMATION: S.P. Fitzpatrick, Dept. of Math., Univ. of Western Australia, WA 6009, Australia.

* 2–4. **Conference in Mathematical Logic**, Paris, France.

PROGRAM: The talks will give a survey of recent research in mathematical logic which will be acccessible to a general mathematical audience.
INVITED SPEAKERS: T. Coquand, A. Louveau, A. Prstel, P. Pudlak, A. Wilkie, and B. Zilber.
INFORMATION: Colloque de Logique, Equipe de Logique, UFR de Mathematiques, Universite de Paris VII, 2, Place Jussieu, 75251 Paris Cedex 05, France; email: colloque@logique.jussieu.fr.

5–11. **Mathematische Modellierung und Simulation Elektrischer Schaltungen**, Oberwolfach, Germany. (Jul./Aug. 1991, p. 645)

5–August 1. **NSF Regional Geometry Institute: Computational Algebraic Geometry**, Amherst College, Amherst, MA. (Oct. 1991, p. 1010)

6–10. **European Congress of Mathematics**, Paris, France. (Apr. 1992, p. 345)

6–10. **Mathematical Conferences in Perth**, University of Western Australia. (Sep. 1991, p. 838)

6–10. **Eighteenth Australasian Conference on Combinatorial Mathematics and Combinatorial Computing**, Perth, Western Australia. (Nov. 1991, p. 1170)

6–10. **Thirty-Sixth Annual Meeting of the Australian Mathematical Society**, Perth, Western Australia. (Nov. 1991, p. 1170)

6–10. **Strange Attractors and Knots**, Dynamical Systems Institute, Boston University, Boston, MA. (Feb. 1992, p. 144)

* 6–10. **Fourth Workshop on Stochastic Analysis**, Oslo, Norway. (Please note change of place and time from Jul./Aug. 1991, p. 645)

ORGANIZING COMMITTEE: A.S. Ustunel (Paris), M. Zakai (Haifa), T. Lindstrom and B. Oksendal (Oslo).
INFORMATION: A.S. Ustunel, ENST, Dept. Reseaux, 46, rue Barrault, 75634 Paris Cedex 13, France; Fax: 33-1-45891664; email: ustunel@cal.enst.fr or T. Lindstrom and B. Oksendal, Dept. of Math., Univ. of Oslo, Box 1053 Blindern, N-0316 Oslo, Norway; Fax: 47-2-854349; email: lindstro@math.uio.no or oksendal@math.uio.no.

6–11. **RICA '92: RISC-LINZ Summer School in Computer Algebra 1992**, Johannes Kepler University, Linz, Austria. (Feb. 1992, p. 144)

* 6–11. **Interactive Mathematics Text Project: Mathematica for Windows**, University of Pennsylvania.

INSTRUCTOR: J. Manfredi.
COST: $650.
INFORMATION: M. Hoft, Dept. of Math., Univ. of Michigan-Dearborn, Dearborn, MI 48128; 313-593-5175.

* 6–11. **Interactive Mathematics Text Project: Mathcad 3.1**, University of Pennsylvania.

INSTRUCTOR: J. Goebel.
COST: $500.
INFORMATION: H. Gore, Dept. of Math., Morehouse College, Atlanta, GA 30314; 404-215-2614.

6–13. **Regional Institute in Geometry and Computational Algebraic Geometry**, Amherst College, MA. (Apr. 1992, p. 345)

6–17. **Conference on Contemporary Topics in Combinatorics**, University of Wyoming, Laramie, WY. (Feb. 1992, p. 144)

6–31. **IMA Summer Program on Environmental Studies: Mathematical, Computational, and Statistical Analysis**, Institute for Mathematics and its Applications, University of Minnesota. (Sep. 1991, p. 838)

6–August 14. **Summer Program in Mathematical Physiology**, Mathematical Sciences Research Institute, Berkeley, CA. (Sep. 1991, p. 838)

7–August 7. **Workshop on Stochastic Partial Differential Equations**, Mathematical Sciences Institute, Ithaca, NY. (Apr. 1992, p. 345)

8–25. **Twenty-second Summer Ecole d'ete de Calcul des Probabilites**, Saint-Flour (Cantal). (Apr. 1992, p. 345)

10–12. **Annual Meeting for the Australasian Association for Logic**, Australian National University, Canberra, Australia. (Mar. 1992, p. 246)

11–18. **St. Andrews Colloquium**, University of St. Andrews, Scotland. (Jul./Aug. 1991, p. 645)

12–16. **Dynamics of Annulus Maps**, Dynamical Systems Institute, Boston University, Boston, MA. (Feb. 1992, p. 144)

12–17. **International Colloquium on Automata, Languages and Programming**, Vienna, Austria. (Jul./Aug. 1991, p. 645)

12–18. **Arithmetic Algebraic Geometry**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

13–15. **Third Annual Göttingen Workshop on the History of Modern Mathematics**, Mathematischen Institut der Georg-August-Universität Göttingen. (Mar. 1992, p. 246)

* 13–15. **Mathematics and Computers in Sports.**, Bond University, Gold Coast, Queensland.

INFORMATION: N. de Mestre, School of Information and Computer Science, Bond University, Gold Coast, Queensland 4229, Australia; email: neville_de_mestre@macmail.bu.zo.au.

13–17. **Titre a Préciser**, Marseille, France. (Jan. 1992, p. 51)

13–17. **RISC-LINZ Summer Course on Quantifier Elimination**, Johannes Kepler Universität, Linz, Austria. (Feb. 1992, p. 144)

* 13–17. **Instructional Workshop on Numerical Methods for Stochastic Differential Equations**, Geelong, Victoria, Australia.

INFORMATION: P.E. Kloeden, Dept. of Computing and Math., Deakin Univ., Geelong, Victoria 3217, Australia; or E. Platen, School of Math. Sci., The Australian National Univ., Canberra, ACT 2601, Australia.

* 13–18. **Interactive Mathematics Text Project: Mathcad 3.1**, University of Pennsylvania.

INSTRUCTOR: D. Royster.
COST: $500.
INFORMATION: J. Morrison, Dept. of Math., Towson State University, Towson, MD 21204; 410-830-3595.

* 13–18. **Interactive Mathematics Text Project: Mathematica for Windows**, University of Pennsylvania.

INSTRUCTOR: B. Davis.
COST: $650.
INFORMATION: T. McCutcheon, Dept. of Math., Los Angeles Pierce College, 6201 Winnetka Ave., Woodland Hills, CA 91371; 818-347-0551, ext. 468.

* 13–18. **Interactive Mathematics Text Project: Mathematica for Windows**, University of Pennsylvania.

INSTRUCTOR: H. Porta.
COST: $650.
INFORMATION: H. Gore, Dept. of Math., Morehouse College, Atlanta, GA 30314; 404-215-2614.

13–24. **SMS-NATO ASI: Bifurcations and Periodic Orbits of Vector Fields**, Univ. de Montréal, Montréal, Canada. (Dec. 1991, p. 1338)

13–31. **Miniworkshop on Nonlinearity and Chaos**, Trieste, Italy. (Jan. 1992, p. 51)

* 13–August 7. **1992 CRM Summer School on Control Theory**, Montreal, Canada.

INFORMATION: S. Chenevert, CRM, Univ. de Montreal, C.P. 6128-A, Montreal, Quebec H3C 3J7, Canada.

15–17. **Premieres Journees Marocaines de Mathematiques Appliquees**, Rabat, Maroc. (Jan. 1992, p. 51)

* 17–18. **Stochastic Partial Differential Equations**, University of Rochester.

ORGANIZER: C. Mueller.
INFORMATION: J. Chiment, Mathematical Sciences Institute, 409 College Ave., Ithaca, NY 14850; 607-255-8005; Fax: 607-255-9003; email: jjc@cornellc.cit.cornell.edu.

19–23. **Sixth ACM International Conference on Supercomputing**, Washington, DC. (Dec. 1991, p. 1338)

19–23. **Complexity and Computability over the Reals**, Dynamical Systems Institute, Boston University, Boston, MA. (Feb. 1992, p. 144)

19–24. **SIAM Annual Meeting (SIAM's 40th Anniversary)**, Los Angeles, California. (Feb. 1991, p. 147)

19–24. **Neural and Stochastic Methods in Image and Signal Processing**, San Diego, CA. (Feb. 1992, p. 145)

* 19–24. **International Society for Optical Engineering (SPIE) Annual Symposium**, San Diego, CA.

INFORMATION: Tel: 206-676-3290.

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. (Jul./Aug. 1991, p. 645)

19–31. **SERC Numerical Analysis Summer School**, Lancaster University, Lancaster, England. (Dec. 1991, p. 1338)

20–24. **The Fifth International Conference on Fibonacci Numbers and their Applications**, University of St. Andrews, St. Andrews, Scotland. (May/Jun. 1991, p. 476)

20–24. **Second Symposium on Logical Foundations of Computer Science (SCFS '92)**, Tver University, Tver, USSR. (Dec. 1991, p. 1339)

20–24. **Titre a Préciser**, Marseille, France. (Jan. 1992, p. 51)

20–24. **SIAM Fortieth Anniversary Meeting**, Los Angeles, CA. (Mar. 1992, p. 246)

* 20–24. **Third International Conference on Algorithms for Approximation**, Oxford, England.

INFORMATION: E. Smith, Applied and Computational Math. Group, RMCS (Cranfield), Shrivenham, Swindon, Wilts, SN6 8LA, England.

* 20–25. **Interactive Mathematics Text Project: Mathcad 3.1**, University of Pennsylvania.

INSTRUCTOR: C. Alexander.
COST: $500.
INFORMATION: M. Hoft, Dept. of Math., Univ. of Michigan-Dearborn, Dearborn, MI 48128; 313-593-5175.

* 20–25. **Interactive Mathematics Text Project: Maple for Windows**, University of Pennsylvania.

INSTRUCTOR: J. Stan Devitt.
COST: $500.
INFORMATION: E. Deeba, Dept. of Applied Math. Sciences, Univ. of Houston-Downtown, One Main St., Houston, TX 77002; 713-221-8550.

20–26. **International Conference on Algebraic Geometry**, Université Paris-Sud. (Jan. 1992, p. 52)

21–25. **Rademacher Centenary Conference**, Pennsylvania State University, University Park, PA. (Jan. 1992, p. 52)

22–25. **AT LAST: An NSF-ILAS Project to Augment the Teaching of Linear Algebra through the use of Software Tools**, University of Maryland, College Park, MD. (Feb. 1992, p. 145)

Last week of July. **The Ninth Latin American Symposium of Mathematical Logic**, Universidad Nacional del Sur, Bahia Blanca, Argentina. (Mar. 1992, p. 246)

*24–25. **Workshop on Matrix Theory**, University Bielefeld, Germany.

INVITED SPEAKERS: R. Brualdi, S. Friedland, C. He, G. Krause, N. Mehrmann, R. Nabben, A. Pothen, H. Schneider (tentative).
INFORMATION: V. Mehrmann, Fakultaet fuer Mathematik, Universitaet Bielefeld, Postfach 8640, D-4800 Bielefeld 1, FRG; tel: 0521-106-4798; email: Mehrmann@math1.mathematik.uni-bielefeld.de.

26–30. **Dynamics, Competition, and Neural Networks**, Dynamical Systems Institute, Boston University, Boston, MA. (Feb. 1992, p. 145)

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, Germany. (Feb. 1991, p. 147)

26–August 1. **AMS-SIAM Summer Seminar on Exploiting Symmetry in Applied and Numerical Analysis**, Colorado State University, Fort Collins, CO.

INFORMATION: D.L. Salter, AMS, P.O. Box 6887, Providence, RI 02940.

*26–August 15. **SIMS Tutorial: Mathematical Sciences in Genomic Analysis**, Rutgers University.

PROGRAM: The tutorial is intended for advanced undergraduate and graduate students and postdoctorals in the biological and mathematical sciences who have a keen interest in the application of quantitative methodologies to genomic analysis and who have had some experience in their application to other scientific fields.
TUTORIAL TOPICS: Fragment assembly, informatics, pattern analysis of molecular sequences, DNA and protein structure predictions.
TUTORIAL FACULTY: C.J. Benham, C. DeLisi, M. Farach, G. Hamm, E.S. Lander, A. Lapedes, G. Myers, M. Noordewier, W. Sofer, M.S. Waterman.
INFORMATION: SIMS, 97 Parish Road South, New Canaan, CT 06840; 203-966-1008; Fax: 203-972-6069.

*27–29. **International Symposium on Symbolic and Algebraic Computation**, Berkeley, CA. (Please note updated information from Jan. 1992, p. 52)

KEYNOTE SPEAKERS: J.R. Rice, Purdue U.–What is an answer?; and W.M. Kahan, U. of California, Berkeley–A fear of constants.
INFORMATION: K. Yelick, ATTN: ISSAC U92, 571 Evans Hall, Comp. Sci. Division, Univ. of California, Berkeley, CA 94720; email: issac@cs.berkeley.edu.

27–31. **Mathematical Physics of Disordered Systems**, Marseille, France. (Jan. 1992, p. 52)

27–31. **Algorithms for Approximation**, Cranfield Institute of Technology, Oxford. (Feb. 1992, p. 145)

27–August 1. **Workshop on Computational Linear Algebra in Algebraic and Related Problems**, Essen, Federal Republic of Germany. (Jan. 1992, p. 52)

*27–August 1. **Interactive Mathematics Text Project: Maple for Windows**, University of Pennsylvania.

INSTRUCTOR: C. Scheftic.
COST: $400.
INFORMATION: M. Pepe, Dept. of Math., Seattle Central Community College, 1701 Broadway, Seattle, WA 98122; 206-587-4073.

30–August 1. **The State of Matter: Conference on Mathematical Physics, Celebrating the Sixtieth Birthday of E.H. Lieb.**, Copenhagen, Denmark. (Dec. 1991, p. 1339)

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)

August 1992. **Kinetics of Phase Transitions**, International Centre for Mathematical Sciences, Edinburgh, Scotland. (Oct. 1991, p. 1010)

*August 1992–May 1993. **Special Year in Nonlinear PDEs and Dynamical Systems**, Brigham Young University, Provo, UT.

PROGRAM: Throughout the year, long- and short-term visitors will be in residence. The long-term visitors will include P. Hess (Zurich), N. Dancer (Armidale), J. Mallet-Paret (Providence), G. Fusco (Rome), X.-Y. Chen (Atlanta), and X. Chen (Pittsburgh). The program will include weekly seminars in PDEs and dynamical systems and will conclude with a conference.
INFORMATION: P. Bates, Dept. of Math., Brigham Young Univ., Provo, UT 84602; 801-378-4156; Fax: 801-378-2800; email: bates@physc2.byu.edu or peter@hamblin.math.byu.edu.

2–8. **Algebraische Zahlentheorie**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

*2–8. **Conference on Algebra and its Applications**, Middlesbrough, UK.

INFORMATION: A. Oswald, School of Computing and Math., Teesside Polytechnic, Middlesbrough, Cleveland TS1 3BA, UK; email: oswald@scm.tp.ac.uk.

3–6. **Conference on Artificial Intelligence and Symbolic Mathematical Computations**, Karlsruhe, Germany. (Mar. 1992, p. 247)

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. (Jul./Aug. 1991, p. 646)

3–7. **Second Meeting of the International Linear Algebra Society (ILAS)**, University of Lisbon, Portugal. (Mar. 1992, p. 247)

3–8. **Ninth Latin American Symposium on Mathematical Logic**, Bahia Blanca, Argentina. (Jan. 1992, p. 52)

*3–8. **Twelfth Brazilian Algebra Meeting**, Diamantina, Minas Gerais, Brazil.

ORGANIZING COMMITTEE: D. Avritzer, H. Merklen, F.C.P. Milies, I. Vaisencher, and P.H.V. Barros.
INVITED SPEAKERS: E. Becker, A. Prestel, C. Peskine, A. Shokrollahi, H. Yamaki, T.L. Smith, R. Miranda, N. Vonessen, M. Marshall, A. Simis, D. Levcovitz, S.C. Coutinho, H. Goodinho, F. Coelho, and N.R. Rocco.
INFORMATION: M. Spira, Dept. de Matematica,
ICEx–UFMG, Caixa Postal 702, 30.161 Belo Horizonte MG, Brazil; Fax: 55-31-4481559; email: algebra@brufmg.bitnet.

*3–8. **Forty-fourth International Meeting of the ICSIMT**, University of Illinois at Chicago, Illinois.

PROGRAM: Meeting theme: the student confronted by Mathematics. The meeting will focus on the following questions: 1(a) What is the nature of the knowledge and understanding of mathematics that students have?, 1(b) What mathematics do we want students to develop?, 2(a) What out-of-school mathematics do students bring to the classroom?, 2(b) How can we exploit this?, 3(a) What are the obstacles to developing concepts and learning mathematics (language, symbolism, abstraction, formalism, students' and teachers' conception of mathematics)?, 3(b) How do students develop mathematical concepts and how can this be stimulated?, 4(a) How can students

be involved in doing mathematics?, 4(b) How can this involvement lead to the development of mathematical knowledge?
INFORMATION: ICSIMT 44, c/o A.I. Weinzweig, Univ. of Illinois at Chicago, Dept. of Math., Stats., and Comp. Sci., m/c 249, Box 4348, Chicago, IL 60680; 312-996-8612; Fax: 312-996-1491; email: u14818@uicvm.

*3–8. **Interactive Mathematics Text Project: Maple for Windows**, University of Pennsylvania.

INSTRUCTOR: D. Schwalbe.
COST: $500.
INFORMATION: J. Morrison, Dept. of Math., Towson State University, Towson, MD 21204; 410-830-3595.

3–14. **NATO Advanced Study Institute: Linear Algebra for Large Scale and Real-Time Applications**, Leuven, Belgium. (Feb. 1992, p. 145)

3–28. **IMA Summer Program for Graduate Students: Mathematical Modeling**, University of Minnesota, Minneapolis, MN. (Dec. 1991, p. 1339)

4–7. **Chaos and its Applications**, Trieste, Italy. (Jan. 1992, p. 52)

5–9. **Topology**, University of Georgia, Athens, GA. (Apr. 1992, p. 346)

*7–10. **Twelfth International Symposium on Forecasting (ISF-92)**, Wellington, New Zealand.

INFORMATION: L. Fraser Jackson, ISF-92, P.O. Box 10-277, Wellington, New Zealand; email: jackson@matai.vuw.ac.nz.

9–12. **The Twelfth Annual International Conference on Critical Thinking and Educational Reform**, Sonoma State University, California. (Mar. 1992, p. 247)

*9–13. **Joint Statistical Meetings**, Boston, MA.

INFORMATION: American Statistical Association, 1429 Duke St., Alexandria, VA 22314-3402.

9–15. **Jordan-Algebren**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 147)

9–16. **1992 ASL European Summer Meeting (Logic Colloquium '92)**, Budapest, Hungary. (Mar. 1992, p. 247)

10–14. **Kinetics of Phase Transitions**, Edinburgh, Scotland. (Jan. 1992, p. 52)

10–14. **Summer School in the Model Theory of Fields–the Field of Real Numbers with Exponentiation**, University of Crete, Greece. (Mar. 1992, p. 247)

10–14. **NSF-CBMS Regional Conference: Hopf Algebras and Their Actions on Rings**, DePaul University, Chicago, IL. (Mar. 1992, p. 247)

10–15. **A Workshop on Numerical Ranges and Numerical Radii**, The College of William and Mary, Williamsburg, VA. (Apr. 1992, p. 347)

*10–15. **Interactive Mathematics Text Project: Mathcad 3.1**, University of Pennsylvania.

INSTRUCTOR: B. Levy.
COST: $400.
INFORMATION: M. Pepe, Dept. of Math., Seattle Central Community College, 1701 Broadway, Seattle, WA 98122; 206-587-4073.

*10–18. **Canadian Mathematical Society Annual Seminar on Representations of Algebras and Related Topics**, Carleton University, Ottawa, Canada. (Please note additional information to Dec. 1991, p. 1339)

LECTURERS: M. Broué (Paris), W. Crawley-Boevy (Oxford), C.W. Curtis (Oregon), M. Dyer (Notre Dame), R. Dipper (Stuttgart), Yu. A. Drozd (Kiev), K. Erdmann (Oxford), I.M. Gelfand (Rutgers), D. Handelman (Ottawa), D. Happel (Bielefeld), B. Keller (Paris), H. Lenzing (Paderborn), J. McKay (Concordia), R.V. Moody (Alberta), T. Okuyama (Osaka), B.J. Parshall (Virginia), J.A. de la Pena (Mexico), I. Reiten (Trondheim), K.W. Roggenkamp (Stuttgart), A.N. Rudakov (Moscow), L.L. Scott (Virginia), S.P. Smith (Washington), W. Soergel (Bonn), O. Solberg (Brandeis), A. Skowronski (Torun), D.-N. Verma (Bombay), T. Wakamatsu (Saitama), A. Weiss (Alberta).

11–15. **The Seventh KAIST Mathematics Workshop**, Korea Advanced Institute of Science and Technology, Taejon, Korea. (Feb. 1992, p. 146)

13–17. **First Colloquium on Numerical Analysis**, Plovdiv, Bulgaria. (Oct. 1991, p. 1011)

15–19. **International Conference on Associative Rings**, Irkutsk, USSR. (Feb. 1992, p. 146)

16–20. **CRYPTO '92**, University of California, Santa Barbara. (Mar. 1992, p. 248)

16–22. **Reelle Analysis**, Oberwolfach, Germany. (Jul./Aug. 1991, p. 646)

16–29. **1992 NATO Advanced Study Institute: Wavelets and their Applications**, Tuscany, Italy. (Feb. 1992, p. 146)

17–19. **Algebraic Computing in Geometry**, Linz, Austria. (Feb. 1992, p. 146)

17–21. **The Sixth International Conference on Boundary and Interior Layers–Computational and Asymptotic Methods (BAIL VI)**, Summit County, Colorado. (Nov. 1991, p. 1170)

17–21. **The Alan Day Conference on Lattices and Algebras**, McMaster University, Hamilton, Ontario, Canada. (Nov. 1991, p. 1171)

*17–22. **Interactive Mathematics Text Project: Mathcad 3.1**, University of Pennsylvania.

INSTRUCTOR: B. Levy.
COST: $500.
INFORMATION: T. McCutcheon, Dept. of Math., Los Angeles Pierce College, 6201 Winnetka Ave., Woodland Hills, CA 91371; 818-347-0551, ext 468.

17–23. **Seventh International Congress on Mathematical Education (ICME-7)**, Université Laval, Québec, Canada. (Sep. 1991, p. 839)

*17–28. **Fourth European Summer School in Logic, Language, and Information**, University of Essex, Colchester, England.

SECTIONS: Language, logic, computation, language and logic, logic and computation, computation and language.
INFORMATION: D. Arnold or L. Sadler, Dept. of Language and Linguistics, University of Essex, Wivenhoe Park, Colchester CO4 3SQ, UK; or from A. de Roeck, Dept. of Comp. Science, University of Essex; email: folli@essex.ac.uk.

18–22. **Third Colloquium on Differential Equations**, Plovdiv, Bulgaria. (Oct. 1991, p. 1011)

*19–22. **Sixth International Conference on Representations of Algebras (ICRA VI)**, Carleton University, Ottawa, Canada. (Please note additional information to Dec. 1991, p. 1340)

LECTURERS: M. Broué (Paris), W. Crawley-Boevy (Oxford), C.W. Curtis (Oregon), M. Dyer (Notre Dame), R. Dipper (Stuttgart), Yu. A. Drozd (Kiev), K. Erdmann (Oxford), I.M. Gelfand (Rutgers), D. Handelman (Ottawa), D. Happel (Bielefeld), B. Keller (Paris), H. Lenzing (Paderborn), J. McKay (Concordia), R.V. Moody (Alberta), T. Okuyama (Osaka), B.J. Parshall (Virginia), J.A. de la Pena (Mexico), I. Reiten (Trondheim), K.W. Roggenkamp (Stuttgart), A.N. Rudakov (Moscow), L.L. Scott (Virginia), S.P. Smith (Washington), W. Soergel (Bonn), O. Solberg (Brandeis), A. Skowronski (Torun), D.-N. Verma (Bombay), T. Wakamatsu (Saitama), A. Weiss (Alberta).

19–26. **World Congress of Nonlinear Analysts**, Melbourne, FL. (Nov. 1991, p. 1171)

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)

23–29. **Web Geometry**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 53)

*24–28. **Tenth Symposium on Computational Statistics (COMPSTAT)**, Neuchatel, Switzerland.

INFORMATION: COMPSTAT Secretariat, Groupe de Statistique, Univ. de Neuchatel, Pierre-a-Mazel 7, CH-2000 Neuchatel, Switzerland.

25–29. **Sixth School of Algebra and Analysis**, Irkutsk, USSR. (Feb. 1992, p. 146)

*25–29. **Third Islamic Countries Conference on Statistical Sciences**, Rabat, Morocco.

INFORMATION: Secretary, Executive Board, Islamic Society of Statistical Sciences, 122-F, Liberty Plaza, Gulberg-III, Lahore, Pakistan; or M. Benyaklef, Conference Chairman, I.N.S.E.A. BP 6217, Rabat, Morocco.

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)

30–September 5. **Seventy-five Years of Radon Transform**, Universitaet Wien, Wien, Austria. (Apr. 1992, p. 347)

30–September 5. **International Congress on Nonlinear Analysis; Variational and Topological Methods**, Xalapa, Veracruz, Mexico. (Apr. 1992, p. 347)

31–September 2. **Fourth International Workshop on Generalized Convexity**, Pécs, Hungary. (Jan. 1992, p. 53)

31–September 4. **Large Scale Scientific Computation**, Universität Bielefeld. (Feb. 1992, p. 146)

*31–September 4. **International Symposium on Numerical Analysis–ISNA '92**, Prague, Czechoslovakia.

PRINCIPLE LECTURERS: J. Albrecht (Clausthal), O. Xelsson (Nijmegen), J. Douglas (Purdue), Yu. Kuznetsov (Moscow), R. Rannacher (Heidelberg), J.R. Whiteman (Brunel), T. Yamamoto (Matsuyama).
INFORMATION: The Secretary of ISNA '92, MFF University Karlovy, Malostranske namesti 25, 118 00 Praha 1, Czechoslovakia; email: isna@cspguk11.bitnet; Fax: 422 532742.

31–September 11. **Arithmetic Algebraic Geometry (Advanced Workshop)**, Trieste, Italy. (Jan. 1992, p. 53)

September 1992

September 1992. **IMACS 2nd International Conference on System Simulation and Scientific Computing-BICSC '92**, Beijing, China. (May/Jun. 1991, p. 477)

September 1992. **Workshop on Topics in Probability and Lie Groups—Boundary Theory**, Centre de Recherches Mathématiques, Université de Montréal, Montréal Quebec, Canada. (Apr. 1992, p. 347)

*Academic Year 1992–1993. **Real Closed Fields**, Cornell University, Ithaca, NY.

PROGRAM: ACSyAM, the MSI center for Symbolic Methods in ALgorithmic Mathematics at Cornell University, Will emphasize Real Closed Fields for 1992–1993.
INFORMATION: M. Sweedler, jc5@cornella.bitnet, MSI, 409 College Ave., Ithaca, NY 607-255-8005.

2–4. **Ninth IFAC Workshop on Control Applications of Optimization**, Munich, Germany. (Apr. 1992, p. 348)

4–9. **Homotopy Theory**, Lake of Garda, Italy. (Apr. 1992, p. 348)

6–12. **Topologie**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 148)

7–11. **Réseaux**, Marseille, France. (Jan. 1992, p. 53)

7–14. **IMACS Conference on Innovative Methods in Numerical Analysis**, Padova University at Bressanone, Italy. (Jan. 1992, p. 53)

8–11. **IMA Tutorial: Introduction to Linear Multivariable Control, Optimal Design, and Parameter Estimation**, Institute for Mathematics and its Applications, University of Minnesota. (Sep. 1991, p. 839)

*9–10. **Symposium on High Performance Distributed Computing, HPDC-1**, Syracuse, NY.

PROGRAM: The theme of HPDC-1 is to investigate software techniques and architectural support for application of parallel and distributed computing for solving computationally intensive applications across a network of high-performance computers.
CONFERENCE TOPICS: Parallel and distributed algorithms to solve computationally intensive problems across a LAN, MAN, or WAN; architectural support for high-speed communications or interconnection networks; gigabit network architectures; networking for multimedia data; high-speed communication transport protocols to achieve Gigabit/sec application-to-application transfer rates; performance evaluation of experimental systems to solve supercomputing applications across a network of computers.
INFORMATION: Syracuse University, 111 Link Hall, Syracuse, NY 13244; 315-443-4282; G. Fox (General Chair), 315-443-4741, hpdc@nova.npac.syr.edu; or G. Craig (Local Chair), 315-443-4389, craig@cat.syr.edu.

9–11. **Royal Statistical Society Full Conference**, Sheffield, UK. (Nov. 1991, p. 1171)

*13–15. **MSI Workshop on Stochastic Analysis**, Cornell University.

PROGRAM: The workshop will focus on the interplay of analysis and probability.
INVITED SPEAKERS: R. Banuelos, C. Bishop, K. Burdzy, D. Burkholder, E. Carlen, M. Freidlin, E. Hsu, N. Krylov, P. March, M. Pinsky, T. Salisbury, and Z. Zhao.
INFORMATION: J. Chiment, Mathematical Sciences Institute, 409 College Ave., Ithaca, NY 14850; 607-255-8005; Fax: 607-255-9003; jjc@cornellc.cit.cornell.edu.

*13–18. **Sixth International Conference on Stochastic Programming**, Udine, Italy.

INFORMATION: G. Andreatta, Dept. of Pure and Applied Math., Via Belzoni, No. 7, 35131 Padova, Italy.

13–19. **4-Dimensional Manifolds**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 148)

13–19. **DMV-Jahrestagung**, Berlin, Federal Republic of Germany. (Jan. 1992, p. 53)

13–19. **Symposium on Analytic and Geometric Aspects of Hyperbolic Geometry: Instructional Conference**, University of Warwick, Coventry, UK. (Mar. 1992, p. 248)

14–18. **Twentieth European Meeting of Statisticians**, Bath, UK. (Nov. 1991, p. 1171)

14–18. **Second Atelier International de Théorie des Ensembles**, Marseille, France. (Jan. 1992, p. 53)

14–25. **Algebra (Advanced Workshop)**, Trieste, Italy. (Jan. 1992, p. 53)

16–18. **Second SIAM Conference on Control in the 90s**, Minneapolis, MN. (Feb. 1991, p. 148)

16–20. **IMACS/SICE International Symposium on Robotics, Mechatronics and Manufacturing Systems**, Kobe, Japan. (Jan. 1992, p. 53)

17–19. **International Conference on Group Theory**, University of Timisoara, Romania. (Jul./Aug. 1991, p. 646)

17–19. **SIAM Conference on Control and its Applications**, Minneapolis, MN. (Mar. 1992, p. 248)

20–26. **Funktionalgeichungen**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 148)

21–23. **Seventh International Conference on Multivariate Analysis in Memory of Ronald A. Fisher**, Barcelona, Spain. (Jan. 1992, p. 53)

21–23. **Workshop on Algebraic Cycles**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1992, p. 53)

21–25. **IMA Workshop on Robust Control Theory**, Institute for Mathematics and its

Applications, University of Minnesota. (Sep. 1991, p. 839)

*26–27. **Thirty-second Midwest Partial Differential Equations Seminar**, Purdue University, West Lafayette, IN.

INFORMATION: D. Phillips, Purdue University, Dept. of Math., West Lafayette, IN 47907.

27–October 3. **Darstellungstheorie Endlicher Gruppen**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 148)

30–October 2. **Thirtieth Annual Allerton Conference on Communication, Control, and Computing**, University of Illinois, IL. (Feb. 1992, p. 147)

31–October 4. **Third International Conference on Function Spaces**, Institute of Mathematics, Adam Mickiewicz University, Poznan, Poland. (Feb. 1992, p. 147)

October 1992

October 1992. **Workshop on Superprocesses and Interacting Systems**, Centre de Recherches Mathématiques, Université de Montréal, Montréal, Quebec, Canada. (Apr. 1992, p. 348)

2–3. **Fourth Midwest Conference on the History of Mathematics**, Miami University, Oxford, OH. (Mar. 1992, p. 249)

4–10. **Funktionalanalysis**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 148)

*9–10. **Developments from the Stone Age**, University of Chicago, Chicago, IL.

PROGRAM: The basic idea of the conference is to trace the development of some of the major areas in mathematics from their state when Marshall Stone led the math dept. of the U. of Chicago through their current situation to their future prospects. The program will include: The Stone Age: faculty and students (S. Mac Lane); geometry and physics (I. Singer); Hilbert space and functional analysis (R. Kadison); Analysis (A. Calderon); topology (P. May); Algebra (I. Kaplansky).
INFORMATION: K. Swanson, Dept. of Math., 5734 University Avenue, Chicago, IL 60637.

11–17. **Arbeitsgemeinschaft mit Aktuellem Thema**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 148)

12–16. **IMA Workshop on Control Systems Design for Advanced Engineering Systems: Complexity, Uncertainty, Information, and Organization**, Institute for Mathematics and its Applications, University of Minnesota. (Sep. 1991, p. 840)

12–16. **Workshop on Visualization of Geometric Structures**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1992, p. 54)

12–16. **International Conference on Polynomial Automorphisms and Related Topics**, CIRM, Luminy, France. (Jan. 1992, p. 54)

14–20. **First African Conference on Research in Computer Science**, Yaounde, Cameroon. (Feb. 1992, p. 147)

15–17. **Jumelage 92**, Mathematical Sciences Institute, Ithaca, NY. (Apr. 1992, p. 348)

15–19. **SIAM Conference on Applications of Dynamical Systems**, Salt Lake City, UT. (Mar. 1992, p. 249)

17. **Three Decades of Numerical Linear Algebra at Berkeley: A Conference in Honor of the Sixtieth Birthdays of Beresford Parlett and William Kahan**, University of California, Berkeley. (Mar. 1992, p. 249)

18–24. **Geometrie**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 148)

19–21. **The Fourth Symposium on the Frontiers of Massively Parallel Computation**, McLean, VA. (Dec. 1991, p. 1340)

19–23. **Modeles Arch et Applications a la Finance**, Marseille, France. (Jan. 1992, p. 54)

19–23. **Fourth International Symposium on Orthogonal Polynomials and their Applications**, Evian, France. (Feb. 1992, p. 148)

20–23. **Second Beijing International Conference on System Simulation and Scientific Computing-BICSC '92**, Beijing, China. (Jan. 1992, p. 54)

20–25. **Workshop on Conservative Systems and Quantum Chaos**, Fields Institute for Research in Mathematical Sciences, Waterloo, Ontario. (Apr. 1992, p. 349)

21–23. **Documents, Computation, and Preference**, Washington, DC. (Apr. 1992, p. 349)

*22–25. **Semi-Annual Regional Workshop in Dynamical Systems and Related Topics**, Penn State University, State College, PA.

PROGRAM: A regular meeting dedicated to recent results in the theory of smooth dynamical systems, ergodic theory, symbolic dynamics, topological dynamics, Hamiltonian mechanics and related areas in differential geometry, differential equations and Lie theory. 15-20 one hour and 45 minute talks are expected.
ORGANIZERS: A. Katok and H. Weiss.
INFORMATION: A. Katok, 814-865-2266; dsworkshop@math.psu.edu or R. Manning, 814-865-7527, Dept. of Math., Penn State Univ., University Park, PA 16802.

22–30. **Forty-sixth Conference and Congress of the International Federation for Information and Documentation**, Madrid, Spain. (May/Jun. 1991, p. 477)

25–31. **Stochastische Analysis**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 148)

*27–31. **International Workshop on Modern Group Analysis: Advanced Analytic and Computational Methods in Mathematical Physics**, Acireale (Catania), Italy.

CONFERENCE TOPICS: Classical Lie groups, exact solutions, conservation theorems; perturbation methods in group analysis; conditional (partial) symmetries; Bäcklund transformations, nonlocal symmetries; group analysis of finite-difference equations; software packages; and problems of group classification.
INVITED SPEAKERS: W.F. Ames, R.L. Anderson, G.W. Bluman, O. Bogoyavlenski, C. Cercignani, Y. Choquet-Bruhat, A. Donato, V.A. Dorodnitsyn, D. Fusco, W. Fushchich, A. Greco, N.H. Ibragimov, P.G.L. Leach, F. MAgri, A. Morro, P.J. Olver, L.V. Ovsiannikov, C. Rogers, A.A. Samarskii, F. Swarz, and E.S. Suhubi.
CALL FOR PAPERS: Abstracts (of up to 2 pages) for a 20 minute presentation are to be received by June 15, 1992.
INFORMATION: A. Valenti, Dept. of Math., Univ. of Catania, Viale A. Doria, 6, 95125 Catania, Italy; Fax: 95 330094; Tel: 95-339052; email: valenti@mathct.cineca.it.

30–November 1. **Central Section**, Wright State University, Dayton, OH.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6887, Povidence, RI 02940.

*31. **Differential Geometry Day**, Eastern Illinois University, Charleston, IL.

PRINCIPLE SPEAKERS: S. Alexander, U. of Illinois; K. Burns, Northwestern U.; L. Conlon, Washington U.; H.R. Hughes, Southern Illinois U.-Carbondale; J. Kaminker, Indiana U.-Purdue U. at Indianapolis.
INFORMATION: P. Coulton, Dept. of Math., Eastern Illinois Univ., Charleston, IL 61920; 217-581-5902; email: cfprc@ux1.cts.eiu.edu.

November 1992

November 1992. **The International Lie-Lobachevsky Colloquium Dedicated to the Anniversaries of Sophus Lie's 150 birthday and Nikolai Lobachevski's 200 birthday**, Tartu (Estonia). (Feb. 1992, p. 148)

November 1992. **Workshop on Stochastic Control**, Centre de Recherches Mathématiques, Universite de Montréal, Montréal Quebec, Canada. (Apr. 1992, p. 349)

1–6. **The First Pan American Conference on Pre-Columbia Mathematics, Astronomy, and Modes of Thought**, Univ. Francisco Marroquin, Guatamala City and Tikal. (Dec. 1991, p. 1340)

1–7. **Kombinatorik**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 148)

2–6. **Workshop on Symbolic Dynamics**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1992, p. 54)

*7–11. **Mathematics and Molecular Biology III: Computational Approaches to Nucleic Acid Structure and Function**, Santa Fe, NM.

SESSIONS: Structural correlates of RNA function, simulations of DNA structure, simplified models of DNA, computation of DNA structures, measures of molecular evolution, RNA conformations, structural theory, and graphics programs.
CALL FOR PAPERS: Abstract deadline: September 15, 1992.
INFORMATION: PMMB, 103 Donner Laboratory, U. of California, Berkeley, CA 94720; Fax: 510-642-4071; sylviaj@violet.berkeley.edu.

8–14. **Numerische Integration**, Oberwolfach, Federal Republic of Germany. (February 1991, p. 148)

8–14. **Third Austrian Symposium on the History of Mathematics**, Neuhofen an der Ybbs (Lower Austria). (Mar. 1992, p. 249)

9–13. **IMA Workshop on Control and Optimal Design of Distributed Parameter Systems**, Institute for Mathematics and its Applications, University of Minnesota. (Nov. 1991, p. 1171)

13–15. **Second Joint Meeting of the Midwest Conference on Ordinary Differential Equations and the Southeastern-Atlantic Regional Conference on Differential Equations**, University of Kentucky, Lexington, KY. (Apr. 1992, p. 349)

14–16. **The Third Biennial Conference of the Allahabad Mathematical Society**, Allahabad, India. (May/Jun. 1991, p. 477)

15–20. **An Applications Symposium on Optics, Electro-Optics, and Lasers in Industry**, Boston, MA. (Feb. 1992, p. 148)

15–21. **Komplexitatstheorie**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 148)

16–18. **Workshop on Higher Dimensional Geometry**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1992, p. 54)

16–20. **International Congress on Numerical Methods in Engineering and Applied Sciences**, University of Concepción, Concepción, Chile. (Jul./Aug. 1991, p. 646)

16–20. **IMA Period of Concentration: Flow Control**, Institute for Mathematics and its Applications, University of Minnesota. (Sep. 1991, p. 840)

*16–20. **The Fifth Annual High Performance Computing and Communication Conference–Supercomputing 92**, Minneapolis, MN. (Please note updated information to Apr. 1992, p. 349)

PROGRAM: Voyages of Discovery through Time and Technology will be the theme. L. Smarr (National Center for Supercomputing Application) will give the keynote address "Grand Challenges". Special sessions on massively parallel vs "traditional" supercomputers, visualization, and machine clustering will be offered. Also, special sessions dedicated to pharmaceutical and medical issues relating to supercomputers.
INFORMATION: P. Samide, SC92 Conference Office, SCD/NCAR, P.O. Box 3000, Boulder, CO 80307; 303-497-1808; Fax: 303-497-1298; sc92info@ncar.ucar.edu.

16–22. **Workshop on Normal Forms, Homoclinic Bifurcations and Chaos**, Fields Institute for Research in Mathematical Sciences, Waterloo, Ontario. (Apr. 1992, p. 350)

*20–22. **Academic Knowledge and Power**, University of Maryland, College Park, MD.

INFORMATION: R. Harvey, Dept. of Sociology, UMCP, 2112 Art Sociology Building, College Park, MD 20742; 301-405-6392.

23–25. **European Symposium on Research in Computer Security**, Toulouse, France. (Feb. 1992, p. 148)

23–27. **Séminaire Sud-Rhodanien de Geometrie**, Marseille, France. (Jan. 1992, p. 54)

29–December 5. **Theory of Large Deviations**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 148)

December 1992

2–4. **Workshop on Curves, Abelian Varieties, and their Moduli**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1992, p. 54)

4–5. **International Workshop on Matrix Methods for Statistics**, University of Auckland, Auckland, New Zealand. (Feb. 1992, p. 148)

6–12. **Theory and Numerical Methods for Initial-Boundary Value Problems**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 148)

7–11. **IMACS Symposium on Scientific Computing and Mathematical Modelling**, Bangalore, India. (May/Jun. 1991, p. 477)

8–11. **International Conference on Computer Science and Control**, Paris, France. (Apr. 1992, p. 350)

11–16. **Workshop on Generalized Inverses–Computational Techniques and Applications**, Indian Statistical Institute, Delhi, India. (Mar. 1992, p. 249)

13–19. **Asymptotische Statistik**, Oberwolfach, Federal Republic of Germany. (Feb. 1991, p. 148)

15–17. **Third IMA Conference on Mathematics Signal Processing**, University of Warwick, England. (Feb. 1992, p. 149)

27–31. **Holiday Symposium on Lie Group Representations and Combinatorics**, New Mexico State University, Las Cruces, NM. (Sep. 1991, p. 840)

1993

1992–1993. **Mittag-Leffler Institute's Academic Program for 1992–1993: Special Problems in Mathematical Physics**, Djursholm, Sweden. (Nov. 1991, p. 1171)

Spring 1993. **IMACS Symposium on Mathematical Modelling**, Wiener Neustadt, Germany. (Jan. 1992, p. 54)

1993. **Second IMACS International Conference on Computational Physics**, Univ. of Colorado, Boulder, CO. (Jan. 1992, p. 55)

January 1993

3–7. **International Conference on Scientific Computation and Differential Equations**, Auckland, New Zealand. (May/Jun. 1991, p. 477)

3–9. **Grundlagen der Geometrie**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 55)

3–9. **Extensions of Buildings and Geometries**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 55)

4–9. **Advances in Computational Mathematics**, India International Center, New Delhi, India. (Feb. 1992, p. 149)

*10–15. **First Panamerican Workshop in Applied and Computational Mathematics**, Simon Bolivar University, Caracas, Venezuela.

ORGANIZING COMMITTEE: (U.S.A. and Canada): P. Boggs, Vice Chairman (National Institute of Standards and Technology); J. Castillo, Chairman (San Diego State U.); J. Dennis (Rice U.); R. O'Malley (U. of Washington); R. Russel (Simon Fraser U.); S. Steinberg (U. of New Mexico); R. Tapia (Rice U.).
WORKSHOPS: Matrix analysis and computation; optimization; mathematical oil recovery; network modelling; mathematics in industry; applied probability and statistics; scientific computing; numerical methods; numerical differential equations; solving partial differential equations in irregular regions; applied sciences and engineering; and mathematical ecology.
INVITED TALKS: G. Ponce, J. Nocedal, B. O'Malley, V. Pereyra, C. Grebogi, B. Cockburn, J. Koiller, H. Keller, D. Tapia, H. Simon.
SHORT COURSES: P. Boggs and H. Simon.
CALL FOR PAPERS: Send a one page extended abstract to the appropriate workshop organizer by June 30, 1992.

10–16. **Computational Methods for Nonlinear Phenomena**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 55)

13–16. **Joint Mathematics Meetings**, San Antonio, TX. (including the annual meetings of the AMS, AWM, MAA, and NAM)

INFORMATION: H. Daly, AMS, P.O. Box 6887, Providence, RI 02940.

*15–16. **1992–1993 ASL Winter Meeting**, San Antonio, TX.

PROGRAM: This meeting will be held in conjunction with the annual meeting of the AMS.
CALL FOR PAPERS: Deadline for abstracts: October 1992.

17–22. **1993 IEEE International Symposium on Information Theory**, San Antonio, TX. (Feb. 1992, p. 149)

17–23. **Combinatorial Optimization**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 55)

24–30. **Optimale Steuerung Partieller Differentialgleichungen**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 55)

*25–27. **Fourth ACM-SIAM Symposium on Discrete Algorithms.**, Austin, Texas. (Please note update to Mar. 1992, p. 250)

25–29. **IMA Workshop on Robotics**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, MN. (Nov. 1991, p. 1171)

31–February 6. **Asymptotics and Adaptivity in Computational Mechanics**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 55)

February 1993

1–3. **IMA Minisymposium on Biological Control of Movement**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, MN. (Nov. 1991, p. 1172)

7–13. **Partielle Differentialgleichungen**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 55)

8–17. **IMA Workshop on Nonsmooth Analysis and Geometric Methods in Deterministic Optimal Control**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, MN. (Mar. 1992, p. 250)

14–20. **Applicable Algebra**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 55)

16–25. **IMA Workshop on Nonsmooth Analysis and Geometric Methods in Control**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, MN. (Nov. 1991, p. 1172)

21–27. **Curves, Images, Massive Computation**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 55)

22–28. **Workshop on Pattern Formation and Symmetry Breaking**, Fields Institute for Research in Mathematical Sciences, Waterloo, Ontario. (Apr. 1992, p. 351)

*25–March 1. **A Conference on Numerical Analysis with Automatic Result Verification**, Lafayette, LA. (Please note additional information to Jan. 1992, p. 55)

INVITED SPEAKERS: *Partial List*: F. Alvarado (Wisconsin), E. Hansen (Los Altos), A. Neumaier (U. Freiburg), M. Plum (U. Köln), and S. Rump (U. Hamburg).
CALL FOR PAPERS: Abstracts due by August 1, 1992.

28–March 6. **Medical Statistics: Statistical Methods for Risk Assessment**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 55)

March 1993

7–13. **Mathematische Stochastik**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 55)

14–20. **Gewöhnliche Differentialgleichungen**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 55)

15–19. **IMA Workshop on Systems and Control Theory for Power Systems**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, MN. (Nov. 1991, p. 1172)

*17–20. **Pure and Applied Linear Algebra: The New Generation**, University of West Florida, Pensacola, FL.

INVITED SPEAKERS: R. Bapat (Indian Statistical Inst.), J. Cohen (The Rockefeller U.), G. Cybenko (U. of Illinois), B. de Moor (Katholieke U. Leuven), R. Guralnick (U. of Southern California), D. Hershkowitz (Technion-Israel Inst. of Tech.), C.K. Li (College of William and Mary), R. Mathias (College of William and Mary), V. Mehrmann (U. Bielefeld), D. O'Leary (U. of Maryland), A. Ran (U. Amsterdam), H. Shapiro (Swarthmore College), I. Zaballa (U. Del Pois Vasco).
BANQUET SPEAKER: P. Halmos (Santa Clara U.).
CALL FOR PAPERS: Participants are invited to present 10 to 15 minute talks on topics in linear algebra. Send an abstract, camera ready, 7.5 inches wide by 5 inches long with at most 4 lines per inch by January 20, 1993.
INFORMATION: J.R. Weaver, Dept. of Math. and Stats., 1000 University Parkway, Univ. of West Florida, Pensacola, FL 32514-5751; 904-474-2283; email: jweaver@uwf.bitnet.

21–24. **Sixth SIAM Conference on Parallel Processing for Scientific Computing**, Norfolk, VA. (Mar. 1992, p. 250)

21–27. **Analysis auf Lokalsymmetrischen Räumen**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 55)

22–28. **Workshop on Pattern Formation in Earth Sciences and Biology**, Fields Institute for Research in Mathematical Sciences, Waterloo, Ontario. (Apr. 1992, p. 351)

24–25. **Central Section**, DePaul University, Chicago, IL.

INFORMATION: W. Drady, AMS, P.O. Box 6887, Providence, RI 02940.

28–April 3. **Combinatorial Convexity and Algebraic Geometry**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 56)

*29–April 2. **Workshop on Diophantine Geometry**, Mathematical Sciences Research Institute, Berkeley, CA.

PROGRAM: This workshop is part of the MSRI program on Transcendance and Diophantine problems taking place during the second half of 1992–1993.
ORGANIZER: P. Vojta.
INFORMATION: I. Kaplansky, Director, Mathematical Sciences Research Institute, 1000 Centennial Dr., Berkeley, CA 94720.

April 1993

4–10. **Topics in Pseudo-Differential Operators**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 56)

5–9. **IMA Tutorial: Design and Analysis of Adaptive Systems**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, MN. (Nov. 1991, p. 1172)

9–10. **Western Section**, University of Utah, Salt Lake City, Utah.

INFORMATION: W. Drady, AMS, P.O. Box 6887, Providence, RI 02940.

11–17. **Arbeitsgemeinschaft mit Aktuellem Thema**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 56)

12–16. **IMA Workshop on Adaptive Control, Filtering, and Signal Processing**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, MN. (Nov. 1991, p. 1172)

14–16. **Seventh SEFI European Seminar on Mathematics in Engineering Education**, Eindhoven University of Technology, The Netherlands. (Feb. 1992, p. 149)

15–22. **Symposium on Analytic and Geometric Aspects of Hyperbolic Geometry: Research Level Workshop**, University of

Warwick, Coventry, UK. (Mar. 1992, p. 250)

18–24. **The Arithmetik of Fields**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 56)

18–24. **Mathematische Grundlagen und Numerische Verfahren bei Transsonischen Strömungen**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 56)

25–May 1. **Low Dimensional Dynamics**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 56)

May 1993

3–7. **IMA Tutorial: Verification Issues in Discrete Event Systems, as well as Performance and Control**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, MN. (Nov. 1991, p. 1172)

3–9. **Workshop on Ecological Systems**, Fields Institute for Research in Mathematical Sciences, Waterloo, Ontario. (Apr. 1992, p. 352)

9–15. **Reelle Algebraische Geometrie**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 56)

10–12. **IMACS Symposium on Signal Processing and Neural Networks–SPANN '93**, Université du Québec at Montréal, Canada. (Jan. 1992, p. 56)

10–14. **IMA Workshop on Discrete Event Systems, Manufacturing Systems, and Communication Networks**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, MN. (Nov. 1991, p. 1172)

16–22. **Mathematical Problems in Viscoelastic Flows**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 56)

20–23. **International Conference on Approximation Probability and Related Fields**, University of California, Santa Barbara, CA. (May/Jun. 1991, p. 477)

21–22. **Central Section**, Northern Illinois University, DeKalb, IL.

INFORMATION: W.S. Drady, AMS, P.O. Box 6887, Providence, RI 02940.

23–29. **Differentialgeometrie im Grossen**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 56)

30–June 5. **Funktionalanalysis und Nichtlineare Partielle Differentialgleichungen**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 56)

June 1993

June 1993. **Fourth IMACS International Symposium on Computational Acoustics**, Cambridge, England. (Jan. 1992, p. 56)

6–9. **Annual Meeting of the Statistical Society of Canada**, Wolfville, Nova Scotia, Canada. (Feb. 1992, p. 149)

6–12. **Analysis auf Kompakten Varietäten**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 56)

7–11. **IMA Tutorial: Mathematical Theory which Has become an Integral Part of Modern Financial Economics**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, MN. (Nov. 1991, p. 1172)

7–13. **Workshop on Pattern Formation and Cellular Automata**, Fields Institute for Research in Mathematical Sciences, Waterloo, Ontario. (Apr. 1992, p. 352)

13–19. **Differential-Algebraic Equations: Theory and Applications in Technical Simulation**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 56)

*14–17. **The Fifth Asian Logic Conference**, National University of Singapore, Singapore.

PROGRAM: The conference will cover all major areas of mathematical logic, as well as related areas in computer science. There will be sessions for contributed papers.
INVITED SPEAKERS: H.P. Barendregt, L. Blum, H.J. Keisler, W.J. Mitchell, T.A. Slaman, L. van der Dries, and H. Woodin.
CALL FOR PAPERS: Abstracts due by April 1993.
INFORMATION: Fifth Asian Logic Conference, Dept. of Math., National Univ. of Singapore, Singapore 0511; email: matlogic@nusvm.bitnet.

14–18. **IMA Workshop on Mathematical Finance**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, MN. (Nov. 1991, p. 1172)

*14–18. **Linear Logic Workshop**, Mathematical Sciences Institute, Cornell University, Ithaca, NY.

PROGRAM: The workshop will be held at Cornell and sponsored by MSI. Presentations will be by invitation only, but attendance will be open to anyone interested in the subject. MSI will be able to provide partial support for a limited number of participants.
INFORMATION: J. Chiment, Mathematical Sciences Institute, 409 College Ave., Ithaca, NY 14850; 607-255-8005; Fax: 607-255-9003; email: jjc@cornellc.cit.cornell.edu.

15–18. **Third IMACS International Workshop on Qualitative Reasoning and Decision Technologies–QR&DT-3**, Polytechnique of Barcelona, Spain. (Jan. 1992, p. 56)

20–26. **Konvexgeometrie**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 56)

*23–26. **Convergence in Ergodic Theory and Probability**, Ohio State University, Columbus, OH.

INFORMATION: J. Rosenblatt, Math. Dept., Ohio State University, 100 Mathematics Building, 231 West 18th Ave., Columbus, OH 43210-1174; 614-292-4975.

27–July 3. **Algebraische K-Theorie**, Oberwolfach, Federal Republic of Germany. (Jan. 1992, p. 57)

July 1993

*6–9. **European Multigrid Conference '93**, Amsterdam, The Netherlands.

PROGRAM: The conference aims at providing a forum for the presentation and discussion of recent research in the general area of multilevel methods. The conference will consist of 10 invited lectures in plenary sessions and selected presentations in two parallel sessions.
CONFERENCE THEMES: Computational fluid dynamics, reservoir engineering, semiconductor device modeling, statistical physics, parallel computing, adaptive computing, and numerical analysis of multigrid methods.
CALL FOR PAPERS: Send three copies of an extended abstract of no more than 2 pages by December 15, 1992.
INFORMATION: EMG '93, European Multigrid Conference 1993, c/o CWI, Simone van der Wolff, P.O. Box 4079, 1009 AB Amsterdam, The Netherlands, tel: 020-5929333; Fax: 020-5924199; email: simone@cwi.nl.

*12–23. **Conference on Universal Algebra and Category Theory**, Mathematical Sciences Research Institute, Berkeley, CA.

PROGRAM: The aim of this conference is to bring together workers in the two fields in question. In addition to research reports, there will be tutorial lectures and time for informal contacts.
ORGANIZING COMMITTEE: F. Linton, S. Mac Lane (cochair), R. Mckenzie (cochair), G. McNulty, W. Taylor, and C. Wells.
INFORMATION: I. Kaplansky, Director, Mathematical Sciences Research Institute, 1000 Centennial Dr., Berkeley, CA 94720.

August 1993

*1–14. **Groups 93 Galway/St. Andrews**, Galway, Ireland. (Please note additional information to Jan. 1992, p. 57)

ORGANIZERS: C.M. Campbell, T.C. Hurley, E.F. Robertson, S. Tobin, J.J. Ward.
INVITED SPEAKERS: J.L. Alperin, M. Broué, P.H. Kropholler, E.I. Zel'manov.

GAP WORKSHOP: J. Neubüser and M. Schönert.
INFORMATION: Groups 93, Mathematical Institute, St. Andrews, KY16 9SS, Fife, Scotland; groups93@st-andrews.ac.uk.

*2–6. **Second Gauss Symposium**, Munich, Germany.

PROGRAM: The theme of the symposium is the direct and indirect thrust of Gaussian works in all areas of mathematical sciences.
CALL FOR PAPERS: One page abstract to be submitted by January 31, 1993.
INFORMATION: Second Gauss Symposium, P.O. Box 56, McMaster University, Hamilton, Ontario, Canada L8S 1CO; Fax: 416-332-4460.

*2–13. **Georgia International Topology Conference**, University of Georgia, Athens, GA.

PROGRAM: The conference will cover a wide range of topics with emphasis on 3- and 4-dimensional topology. There will be about 20 invited lectures.
INFORMATION: W. Kazez, Math. Dept., Univ. of Georgia, Athens, GA 30602; email: will@joe.math.uga.edu; 404-542-2544.

*17–20. **The Mathematical Heritage of Sir William Rowan Hamilton**, Dublin, Ireland.

PROGRAM: October 16, 1993 marks the sesquicentennial of the discovery of the quaternions by Hamilton. This event marks the final break between algebra and arithmetic. To celebrate this occasion, an international conference on algebra, combinatorics, and dynamical systems has been organized by the Royal Irish Academy in Trinity College, Dublin.
INVITED SPEAKERS: N.L. Biggs (L.S.E., London), J.K. Moser (ETH, Zurich), P.M. Neumann (Queens College, Oxford), A.C. Newell (Tucson, AZ), C. Procesi (La Sapienza, Roma), G.-C. Rota (MIT, Cambridge).
INFORMATION: B. Goldsmith, Dublin Inst. of Tech., Kevin Street, Dublin 8, Dept. of Math., Stats., and Comp. Sci., Tel: 757541; Fax: 780282; bgoldsmith@dit.ie.

22–29. **Twenty-ninth International Congress of History of Science**, Zaragoza, Spain. (Apr. 1992, p. 352)

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.

September 1993

*5–12. **First World Conference on Branching Processes**, Varna, Bulgaria.

INFORMATION: N.M. Yanev, Dept. of Probability and Statistics, Institute of Mathematics, Bulgarian Academy of Sciences, 8, G. Bontchev Str., Sofia 1113, Bulgaria; Telex: 22628 BAN BG; Fax: +359-2-752078.

*13–18. **Different Aspects of Differentiability**, Warsaw, Poland.

CONFERENCE TOPICS: Algebraic analysis; operational calculi; generalized functions; related convergence problems; structures with derivation; subdifferentials, their generalizations and applications to optimization.
ORGANIZERS: P. Antosik and D. Przeworska-Rolewicz.
INFORMATION: D-A-D, Inst. of Math., Polish Academy of Sciences, Sniadseckich 8, 00-950 Warszawa, Poland; Fax: 0048-22-293997; impanw@plwatu21.bitnet.

June 1994

*13–17. **Fifth International Conference on Hyperbolic Problems Theory, Numerical Methods, and Applications**, Stony Brook, NY.

ORGANIZING COMMITTEE: A. Donato (Messina), B. Engquist (UCLA), J. Glimm, Chair (Stony Brook), B. Keyfitz (U. Houston), P. Lax (NYU), T.-P. Liu (Stanford), D. Serre (Lyons).
INFORMATION: T. Mills, Dept. of Applied Math., Univ. at Stony Brook, Stony Brook, NY 11794-3600; 516-632-9125; Fax: 516-632-8490; tmills@ccmail.sunysb.edu.

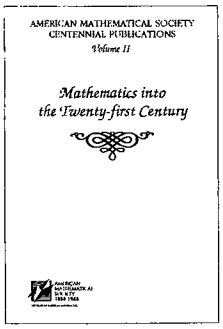
August 1994

*1–5. **Third World Congress on Computational Mechanics (WCCM III)**, Chiba, Japan.

PROGRAM: 1). An ambitious program will be planned to cover challenging topics in basic sciences and technologies. 2). A number of best papers will be given awards through recommendations of an international paper reviewing committee. 3). Promising young researchers from all over the world will be encouraged to attend. The WCCM III is expected to be a forum to communicate ideas and new developments from a wide range of views. Researchers and engineers interested in the field are welcome.
CONGRESS THEMES: Mathematical modeling and numerical methods; solid and structural mechanics; fluid dynamics; nonlinear dynamics; material science; CAD/CAM/CAE, AI, expert system, CG; smart algorithms and adaptive methods; parallel computing; computational physics; and industrial applications.
INFORMATION: T. Kawai, WCCM III Office, Dept. of Electrical Engineering, Science U. of Tokyo, 1-3 Kagurazaka, Shijuku-ku, Tokyo 162, Japan; tel: +81-3-3235-5630; Fax: +81-3-3260-8236.

3–11. **The International Congress of Mathematicans 1994**, Zürich, Switzerland. (Mar. 1992, p. 249)

New Publications Offered by the AMS



Mathematics into the Twenty-first Century

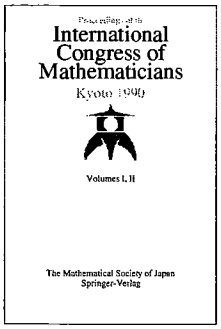
Felix E. Browder, Editor

In the summer of 1988 in Providence, the AMS celebrated its Centennial with a wide range of mathematical activities. Among those was a symposium, "Mathematics into the Twenty-first Century," which brought together a number of the top research mathematicians who will likely have a significant impact on the mathematics of the next century. This book contains the lectures presented by sixteen of the eighteen individuals who spoke during the symposium. Written by some of the major international figures in mathematical research, this group of articles covers a panorama of the vital areas of mathematics in the present epoch and will give the general mathematical reader a broad perspective on some of the major trends in research today.

Contents

F. E. Browder, *Introduction*; **M. Aschbacher**, *Representations of finite groups as permutation groups*; **L. A. Caffarelli**, *Regularity of solutions and level surfaces of elliptic equations*; **P. Diaconis**, *Sufficiency as statistical symmetry*; **C. Fefferman**, *Atoms and analytic number theory*; **M. H. Freedman**, *Working and playing with the 2-disk*; **H. Friedman**, *The incompleteness phenomena*; **B. H. Gross**, *Elliptic curves and modular forms*; **J. Harris**, *Developments in algebraic geometry*; **R. Howe**, *A century of Lie theory*; **V. F. R. Jones**, *From quantum theory to knot theory and back: a von Neumann algebra excursion*; **V. G. Kac**, *Modular invariance in mathematics and physics*; **A. J. Majda**, *Mathematical fluid dynamics: the interaction of nonlinear analysis and modern applied mathematics*; **C. S. Peskin**, *Two examples of mathematics and computing in the biological sciences: Blood flow in the heart and molecular dynamics*; **D. Sullivan**, *Bounds, quadratic differentials, and renormalization conjectures*; **K. Uhlenbeck**, *Instantons and their relatives*; **E. Witten**, *Geometry and quantum field theory.*

1991 *Mathematics Subject Classifications*: 00-02, 00A69, 00B10, 00B20
ISBN 0-8218-0167-8, LC 91-22093
491 pages (hardcover), May 1992
Individual member $99, List price $165, Institutional member $132
To order, please specify HMBROWDER/N



Proceedings of the International Congress of Mathematicians, Kyoto, 1990

Ichiro Satake, Editor

Held every four years, the International Congress of Mathematicians features the frontier mathematics of the day. Each Congress is a historic event: a time for taking stock of current results in the development of the field, a time for lauding the mathematical stars of the day, and a time for camaraderie within the international mathematical community.

Published by Springer-Verlag, this two-volume set captures the spirit of ICM-90, featuring the official record of the Congress, photos from the opening ceremonies and other events, reports on the works of Fields Medalists and the Nevanlinna Prize Winner, the Plenary Addresses, and the Invited Addresses. If you were at ICM-90, you'll want this special publication as a memento. And if you missed ICM-90, you'll want it to stay informed about one of the most important conferences in mathematics.

(The AMS also offers a series of videotapes featuring several ICM-90 lectures, suitable for viewing in class and at home. Call for a free brochure.)

Contents

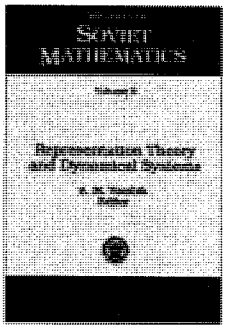
Vol. 2: *The work of the Fields Medalists and the Rolf Nevanlinna Prize Winner*; *Invited one-hour addresses at the plenary sessions*; *Invited forty-five minute addresses at the section meetings*; **1.** *Mathematical logic and foundations*; **2.** *Algebra*; **3.** *Number theory*; **4.** *Geometry*; **5.** *Topology*; **6.** *Algebraic geometry*; **7.** *Lie groups and representations*; **8.** *Real and complex analysis*; **9.** *Operator algebras and functional analysis*; **10.** *Probability and mathematical statistics*; **11.** *Partial differential equaitons*; **12.** *Ordinary differential equations and dynamical systems*; **13.** *Mathematical physics*; **14.** *Combinatorics*; **15.** *Mathematical aspects of computer science*; **16.** *Computational methods*; **17.** *Applications of mathematics to the sciences*; **18.** *History, teaching, and the nature of mathematics.*

1991 *Mathematics Subject Classifications*: 00
ISBN 4-431-70047-1, LC 91-4972
1684 pages (hardcover), 1991
List price $160
To order, please specify PICM/90N

*The AMS distributes this book in the United States, Canada, and Mexico. Orders from other countries should be sent to Springer-Verlag, 49-6221-4870, Tiergartenstr. 17, 6900 Heidelberg, Germany.

Use the order form in the back of this issue or call 800-321-4AMS (800-321-4267) in the U.S. and Canada to use VISA or MasterCard.

ADVANCES IN SOVIET MATHEMATICS



Representation Theory and Dynamical Systems

A. M. Vershik, Editor

Volume 9

This volume presents research conducted between 1989 and 1991 by the participants in the Leningrad Seminar on representation theory, dynamical systems, and their applications, headed by A. M. Vershik. The primary areas covered here are mathematical physics, Lie groups and their representations, infinite-dimensional groups, topology, and dynamical systems. The book contains a number of useful introductory surveys; for example, one paper by Vaksman and Soĭbelman provides a systematic description of the theory of quantum groups in the spirit of representation theory—a new and popular area for which there are few introductory surveys. A portion of the book is devoted to adic transformations and substitutions, a new area of ergodic theory. With a balance of survey papers and frontier research results, this book will appeal to graduate students and researchers alike.

Contents

1991 *Mathematics Subject Classifications*: 03D15, 05A99, 20C30, 20C32, 28D05, 46K10, 46L55, 53C20, 58A30, 58B30, 58F17, 81R50; 05A20, 20C30, 22A30, 22D25, 33D, 46L05, 53C20, 68Q14, 70F25
ISBN 0-8218-4108-4, LC 91-640741, ISSN 1051-8037
267 pages (hardcover), June 1992
Individual member $70, List price $116, Institutional member $93
To order, please specify ADVSOV/9N

CONTEMPORARY MATHEMATICS

New Approaches in Spectral Decomposition

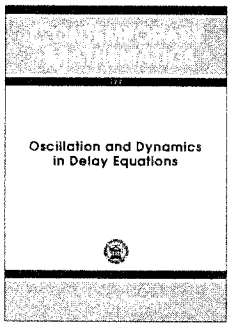
Ridgley Lange and Shengwang Wang

Volume 128

Aimed at a general mathematical audience, this book provides a careful exposition of recent developments in the theory of spectral decomposition. Bringing the reader from the basics up to the level of current research in the area, Lange and Wang present a readable account of the techniques used in the theory and applications of decomposable operators and related classes of operators. The book begins with a discussion of criteria for decomposable and related types of operators, and an analysis that relates and distinguishes among them. Perturbation theory of decomposable and other operators, applications to classical Hilbert space operators, quasisimilarity, and a new class of weakly decomposable operators are also discussed. The book closes with an exposition of some classical theories on invariant subspaces for subdecomposable and hyponormal operators, and a presentation of the parallel spectral theory of commuting systems.

Contents

1991 *Mathematics Subject Classifications*: 47A10, 47A13, 47A15, 47A55, 47B20, 47B40; 46E10, 46E35, 46F05, 46J15, 46M20, 46M40, 47A53, 47A60, 47B10, 47B15, 47B66, 47F05
ISBN 0-8218-5139-X, LC 92-6183, ISSN 0271-4132
273 pages (softcover), June 1992
Individual member $26, List price $44, Institutional member $35
To order, please specify CONM/128N



Oscillation and Dynamics in Delay Equations

John R. Graef and Jack K. Hale, Editors

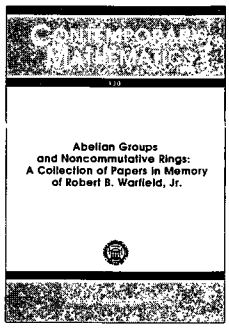
Volume 129

Oscillation theory and dynamical systems have long been rich and active areas of research. Containing frontier contributions by some of the leaders in the field, this book brings together papers based on presentations at the AMS meeting in San Francisco in January, 1991. With special emphasis on delay equations, the papers cover a broad range of topics in ordinary, partial, and difference equations and include applications to problems in commodity prices, biological modeling, and number theory. The book would be of interest to graduate students and researchers in mathematics or those in other fields who have an interest in delay equations and their applications.

Contents

T. A. Burton, J. Terjéki, and B. Zhang, *A wave equation viewed as an ordinary differential equation*; **Y. Cao**, *The oscillation and exponential decay rate of solutions of differential delay equations*; **S.-N. Chow and W. Huang**, *Transition layers for a singularly perturbed 2-dimensional system of differential-difference equations*; **H. G. Diamond and H. Halberstam**, *Differential difference equations in analytic number theory*; **A. M. Farahani and E. A. Grove**, *A simple model for price fluctuations in a single commodity market*; **J. R. Graef, M. K. Grammatikopoulos, and P. W. Spikes**, *Some results on the asymptotic behavior of the solutions of a second order nonlinear neutral delay equation*; **G. Ladas and C. Qian**, *Linearized oscillations for nonautonomous delay difference equations*; **S. M. Verduyn Lunel**, *Small solutions and completeness for linear functional differential equations*; **H. L. Smith and Y. Kuang**, *Periodic solutions of differential delay equations with threshold-type delays*; **H.-O. Walther**, *Unstable manifolds of periodic orbits of a differential delay equation*; **J. Wiener and L. Debnath**, *The Fourier method for partial differential equations with piecewise continuous delay.*

1991 *Mathematics Subject Classifications*: 34-06, 34K05, 34K10, 34K15, 34K25, 34K30, 34K40, 34A05, 34C10, 34C11, 34C15, 34E05, 34E10, 11N25, 35B05, 35B25, 35B40, 35L10, 39A12, 45E10, 58F09
ISBN 0-8218-5140-3, LC 92-12229, ISSN 0271-4132
263 pages (softcover), June 1992
Individual member $22, List price $36, Institutional member $29
To order, please specify CONM/129N



Abelian Groups and Noncommutative Rings: A Collection of Papers in Memory of Robert B. Warfield, Jr.

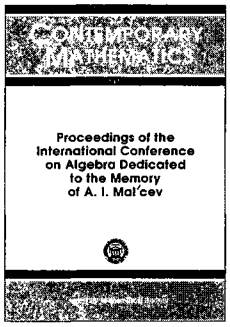
L. Fuchs, K. R. Goodearl, J. T. Stafford, and C. Vinsonhaler, Editors
Volume 130

This collection of research papers is dedicated to the memory of the distinguished algebraist Robert B. Warfield, Jr. Focusing on abelian group theory and noncommutative ring theory, the book covers a wide range of topics reflecting Warfield's interests and includes two articles surveying his contributions to mathematics. Because the articles have been refereed to high standards and will not appear elsewhere, this volume is indispensable to any researcher in noncommutative ring theory or abelian group theory. With papers by some of the major leaders in the field, this book will also be important to anyone interested in these areas, as it provides an overview of current research directions.

Contents

Robert Breckenridge Warfield, Jr.; **C. Vinsonhaler**, *The abelian group papers of Robert B. Warfield, Jr.*; **K. R. Goodearl and J. T. Stafford**, *Warfield in ring theory*; **U. Albrecht**, *Endomorphism rings, tensor products, and Fuchs' problem 47*; **R. Behler, R. Göbel, and R. Mines**, *Endomorphism rings of p-groups having length cofinal with ω*; **A. D. Bell**, *Skew differential operators on commutative rings*; **G. M. Bergman**, *Isomorphisms from top to bottom*; **A. Braun**, *Power intersection in Noetherian P.I. rings*; **K. A. Brown and M. Lorenz**, *Colimits of functors and Grothendieck groups of infinite group algebras*; **P. M. Cohn**, *Modules over hereditary rings*; **A. van den Essen and A. H. M. Levelt**, *An explicit description of all simple $k[[x]][\partial]$-modules*; **L. Fuchs and C. Metelli**, *Countable Butler groups*; **K. R. Goodearl**, *An unbounded localizable clique*; **I. Herzog**, *The Auslander-Reiten translate*; **B. Zimmermann Huisgen**, *On the abundance of $\aleph_1$-separable modules*; **R. S. Irving**, *Graded BGG algebras*; **D. A. Jordan**, *Krull and global dimension of certain iterated skew polynomial rings*; **G. Krause**, *Prime factor series of modules over a Noetherian algebra*; **T. H. Lenagan**, *Enveloping algebras of solvable Lie superalgebras are catenary*; **E. S. Letzter**, *Prime and primitive ideals in enveloping algebras of solvable Lie superalgebras*; **W. May**, *Endomorphism algebras of not necessarily cotorsion-free modules*; **J. C. McConnell and R. B. Warfield, Jr.**, *Direct sum decompositions of vector spaces equipped with linear and bilinear forms*; **G. O. Michler**, *Maximal orders and deformations of modular group algebras*; **R. Mines and C. Vinsonhaler**, *Butler groups and Bext: A constructive view*; **B. J. Müller**, *Goldie-prime serial rings*; **J. Osterburg, D. S. Passman, and D. Quinn**, *A Connes spectrum for Hopf algebras*; **R. S Pierce**, *Minimal regular rings*; **C. E. Praeger and P. Schultz**, *The Loewy length of the Jacobson radical of a bounded endomorphism ring*; **J. D. Reid**, *Warfield duality and irreducible groups*; **F. Richman**, *The constructive theory of countably generated Warfield modules*; **D. J. Saltman**, *A note on generic division algebras.*

1991 *Mathematics Subject Classifications*: 16-06, 20-06, 16Pxx, 16Sxx, 20Kxx; 16Dxx, 16Exx
ISBN 0-8218-5142-x, LC 92-13697, ISSN 0271-4132
394 pages (softcover), June 1992
Individual member $29, List price $49, Institutional member $39
To order, please specify CONM/130N



Proceedings of the International Conference on Algebra Dedicated to the Memory of A. I. Mal'cev

L. A. Bokut', Yu. L. Ershov, and A. I. Kostrikin, Editors
Volume 131

In August 1989, more than 700 Soviet algebraists and more than 200 foreign mathematicians convened in Novosibirsk in the former Soviet Union for the International Conference on Algebra. Dedicated to the memory of A. I. Mal'cev, the great Russian algebraist and logician, the conference marked the first time since the International Congress of Mathematicians was held in Moscow in 1966 that Soviet algebraists could meet with a large number of their foreign colleagues. This volume contains the proceedings from this historic conference. Some of the Soviet contributions to this volume are not easily available from other sources.

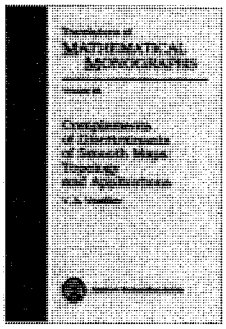
Some of the major figures in the field, including P. M. Cohn, P. Gabriel, N. Jacobson, E. R. Kolchin, and V. Platonov, contributed to this volume. The papers span a broad range of areas including groups, Lie algebras, associative and nonassociative rings, fields and skew fields, differential algebra, universal algebra, categories, combinatorics, logic, algebraic geometry, geometry, topology, and mathematical physics.

Contents

Section 1: *Groups*; **Section 2:** *Geometry*; **Section 3:** *Lie algebras*; **Section 4:** *Rings*; **Section 5:** *Fields and skew fields/differential algebras*; **Section 6:** *Nonassociative rings*; **Section 7:** *Universal algebra, categories, and combinatorics*; **Section 8:** *Algebraic geometry*; **Section 9:** *Logic.*

1991 *Mathematics Subject Classifications*: 00, 03, 06, 08, 12, 13, 14, 16, 17, 18, 20, 22, 51; 05, 11, 15, 19, 53
ISBN (*Set*) 0-8218-5134-9; ISBN (*Part* 1) 0-8218-5136-5; ISBN (*Part* 2) 0-8218-5137-3; ISBN (*Part* 3) 0-8218-5138-1, LC 92-9983, ISSN 0271-4132; 712 pages (*Part* 1); 704 pages (*Part* 2); 666 pages (*Part* 3) (softcover), May 1992
Set: **Individual member $124**, List price $206, Institutional member $165
Part 1: **Individual member $48**, List price $80, Institutional member $64
Part 2: **Individual member $47**, List price $79, Institutional member $63
Part 3: **Individual member $42**, List price $70, Institutional member $56
To order, please specify CONM/131N (Set), CONM/131.1N (Part 1), CONM/131.2N (Part 2), CONM/131.3N (Part 3)

TRANSLATIONS OF MATHEMATICAL MONOGRAPHS



Complements of Discriminants of Smooth Maps: Topology and Applications

V. A. Vassiliev

Volume 98

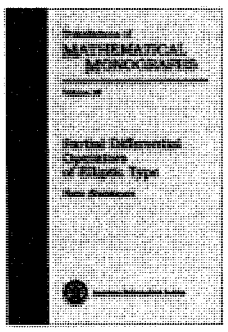
This book examines a wide class of topological spaces, including many that play important roles in differential and homotopy topology, algebraic geometry, and catastrophe theory. Among these are spaces of Morse and generalized Morse functions, iterated loop spaces of spheres, classifying spaces of braid groups, and spaces of knots. Vassiliev develops a general method for investigating such spaces topologically, providing new proofs and generalizations of many results. One of the book's main results is a system of knot invariants which is stronger than all known polynomial invariants. In addition, an important relationship between topology and complexity theory is used to obtain the best known estimates for the numbers of branchings of algorithms solving polynomial equations.

A major contribution to the field of algebraic topology, this book provides the first comprehensive report on these developments. Vassiliev, whose results have proved especially fruitful in recent research in knot theory, is a major leader in the field. This book will interest mathematicians in differential and homotopy topology and complexity theory, as well as physicists interested in string theory and Feynman diagrams. It is also suitable as a textbook for graduate courses in topology, catastrophe theory, and, to a more limited extent, complexity theory.

Contents

Cohomology of braid groups and configuration spaces; *Applications: complexity of algorithms, and superpositions of algebraic functions*; *Topology of spaces of real functions without complicated singularities*; *Stable cohomology of complements of discriminants and caustics of isolated singularities of holomorphic functions*; *Cohomology of the space of knots*; *Appendix* 1: *Classifying spaces and universal bundles. Join*; *Appendix* 2: *Hopf algebras and H-spaces*; *Appendix* 3: *Loop spaces*; *Appendix* 4: *Germs, jets, and transversality theorems*; *Appendix* 5: *Homology of local systems.*

1991 *Mathematics Subject Classifications*: 55P53, 57M25, 57R45
ISBN 0-8218-4555-1, LC 92-8176, ISSN 0065-9282
208 pages (hardcover), June 1992
Individual member $98, List price $164, Institutional member $131
To order, please specify MMONO/98N



Partial Differential Operators of Elliptic Type

Norio Shimakura

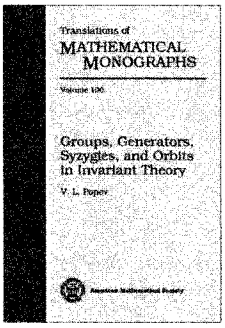
Volume 99

This book, which originally appeared in Japanese, was written for use in an undergraduate course or first year graduate course in partial differential equations and is likely to be of interest to researchers as well. This book presents a comprehensive study of the theory of elliptic partial differential operators. Beginning with the definitions of ellipticity for higher order operators, Shimakura discusses the Laplacian in Euclidean spaces, elementary solutions, smoothness of solutions, Vishik-Sobolev problems, the Schauder theory, and degenerate elliptic operators. The appendix covers such preliminaries as ordinary differential equations, Sobolev spaces, and maximum principles. Because elliptic operators arise in many areas, readers will appreciate this book for the way it brings together a variety of techniques that have arisen in different branches of mathematics.

Contents

Partial differential operators of elliptic type; *The Laplacian in Euclidean spaces*; *Constructions and estimates of elementary solutions*; *Smoothness of solutions*; *Vishik-Sobolev problems*; *General boundary value problems*; *Schauder estimates and applications*; *Degenerate elliptic operators.*

1991 *Mathematics Subject Classifications*: 35-02; 35A, 35B, 35J
ISBN 0-8218-4556-X, LC 92-2953, ISSN 0065-9282
288 pages (hardcover), May 1992
Individual member $79, List price $132, Institutional member $106
To order, please specify MMONO/99N



Groups, Generators, Syzygies, and Orbits in Invariant Theory

V. L. Popov

Volume 100

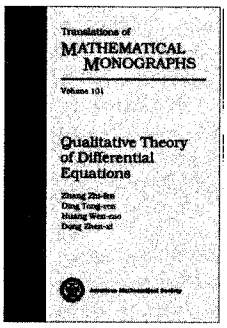
The history of invariant theory spans nearly a century and a half, with roots in certain problems from number theory, algebra, and geometry appearing in the work of Gauss, Jacobi, Eisenstein, and Hermite. Although the connection between invariants and orbits was essentially discovered in the work of Aronhold and Boole, a clear understanding of this connection had not been achieved until recently, when invariant theory was in fact subsumed by a general theory of algebraic groups.

Written by one of the major leaders in the field, this book provides an excellent, comprehensive exposition of invariant theory. Its point of view is unique in that it combines both modern and classical approaches to the subject. The introductory chapter sets the historical stage for the subject, helping to make the book accessible to nonspecialists.

Contents

The role of reductive groups in invariant theory; *Constructive invariant theory*; *The degree of the Poincaré series of the algebra of invariants and a finiteness theorem for representations with free algebra of invariants*; *Syzygies in invariant theory*; *Representations with free modules of covariants*; *A classification of normal affine quasihomogeneous varieties of* SL_2; *Quasihomogeneous curves, surfaces, and solids.*

1991 *Mathematics Subject Classifications*: 14D25, 14L30; 14J10, 20G20
ISBN 0-8218-4557-8, LC 92-10604, ISSN 0065-9282
245 pages (hardcover), June 1992
Individual member $109, List price $181, Institutional member $145
To order, please specify MMONO/100N



Qualitative Theory of Differential Equations

Zhang Zhi-fen, Ding Tong-ren, Huang Wen-zao, and Dong Zhen-xi (Translated from the Chinese by Anthony Wing-Kwok Leung)

Volume 101

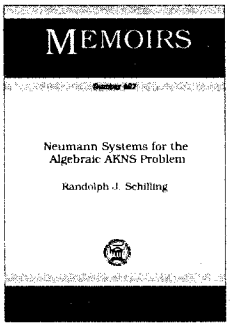
This book provides an introduction to and a comprehensive study of the qualitative theory of ordinary differential equations. It begins with fundamental theorems on existence, uniqueness, and initial conditions, and discusses basic principles in dynamical systems and Poincaré-Bendixson theory. The authors present a careful analysis of solutions near critical points of linear and nonlinear planar systems and discuss indices of planar critical points. A very thorough study of limit cycles is given, including many results on quadratic systems and recent developments in China. Other topics included are: the critical point at infinity, harmonic solutions for periodic differential equations, systems of ordinary differential equations on the torus, and structural stability for systems on two-dimensional manifolds. This book would be accessible to graduate students and advanced undergraduates and would also be of interest to researchers in this area. Exercises are included at the end of each chapter.

Contents

Fundamental theorems; *Critical points on the plane*; *Indices of planar critical points*; *Limit cycles*; *Critical points at infinity*; *Harmonic solutions for two-dimensional periodic systems*; *Systems of ordinary differential equations on the torus*; *Structural stability*.

1991 *Mathematics Subject Classifications*: 34; 34A, 34C, 34D
ISBN 0-8218-4551-9, LC 91-23961, ISSN 0065-9282
461 pages (hardcover), May 1992
Individual member $173, List price $288, Institutional member $230
To order, please specify MMONO/101N

MEMOIRS OF THE AMS



Neumann Systems for the Algebraic AKNS Problem

Randolph J. Schilling

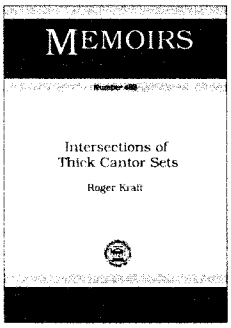
Number 467

The Neumann system, an algebraically completely integrable Hamiltonian system, consists of harmonic oscillators constrained to move on the unit sphere in configuration space. Any finite gap potential of Hill's equation may be expressed in terms of a solution to the Neumann problem. The present work is concerned with an algebraically completely integrable Hamiltonian system whose solutions may be used to describe the finite gap solutions of the AKNS spectral problem, a first order two-by-two matrix linear system. Trace formulas, constraints, Lax pairs, and constants of motion are obtained using Krichever's algebraic inverse spectral transform. Computations are carried out explicitly over the class of spectral problems with square matrix coefficients.

Contents

The geometry of Neumann systems; *A Neumann system for the* AKNS *problem*; *The divisor map*; *Hamiltonian formalism*; *The Neumann system*; *Bibliography*.

1991 *Mathematics Subject Classifications*: 58F07; 35Q20, 58F05, 58F19, 17B65, 14H40
ISBN 0-8218-2537-2, LC 92-6951, ISSN 0065-9266
59 pages (softcover), May 1992
Individual member $14, List price $23, Institutional member $18
To order, please specify MEMO/467N



Intersections of Thick Cantor Sets

Roger Kraft

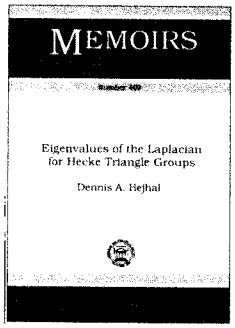
Number 468

Problems in dynamical systems involving homoclinic tangencies, homoclinic bifurcations, and the creation of horseshoes have led to the problem of analyzing the difference sets $\{t|\Gamma \cap (\Gamma' + t) \neq 0\}$ of Cantor sets Γ and Γ' embedded in the real line. In this work, the author proves two theorems about difference sets of Cantor sets, both of which involve the concept of the thickness of a Cantor set. The first gives conditions on the thicknesses of two Cantor sets that determine if the intersection of the two Cantor sets must contain a Cantor set or if the intersection may, in a nontrivial way, be as small as one point. The second theorem states that if the product of the thicknesses of two Cantor sets is strictly greater than one, then for a generic point t in their difference set, $\Gamma \cap (\Gamma' + t)$ contains a Cantor set.

Contents

Theorems and examples; *Cantor sets and thickness*; *Proof of Theorem* 1.2; *Third kind of overlapped point*; *Second Kind of overlapped point*; *First kind of overlapped point*; *The dynamics of* $\Psi_{\tau\tau'}$; *Results about the geometric process*; *Proof of Theorem* 6.2(1); *The boundary between* Λ_1 *and* Λ_2; *Proof of Theorem* 1.1.

1991 *Mathematics Subject Classifications*: 58F14, 34C37, 54F50, 28A80
ISBN 0-8218-2528-3, LC 92-6942, ISSN 0065-9266
119 pages (softcover), May 1992
Individual member $16, List price $26, Institutional member $21
To order, please specify MEMO/468N



Eigenvalues of the Laplacian for Hecke Triangle Groups

Dennis A. Hejhal

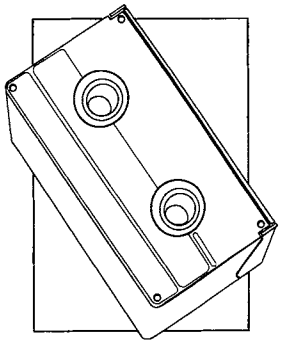
Number 469

This work is concerned with computational aspects of the Selberg trace formalism. In this area, computing the discrete spectrum of the non-Euclidean Laplacian is especially important. Hecke triangle groups represent one of the simplest possible cofinite settings for this type of problem. In addition to considering the usual type of eigenfunction, the author discusses an updated analysis of pseudo cusp forms and their residual effects. The actual computer code, run on a Cray supercomputer, is included in the appendices. Possibilities for further work, both theoretical and computational, are examined.

Contents

1991 *Mathematics Subject Classifications*: 11F30, 11F72, 30F35, 35P05, 65N35
ISBN 0-8218-2529-1, LC 92-6943, ISSN 0065-9266
165 pages (softcover), May 1992
Individual member $19, List price $29, Institutional member $23
To order, please specify MEMO/469N

VIDEOTAPES

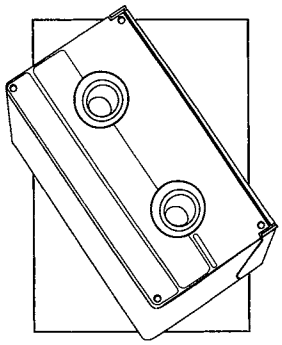


Compound Soap Bubbles, Shortest Networks, and Minimal Surfaces

Frank Morgan

The study of soap bubbles has long fascinated mathematicians and children alike. In this polished and engaging videotaped lecture, Frank Morgan shares his passion for soap bubbles and related topics. The lecture balances intuitive enjoyment and mathematical rigor, indicating the daunting technical challenges the subject poses. Morgan sprinkles enough open questions throughout the lecture to intrigue anyone—for example, it is unknown whether the common triple bubble succeeds in minimizing surface area, or whether there is some as yet undiscovered configuration that encloses the same three volumes with less area. In an entertaining twist, Morgan has the audience vote on which configurations comprise the least area—and the answers are often surprising. Combining intuitive pictures, personal touches, challenging open questions, and humor, this lecture will spark the interest of students and researchers alike. It would be accessible to undergraduate mathematics majors.

1991 *Mathematics Subject Classifications*: 53, 49
ISBN 0-8218-8063-2
NTSC format on 1/2" VHS videotape; approx. one hour, May 1992
Individual member $29.95, List price $49.95, Institutional member $39.95
To order, please specify VIDEO/67N

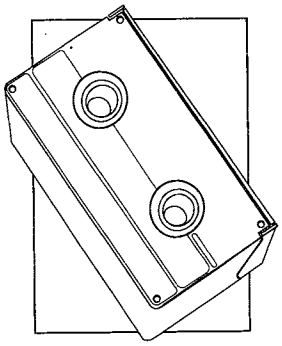


Laplacians of Graphs and Hypergraphs

Fan R. K. Chung

"Can you hear the shape of a graph?" may sound like a nonsensical twist on the famous drum problem, but in fact it captures an intriguing analogy between manifolds and graphs. In this clear and well-paced lecture, the noted graph theorist Fan Chung exploits this analogy to produce some interesting and useful results. She starts with a historical perspective on graphs, their uses in computer science, and their inherent mathematical interest. She discusses Laplacians of graphs and hypergraphs from both the homological and graph theoretical viewpoints. The eigenvalues of the Laplacians can be related to various properties of hypergraphs and used to strengthen and imply previous graph-theoretic results. A variety of applications to extremal combinatorics and computational complexity are discussed, in addition to a number of open problems.

1991 *Mathematics Subject Classification*: 05
ISBN 0-8218-8064-0
NTSC format on 1/2" VHS videotape; approx. one hour, May 1992
Individual member $29.95, List price $49.95, Institutional member $39.95
To order, please specify VIDEO/68N

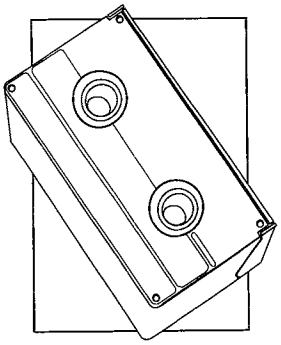


The Theory and Applications of Harmonic Mappings between Riemannian Manifolds

Richard M. Schoen

Over the last fifteen years, there have been numerous results in harmonic maps, making it an important area having ramifications in other branches of mathematics. Richard Schoen, one of the major figures in the field, provides an excellent introduction to the field in this expository lecture. He discusses existence, uniqueness, and regularity questions, as well as various applications of the theory. In addition, he explains the great differences in the theory depending on the sign of the curvature of the target manifold or space. The Bochner method and the application to rigidity questions for discrete groups is also covered. Requiring little background in harmonic maps, the lecture is aimed at the level of advanced undergraduates or graduate students.

1991 *Mathematics Subject Classifications*: 35, 49, 53, 58
ISBN 0-8218-8065-9
NTSC format on 1/2" VHS videotape; approx. one hour and a half, May 1992
Individual member $29.95, List price $49.95, Institutional member $39.95
To order, please specify VIDEO/69N

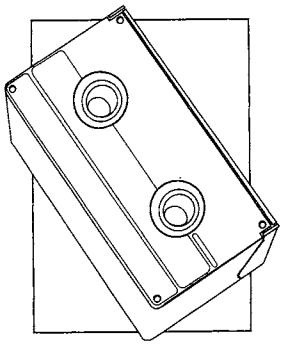


Algorithms in Algebraic Number Theory

H. W. Lenstra, Jr.

Algorithms in algebraic number theory are as old as the field itself. Traditionally, the users of such algorithms were number theorists needing to do computations in algebraic number fields. However, recent applications, such as factoring large integers, have changed this situation. In this videotape, Lenstra presents a clear, well-paced, and fascinating lecture on some of the fundamental questions arising in this area. He formulates the basic problems of algorithmic algebraic number theory in rigorous terms, explaining what advances have been made and where work still needs to be done. The main topic of the lecture is the investigation of the multiplicative structure of rings of algebraic integers, the principal tool being a group that simultaneously describes the class group and the group of units of such a ring. Lenstra shows that the study of algorithms not only increases understanding of algebraic number fields, but also stimulates curiosity about them. For this reason, the lecture would be an excellent addition to a course touching on these topics. It is accessible to advanced undergraduates and graduate students with backgrounds in algebra and number theory.

1991 *Mathematics Subject Classifications*: 11Y40, 11Y16, 11R65
ISBN 0-8218-8066-7
NTSC format on 1/2" VHS videotape; approx. one hour and a half, May 1992
Individual member $29.95, List price $49.95, Institutional member $39.95
To order, please specify VIDEO/70N



Mathematics under Hardship Conditions in the Third World

Neal I. Koblitz

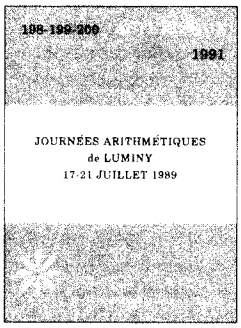
What is the situation for mathematics in the Third World? In this lively and controversial videotaped lecture, Koblitz examines such questions as why mathematics research flourishes in Vietnam, while other countries contend with "brain drain" to the U.S. and Europe. He also looks at mathematics education in Central America, where the "New Math" craze took hold, sometimes with disastrous results. Some of the stories he relates show the deprivation and nearly overwhelming problems, while other stories describe people of great tenacity, resourcefulness, and heroism. At the end of his lecture, he suggests specific actions that individuals and mathematics organizations can take to help keep mathematics alive and growing in the Third World. Anyone with an interest in international issues of mathematics research and education will enjoy this eye-opening lecture.

1991 *Mathematics Subject Classifications*: 01, 00
ISBN 0-8218-8067-5
NTSC format on 1/2" VHS videotape; approx. one hour, May 1992
Individual member $29.95, List price $49.95, Institutional member $39.95
To order, please specify VIDEO/71N

SOCIÉTÉ MATHÉMATIQUE DE FRANCE, ASTÉRISQUE

The AMS distributes Astérisque only in the U.S., Canada, and Mexico. Orders from other countries should be sent to the Maison de la SMF, Case 916, Luminy, 13288 Marseille Cedex 9, France or to OFFILIB, 48 rue Gay-Lussac, 75240 Paris Cedex 05, France. Individual members of either AMS or SMF are entitled to the member price. (ISSN 0303-1179)

ASTÉRISQUE



Journées Arithmétiques de Luminy, 17–21 Juillet 1989

G. Lachaud, Editor

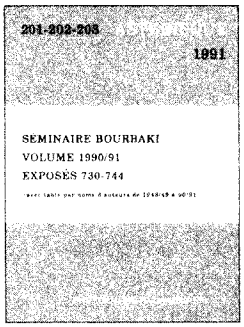
Number 198–199–200

Every two years, the "Journées Arithmétiques" present a wide panorama on the state of the art in number theory. This book contains five reports on recent progress in a variety of areas, including transendence; the Beilinson conjectures for elliptic curves; motives (with three texts by A. Grothendieck); Arakelov geometry and transcendental number theory; and global fields, codes, and sphere packings. The volume contains more than twenty-six papers presented by the conference participants.

Contents

J. P. Allouche, *Sur la transcendance de la série formelle* II; **A. M. Bergé and J. Martinet**, *Réseaux extrémes pour un groupe d'automorphismes*; **A. Bertrand**, *Nombres de Perron et problèmes de rationalité*; **M. Car**, *Le problème de Waring pour les corps de fonctions*; **J. Cherly**, *Résolution du problème de Waring pour les cubes dans* $F_2[X]$; **P. Cohen and J. Wolfart**, *Monodromie des fonctions d'Appell, variétés abéliennes, et prolongement modulaire*; **E. Dubois and R. P.-Le Roux**, *Sur la longueur du développement en fraction continue de* $\sqrt{f(n)}$; **W. Duke**, *Sums over Primes of the Fourier coefficients of Half-integral weight cusp forms*; **N. Elkies**, *Distribution of supersingular primes*; **B. Erez**, *A survey of recent work on the square root of the inverse different*; **D. R. Heath-Brown**, *The number of abelian groups of order at most* x; **M. N. Huxley**, *Exponential sums after bombieri and Iwaniec*; **D.-O. Jaquet**, *Classification des réseaux dans* R^7; **J. F. Jaulent**, *Noyau universel et valeurs absolues*; **M. Laurent**, *Sur quelques résultats récents de transcendance*; **R. Massy**, *Sur les Bases normales d'entiers relatives*; **T. Matala-Aho**, *On recurrences for some hypergeometric type polynomials*; **F. Morain**, *Elliptic curves, primality proving, and some titanic primes*; **L. Murata**, *On the magnitude of the least primitive root*; **H. Nakada and G. Wagner**, *Duffin-Schaeffer theorem on diophantine approximation for complex numbers*; **J. Pas**, *Some applications of uniform p-adic cell decomposition*; **R. Quême**, *On diophantine approximation by algebraic numbers of a given number field*; **P. Rambour**, *Eléments fixes du complété d'une cloture séparable sous l'action de son groupe de Galois*; **P. Satgé**, *Quelques problèmes de rationalité liés au théorème de Poncelet*; **N. Schappacher**, *Les conjectures de beilinson pour les courbes elliptiques*; **H. P. Schlickewei**, *Résultats quantitatifs en approximation diophantienne*; **J.-P. Serre**, *Motifs*; **J.-P. Serre**, *Lettre à M. Tsfasman*; **C. Soulé**, *Géométrie d'Arakelov et théorie des nombres transcendants*; **M. Tsfasman**, *Global fields, codes, and sphere packings*; **W. Veys**, *Relations between numerical data of an imbedded resolution.*

1991 *Mathematics Subject Classifications*: 11, 12, 14
ISSN 0303-1179
405 pages (softcover), 1992
Individual AMS or SMF member $41, List price $58
To order, please specify AST/198/200N



Séminaire Bourbaki

Number 201–202–203

This volume grew out ot the Bourbaki Seminar and consists of fifteen survey lectures on a variety of current research topics. In particular, there are expositions of recent results on the geometry of Brownian motion in the plane, the Riemann-Roch theorem in Arakelov geometry, the determination of indecomposable knots by the fundamental group of their complement, Floer homology, Igusa's zeta function, the combinatorics of resultants, and representations of quantum groups.

Contents

G. B. Arous, *Géométrie de la courbe brownienne plane*; **J.-B. Bost**, *Théorie de l'intersection et théorème de Riemann-Roch arithmétiques*; **A. Gramain**, *Rapport sur la théorie classique des noeuds (2ème partie)*; **J.-C. Sikorav**, *Homologie associée à une fonctionnelle [d'après A. Floer]*; **J.-C. Yoccoz**, *Polynômes quadratiques et attracteur de Hénon*; **F. Comets**, *Limites hydrodynamiques*; **G. Henniart**, *Représentations des groupes réductifs p-adiques*; **J. Le Potier**, *Fibrés de Higgs et systèmes locaux*; **P. Pansu**, *Le flot géodésique des variétés riemanniennes à courbure négative*; **G. Skandalis**, *Approche de la conjecture de Novikov par la cohomologie cyclique [d'après A. Connes, M. Gromov et H. Moscovici]*; **J.-P. Bourguignon**, *Stabilité par déformation non-linéaire de la métrique de Minkowski [d'après D.*

Christodoulou et S. Klainerman]; **J. Denef**, *Report on Igusa's local zeta function*; **F. Loeser**, *Polytopes secondaires et discriminants*; **O. Mathieu**, *Bases des représentations des groupes simples complexes [d'après Kashiwara, Lusztig, Ringel et al.]*; **M. Rosso**, *Représentations des groupes quantiques*; **G. Henniart**, *Erratum à l'exposé* 711.

1991 *Mathematics Subject Classification*: 00
ISSN 0303-1179
512 pages (softcover), 1992
Individual AMS or SMF member $50, List price $73
To order, please specify AST/201/203N

Warehouse Sale

Selected books from AMS warehouse overstock.

70% Discount on most titles!

Discount applies only to the books on the following pages. DIRECT SALES ONLY. NOT AVAILABLE TO BOOKSTORES OR AGENTS. Orders must be sent on the special Warehouse Sale form (or facsimile). For telephone orders, please specify Warehouse Sale to ensure proper discount. Sale ends July 16, 1992.

CBMS Regional Conference Series in Mathematics

Code	List	Sale
Algebraic and analytic aspects of operator algebras, I. Kaplansky, reprinted 1980, 20 pp. CBMS/1WS	$16	$5
Twisted honeycombs, H.S.M. Coxeter, 1970, 47 pp. CBMS/4WS	$15	$5
Holomorphic vector fields on compact Kähler manifolds, Y. Matsushima, 1971, 38 pp. CBMS/7WS	$15	$5
Notes from a ring theory conference, I. N. Herstein, 1971, 38 pp. CBMS/9WS	$15	$5
Automata on infinite objects and Church's problem, M. Rabin, reprinted 1982, 22 pp. CBMS/13WS	$17	$5
Lectures on linear groups, O. T. O'Meara, third printing 1988, 87 pp. CBMS/22WS	$18	$5
Approximation with rational functions, D. J. Newman, reprinted 1981, 52 pp. CBMS/41WS	$18	$5
Special functions and linear representations of Lie groups, Jean Dieudonné, reprinted 1982, 59 pp. CBMS/42WS	$17	$5
Rudiments of Ramsey theory, Ronald L. Graham, reprinted 1983, 65 pp. CBMS/45WS	$14	$4
Topics in dynamic bifurcation theory, Jack K. Hale, reprinted 1983, 84 pp. CBMS/47WS	$14	$4
Brown-Peterson homology: an introduction and sampler, W. Stephen Wilson, reprinted 1988, 86 pp. CBMS/48WS	$17	$5
Structure of factors and automorphism groups, Masamichi Takesaki, 1983, 107 pp. CBMS/51WS	$25	$8
Ten lectures on operator algebras, William Arveson, reprinted 1988, 93 pp. CBMS/55WS	$21	$6
Prescribing the curvature of a Riemannian manifold, Jerry L. Kazdan, reprinted 1988, 55 pp. CBMS/57WS	$18	$5
Harish-Chandra homomorphisms for $\mathfrak{p}$-adic groups, Roger Howe, 1985, 76 pp. CBMS/59WS	$18	$5
Factorization of linear operators and geometry of Banach spaces, Gilles Pisier, reprinted 1987, 154 pp. CBMS/60WS	$24	$7
Minimax methods in critical point theory with applications to differential equations, Paul H. Rabinowitz, reprinted 1988, 110 pp. CBMS/65WS	$22	$7

Colloquium Publications

Code	List	Sale
Structure and representations of Jordan algebras, N. Jacobson, 1968, 453 pp. COLL/39WS	$50	$15

Contemporary Mathematics

Code	List	Sale
Proceedings of the conference on integration, topology, and geometry in linear spaces, edited by William H. Graves, 1980, 269 pp. CONM/2WS	$26	$8
Problems of elastic stability and vibrations, edited by Vadim Komkov, 1981, 137 pp. CONM/4WS	$16	$5
Plane ellipticity and related problems, edited by Robert P. Gilbert, 1982, 245 pp. CONM/11WS	$32	$10
Proceedings of the Northwestern homotopy theory conference, edited by Haynes R. Miller and Stewart B. Priddy, 1983, 454 pp. CONM/19WS	$40	$12
Value distribution theory and its applications, edited by Chung-Chun Yang, 1984, 253 pp. CONM/25WS	$38	$11
Automated theorem proving: After 25 years, edited by W. W. Bledsoe and D. W. Loveland, reprinted 1985, 360 pp. CONM/29WS	$40	$12
Four-manifold theory, edited by Cameron Gordon and Robion C. Kirby, reprinted 1988, 528 pp. CONM/35WS	$54	$16
Combinatorial methods in topology and algebraic geometry, edited by John R. Harper and Richard Mandelbaum, reprinted 1988, 349 pp. CONM/44WS	$42	$13
Random matrices and their applications, edited by J. E. Cohen, H. Kesten, and C. M. Newman, reprinted 1988, 358 pp. CONM/50WS	$41	$12
Logic and combinatorics, edited by Stephen G. Simpson, reprinted 1990, 394 pp. CONM/65WS	$44	$13
Statistical inference from stochastic processes, edited by N. U. Prabhu, 1988, 386 pp. CONM/80WS	$42	$13

Index of Mathematical Papers

Code	List	Sale
Index of Mathematical Papers, Mathematical Reviews Indexes, July–December 1970. IMP/1WS	$89	$27

Lectures in Applied Mathematics

Code	List	Sale
Lectures in statistical mechanics, G. E. Uhlenbeck, G. W. Ford, and E. W. Montroll, reprinted 1986, 181 pp. LAM/1WS	$43	$13
Space mathematics, Part 2, edited by J. B. Rosser, reprinted 1974, 258 pp. LAM/6WS	$43	$13
Mathematical problems in the geophysical sciences. 1. Geophysical fluid dynamics, edited by W. H. Reid, 1971, 383 pp. LAM/13WS	$63	$19

Code	List	Sale

Mathematical problems in the geophysical sciences. 2. Inverse problems, dynamo theory, and tides, edited by W. H. Reid, 1971, 370 pp.
LAM/14WS $60 $18

Mathematical aspects of physiology, edited by Frank C. Hoppensteadt, 1981, 394 pp.
LAM/19WS $58 $17

Fluid dynamics in astrophysics and geophysics, edited by Norman R. Lebovitz, 1983, 269 pp.
LAM/20WS $67 $20

Lectures on Mathematics in the Life Sciences

Some mathematical questions in biology. II, edited by J. D. Cowan, 1972, 121 pp.
LLSCI/3WS $26 $8

Some mathematical questions in biology. III, edited by J. D. Cowan, 1972, 151 pp.
LLSCI/4WS $30 $9

Some mathematical questions in biology. IV, edited by J. D. Cowan, 1973, 150 pp.
LLSCI/5WS $37 $11

Some mathematical questions in biology. V, edited by J. D. Cowan, 1974, 141 pp.
LLSCI/6WS $29 $9

Some mathematical questions in biology. IX, edited by Simon A. Levin, 1978, 244 pp.
LLSCI/10WS $35 $11

Some mathematical questions in biology. X, edited by Simon A. Levin, 1979, 179 pp.
LLSCI/11WS $26 $8

Some mathematical questions in biology, edited by Simon A. Levin, 1979, 218 pp.
LLSCI/12WS $33 $10

Some mathematical questions in biology, edited by George F. Oster, 1980, 274 pp.
LLSCI/13WS $36 $11

Some mathematical questions in biology—Neurobiology, edited by Robert M. Miura, 1982, 122 pp.
LLSCI/15WS $29 $9

Memoirs of the American Mathematical Society

The decomposition of Walsh and Fourier series, I. I. Hirschman, fourth printing 1983, 65 pp.
MEMO/15WS $20 $6

Produits tensoriels topologiques et espaces nucléaires, A. Grothendieck, sixth printing 1979, 336 pp.
MEMO/16WS $25 $8

The generalized Pontrjagin cohomology operations and rings with divided powers, Emery Thomas, reprinted 1968, 82 pp.
MEMO/27WS $16 $5

Cohomology groups and genera of higher-dimensional fields, E. Snapper, third printing 1971, 100 pp.
MEMO/28WS $16 $5

Twisted polynomial hyperalgebras, E. Halpern, reprinted 1972, 61 pp.
MEMO/29WS $18 $5

Isoclinic n-planes in Euclidean $2n$-space, Clifford parallels in elliptic $(2n-1)$ -space, and the Hurwitz matrix equations, Y.-C. Wong, reprinted 1971, 112 pp.
MEMO/41WS $17 $5

Foundations of relative homological algebra, S. Eilenberg and J. C. Moore, reprinted 1966, 39 pp.
MEMO/55WS $15 $5

Torsion in SU-bordism, P. E. Conner and E. E. Floyd, reprinted 1969, 72 pp.
MEMO/60WS $16 $5

Projections onto translation-invariant subspaces of $L^p(G)$, H. P. Rosenthal, 1966, 84 pp.
MEMO/63WS $15 $5

Deformation theory of pseudogroup structures, V. Guillemin and S. Sternberg, 1966, 80 pp.
MEMO/64WS $15 $5

On the enumeration of non-planar maps, W. G. Brown, 1966, 42 pp.
MEMO/65WS $15 $5

The undecidability of the domino problem, R. Berger, 1966, 72 pp.
MEMO/66WS $15 $5

The modified algorithm of Jacobi-Perron, L. Bernstein, 1966, 44 pp.
MEMO/67WS $15 $5

The metastable homotopy of S^n, M. Mahowald, 1967, 81 pp.
MEMO/72WS $15 $5

Two papers on similarity of certain Volterra integral operators, S. J. Osher, 1967, 47 pp.
MEMO/73WS $15 $5

A class of functional equations of neutral type, J. K. Hale and K. R. Meyer, 1967, 65 pp.
MEMO/76WS $15 $5

Measurable, continuous, and smooth vectors for semigroups and group representations, R. T. Moore, 1968, 80 pp.
MEMO/78WS $15 $5

Denjoy integration in abstract spaces, D. W. Solomon, 1969, 69 pp.
MEMO/85WS $15 $5

Souslinoid and analytic sets in a general setting, A. H. Kruse, 1969, 127 pp.
MEMO/86WS $15 $5

An extension of Mackey's method to Banach *-algebraic bundles, J.M.G. Fell, 1969, 168 pp.
MEMO/90WS $16 $5

A conformal mapping technique for infinitely connected regions, M. G. Arsove and G. Johnson, Jr., 1970, 56 pp.
MEMO/91WS $15 $5

Doubly timelike surfaces, J. K. Beem and P. Y. Woo, 1969, 115 pp.
MEMO/92WS $15 $5

Hitting probabilities of single points for processes with stationary independent increments, H. Kesten, 1969, 129 pp.
MEMO/93WS $16 $5

Equivariant maps of spheres into the classical groups, J. Folkman, 1971, 42 pp.
MEMO/95WS $15 $5

Intrinsic measures on complex manifolds and holomorphic mappings, D. A. Eisenman, 1970, 80 pp.
MEMO/96WS $15 $5

Isometric embeddings of Riemannian and pseudo-Riemannian manifolds, R. E. Green, 1970, 63 pp.
MEMO/97WS $15 $5

Similarity of automorphisms of the torus, R. L. Adler and B. Weiss, 1970, 43 pp.
MEMO/98WS $15 $5

Properties of planar graphs with uniform vertex and face structure, J. Malkevitch, 1970, 116 pp.
MEMO/99WS $15 $5

Unoriented bordism and actions of finite groups, R. E. Stong, 1970, 80 pp.
MEMO/103WS $15 $5

Octonion planes defined by quadratic Jordan algebras, J. R. Faulkner, 1970, 71 pp.
MEMO/104WS $15 $5

Compactly covered reflections, extension of uniform dualities and generalized almost periodicity, M. H. Powell, 1970, 235 pp.
MEMO/105WS $16 $5

Numbers with small prime factors, and the least kth power non-residue, K. K. Norton, 1971, 106 pp.
MEMO/106 $15 $5

Cellular decompositions of 3-manifolds that yield 3-manifolds, S. Armentrout, 1971, 72 pp.
MEMO/107WS $15 $5

Asymptotic behavior of solutions and adjunction fields for nonlinear first order differential equations, W. Strodt and R. K. Wright, 1971, 284 pp.
MEMO/109WS $16 $5

On the mixed problem for a hyperbolic equation, T. Balaban, 1971, 117 pp.
MEMO/112WS $15 $5

Structures in topology, D. Harris, 1971, 96 pp.
MEMO/115WS $15 $5

Constructive measure theory, E. Bishop and H. Cheng, 1972, 85 pp.
MEMO/116WS $15 $5

Extensions of positive-definite functions, J. R. McMullen, 1972, 71 pp.
MEMO/117WS $15 $5

The Cauchy-Goursat problem, P. DuChateau, 1972, 60 pp.
MEMO/118WS $15 $5

On λ-nuclearity, E. Dubinsky and M. S. Ramanujan, 1972, 101 pp.
MEMO/128WS $16 $5

On summability methods for conjugate Fourier-Stieltjes integrals in several variables and generalizations, T. Walsh, 1973, 103 pp.
MEMO/131WS $18 $5

Code	List	Sale

Extension theory of formally normal and symmetric subspaces, E. A. Coddington, 1973, 80 pp.
MEMO/134WS $16 $5

Canonical differential operators and lower-order symbols, R. J. V. Jackson, 1973, 235 pp.
MEMO/135WS $18 $5

Unitary representations on partially holomorphic cohomology spaces, J. A. Wolf, 1974, 152 pp.
MEMO/138WS $17 $5

Derivations and automorphisms of Banach algebras of power series, S. Grabiner, 1974, 124 pp.
MEMO/146WS $17 $5

Uniform simplification in a full neighborhood of a transition point, Y. Sibuya, 1974, 106 pp.
MEMO/149WS $16 $5

Equilibrium states on thin energy shells, R. L. Thompson, 1974, 110 pp.
MEMO/150WS $17 $5

Sur les sections analytiques de la courbe universelle de Teichmüller, J. H. Hubbard, 1976, 137 pp.
MEMO/166WS $21 $6

Parametrized knot theory, S. Ocken, 1976, 114 pp.
MEMO/170WS $21 $6

Local surgery and the exact sequence of a localization for Wall groups, William Pardon, 1977, 171 pp.
MEMO/196WS $21 $6

Boundary-interior layer interactions in nonlinear singular perturbation theory, F. A. Howes, reprinted 1982, 108 pp.
MEMO/203WS $20 $6

Symmetric structures in Banach spaces, W. B. Johnson, B. Maurey, G. Schechtman, and L. Tzafriri, reprinted 1980, 298 pp.
MEMO/217WS $21 $6

Primary homotopy theory, Joseph Neisendorfer, reprinted 1983, 67 pp.
MEMO/232WS $15 $5

The degenerate principal series for Sp($2n$), Robert Gustafson, 1981, 81 pp.
MEMO/248WS $15 $5

On Villamayor and Zelinsky's long exact sequence, Mitsuhiro Takeuchi, 1981, 178 pp.
MEMO/249WS $18 $5

Global structural stability of flows on open surfaces, Janina Kotus, Michal Krych, and Zbigniew Nitecki, reprinted 1983, 109 pp.
MEMO/261WS $18 $5

The cohomology of Chevalley groups of exceptional Lie type, Samuel N. Kleinerman, 1982, 82 pp.
MEMO/268WS $15 $5

C^*-bundles and compact transformation groups, Bruce D. Evans, 1982, 63 pp.
MEMO/269WS $15 $5

The symplectic cobordism ring II, Stanley O. Kochman, 1982, 170 pp.
MEMO/271WS $18 $5

Code	List	Sale

The fundamental principle for systems of convolution equations, Daniele Carlo Struppa, 1982, 167 pp.
MEMO/273WS $18 $5

β-homotopy equivalences have α-cross sections, Luis Montejano, 1982, 37 pp.
MEMO/274WS $15 $5

Algebraic K-theory and localised stable homotopy theory, Victor P. Snaith, 1983, 102 pp.
MEMO/280WS $18 $5

Intersection calculus on surfaces with applications to 3-manifolds, John Hempel, 1983, 48 pp.
MEMO/282WS $15 $5

Geometrical methods in congruence modular algebras, H. Peter Gumm, 1983, 79 pp.
MEMO/286WS $14 $4

Irreducible triangular algebras, Baruch Solel, 1984, 87 pp.
MEMO/290WS $15 $5

Nonmodular lattice varieties, Henry Rose, 1984, 76 pp.
MEMO/292WS $15 $5

Maximal functions measuring smoothness, Ronald A. DeVore and Robert C. Sharpley, 1984, 116 pp.
MEMO/293WS $17 $5

Théorèmes d'indices Gevrey pour les équations différentielles ordinaires, Jean-Pierre Ramis, 1984, 95 pp.
MEMO/296WS $16 $5

Essays in the history of mathematics, George B. Dantzig, Lars Garding, Frank C. Hoppensteadt, Kurt Kreith, Jerzy Neyman, Ralph Price, and Wolfgang Wasow, edited by Arthur Schlissel, reprinted 1987, 74 pp.
MEMO/298WS $15 $5

The structure of shock waves in magnetohydrodynamics, Mahmud Hesaaraki, 1984, 96 pp.
MEMO/302WS $16 $5

Multipliers of radical Banach algebras of power series, W. G. Bade, H. G. Dales, and K. B. Laursen, 1984, 84 pp.
MEMO/303WS $16 $5

Dimensions of spaces of Siegel cusp forms of degree two and three, Minking Eie, 1984, 184 pp.
MEMO/304WS $16 $5

The lattice of interpretability types of varieties, O. C. Garcia and W. Taylor, 1984, 125 pp.
MEMO/305WS $18 $5

The unfolding and determinacy theorems for subgroups of $\mathcal{A}$ and $\mathcal{K}$, James Damon, 1984, 88 pp.
MEMO/306WS $16 $5

Attractors representing turbulent flows, Peter S. Constantin, Ciprian Foias, and Roger Temam, reprinted 1988, 67 pp.
MEMO/314WS $17 $5

Nonlinear stability of shock waves for viscous conservation laws, Tai-Ping Lui, reprinted 1988, 109 pp.
MEMO/328WS $20 $6

Code	List	Sale

Translations of Mathematical Monographs

Harmonic analysis of functions of several complex variables in the classical domains, L. K. Hua, translated by L. Ebner and A. Korányi, fourth printing 1986, 186 pp.
MMONO/6WS $37 $11

Additive theory of prime numbers, L. K. Hua, translated by N. H. Ng, 1965, 190 pp.
MMONO/13WS $40 $12

Intrinsic geometry of surfaces, A. D. Aleksandrov and V. A. Zalgaller; translated by J. M. Danskin, 1967, 327 pp.
MMONO/15WS $42 $13

Expansions in eigenfunctions of selfadjoint operators, Ju. M. Berezanskiĭ; translated by R. Bolstein, J. M. Danskin, J. Rovnyak, and L. Shulman, 1968, 809 pp.
MMONO/17WS $88 $26

The operator of translation along the trajectories of differential equations, M. A. Krasnosel'skiĭ; translated by Scripta Technica, 1968, 294 pp.
MMONO/19WS $49 $15

Statistical problems with nuisance parameters, Ju. V. Linnik; translated by Scripta Technica, 1968, 258 pp.
MMONO/20WS $42 $13

Constructive real numbers and function spaces, N. A. Šanin; translated by E. Mendelson, 1968, 325 pp.
MMONO/21WS $56 $17

Mahler's problem in metric number theory, V. G. Sprindžuk; translated by B. Volkmann, 1969, 192 pp.
MMONO/25WS $34 $10

The Stefan problem, L. I. Rubinšteĭn; translated by A. Solomon, 1971, 419 pp.
MMONO/27WS $74 $22

The functional method and its applications, E. V. Voronovskaja; translated by R. P. Boas, 1970, 203 pp.
MMONO/28WS $53 $16

Differential equations of the second order with retarded argument. Some problems of the theory of vibrations of systems with retardation, S. B. Norkin; translated by L. J. Grimm and K. Schmitt, 1972, 285 pp.
MMONO/31WS $53 $16

Triangular and Jordan representations of linear operators, M. S. Brodskiĭ; translated by J. M. Danskin, 1972, 246 pp.
MMONO/32WS $45 $14

Operators, oscillations, waves, M. S. Livšic; translated by Scripta Technica Ltd., 1973, 274 pp.
MMONO/34WS $63 $19

Theory of convex programming, E. G. Gol'šteĭn; translated by K. Makowski; translation edited by R. T. Rockafellar, 1972, 57 pp.
MMONO/36WS $34 $10

Code List Sale

Projection-iterative methods for solution of operator equations; transl. by Israel Program for Scientific Translations; transl. edited by R. G. Douglas, N. S. Kurpel', 1976, 196 pp.
MMONO/46WS $58 $17

Differential forms orthogonal to holomorphic functions or forms, and their properties, L. A. Aĭzenberg and Sh. A. Dautov, 1983, 165 pp.
MMONO/56WS $50 $15

Proceedings of Symposia in Applied Mathematics

Wave motion and vibration theory, edited by A. E. Heins, 1954, 169 pp.
PSAPM/5WS $34 $10

Numerical analysis, edited by Gene H. Golub and Joseph Oliger, third printing 1985, 135 pp.
PSAPM/22WS $20 $6

Modern statistics: methods and applications, edited by Robert V. Hogg, 1980, 110 pp.
PSAPM/23WS $22 $7

Game theory and its applications, edited by William F. Lucas, reprinted 1983, 136 pp.
PSAPM/24WS $21 $6

Operations research mathematics and models, edited by Saul I. Gass, reprinted 1983, 198 pp.
PSAPM/25WS $18 $5

The mathematics of networks, edited by Stefan A. Burr, reprinted 1984, 142 pp.
PSAPM/26WS $24 $7

Computed tomography, edited by Lawrence A. Shepp, reprinted 1986, 86 pp.
PSAPM/27WS $22 $7

Applied cryptology, cryptographic protocols, and computer security models, edited by Richard A. DeMillo, George I. Davida, David P. Dobkin, Michael A. Harrison, and Richard J. Lipton, reprinted 1985, 192 pp.
PSAPM/29WS $33 $10

Population biology, edited by Simon A. Levin, 1984, 101 pp.
PSAPM/30WS $30 $9

Environmental and natural resources mathematics, edited by Robert W. McKelvey, 1985, 143 pp.
PSAPM/32WS $38 $11

Fair allocation, edited by H. Peyton Young, 1985, 170 pp.
PSAPM/33WS $30 $9

Proceedings of Symposia in Pure Mathematics

Differential geometry, Part 1, edited by S. S. Chern and R. Osserman, reprinted 1982, 451 pp.
PSPUM/27.1WS $63 $19

Differential geometry, Part 2, edited by S. S. Chern and R. Osserman, reprinted 1982, 443 pp.
PSPUM/27.2WS $70 $21

Code List Sale

Mathematical developments arising from Hilbert problems, edited by F. E. Browder, third printing 1976, 628 pp.
PSPUM/28WS $43 $13

Automorphic forms, representations and *L*-functions, Part 1, edited by A. Borel and W. Casselman, third printing 1990, 322 pp.
PSPUM/33.1WS $35 $11

Automorphic forms, representations, and *L*-functions, Part 2, edited by A. Borel and W. Casselman, third printing 1990, 382 pp.
PSPUM/33.2WS $35 $11

Harmonic analysis in Euclidean spaces, Part 1, edited by Guido Weiss and Stephen Wainger, reprinted 1981, 460 pp.
PSPUM/35.1WS $45 $14

Harmonic analysis in Euclidean spaces, Part 1, edited by Guido Weiss and Stephen Wainger, reprinted 1981, 438 pp.
PSPUM/35.2WS $42 $13

Geometry of the Laplace operator, edited by Robert Osserman and Alan Weinstein, reprinted 1982, 323 pp.
PSPUM/36WS $40 $12

Operator algebras and applications, Part 1, edited by Richard V. Kadison, 1982, 632 pp.
PSPUM/38.1WS $64 $19

Operator algebras and applications, Part 2, edited by Richard V. Kadison, 1982, 625 pp.
PSPUM/38.2WS $64 $19

The mathematical heritage of Henri Poincaré, Parts 1 and 2 as a set, edited by Felix E. Browder, reprinted 1984, 905 pp.
PSPUM/39WS $104 $31

Singularities, Part 1, edited by Peter Orlik, 1983, 676 pp.
PSPUM/40.1WS $77 $23

Singularities, Part 2, edited by Peter Orlik, 1983, 680 pp.
PSPUM/40.2WS $77 $23

Complex analysis of several variables, edited by Yum-Tong Siu, 1984, 297 pp.
PSPUM/41WS $67 $20

Recursion theory, edited by Anil Nerode and Richard A. Shore, 1985, 528 pp.
PSPUM/42WS $79 $24

Pseudodifferential operators and applications, edited by François Trèves, 1985, 301 pp.
PSPUM/43WS $58 $17

Geometric measure theory and the calculus of variations, edited by William K. Allard and Frederick J. Almgren, Jr., 1986, 464 pp.
PSPUM/44WS $72 $22

Reviews

Reviews of Papers in Algebraic and Differential Topology, Topological Groups, and Homological Algebra, 1940–67, edited by Norman E. Steenrod, 1969, 1448 pp.
REVTOP/WS $91 $27

Code List Sale

SIAM–AMS Proceedings

Transport theory, edited by I. K. Aub-Shumays, R. Bellman, and G. Birkhoff, 1969, 327 pp.
SIAMS/1WS $40 $12

Numerical solution of field problems in continuum physics, edited by G. Birkhoff and R. S. Varga, 1970, 280 pp.
SIAMS/2WS $37 $11

Mathematical aspects of electrical network analysis, edited by F. Harary and H. S. Wilf, 1971, 206 pp.
SIAMS/3WS $36 $11

Mathematical aspects of statistical mechanics, edited by J.C.T. Pool, 1972, 89 pp.
SIAMS/5WS $32 $10

Stochastic differential equations, edited by J. B. Keller and H. P. McKean, 1973, 209 pp.
SIAMS/6WS $53 $16

Mathematical aspects of chemical and biochemical problems and quantum chemistry, edited by D. S. Cohen, 1974, 153 pp.
SIAMS/8WS $43 $13

Nonlinear programming, edited by R. W. Cottle and C. E. Lemke, reprinted 1980, 200 pp.
SIAMS/9WS $26 $8

Fracture mechanics, edited by Robert Burridge, 1979, 169 pp.
SIAMS/12WS $29 $9

Selected Translations in Mathematical Statistics and Probability

Twenty-five papers on statistics and probability, 1961, 306 pp.
STAPRO/1WS $49 $15

Twenty-two papers on statistics and probability, 1966, 274 pp.
STAPRO/6WS $47 $14

Eleven papers from the fourth Prague conference on information theory, statistical decision functions, and random processes, 1970, 221 pp.
STAPRO/8WS $40 $12

Twenty-two papers on statistics and probability, 1973, 279 pp.
STAPRO/11WS $43 $13

Twenty papers on statistics and probability, 1973, 312 pp.
STAPRO/12WS $60 $18

Twenty papers on statistics and probability, 1973, 298 pp.
STAPRO/13WS $72 $22

Code	List	Sale

Proceedings of the Steklov Institute of Mathematics

Approximation of functions in the mean (1967), edited by S. B. Stečkin, 1969, 138 pp.
STEKLO/88WS $56 $17

The Milne problem with anisotropic scattering (1968), M. V. Maslennikov, 1969, 161 pp.
STEKLO/97WS $57 $17

Parametric normed spaces and normed massives (1969), K. K. Golovkin, 1972, 121 pp.
STEKLO/106WS $53 $16

Equations in free semigroups (1971), Ju. I. Hmelevskiĭ, 1976, 270 pp.
STEKLO/107WS $118 $35

Collection of articles. I (1971), edited by I. G. Petrovskiĭ and S. M. Nikol'skiĭ, 1973, 399 pp.
STEKLO/112WS $103 $31

Problems in the constructive trend in mathematics. V (1970), edited by V. P Orevkov and N. A. Šanin, 1972, 287 pp.
STEKLO/113WS $63 $19

Theory and applications of differentiable functions of several variables. IV (1972), edited by S. M. Nikol'skiĭ, 1974, 403 pp.
STEKLO/117WS $104 $31

On integral functionals with variable domain of integration (1972), edited by I. I. Daniljuk, 1976, 144 pp.
STEKLO/118WS $53 $16

Difference methods of solving problems of mathematical physics. II (1973), edited by N. N. Janenko, 1975, 99 pp.
STEKLO/122WS $53 $16

Regular Dirichlet-Voronoĭ partitions for the second triclinic group (1973), M. I. Štogrin, 1975, 116 pp.
STEKLO/123WS $53 $16

Boundary value problems of mathematical physics. IX (1975), edited by O. A. Ladyžhenskaja, 1977, 179 pp.
STEKLO/127WS $57 $17

Collection of articles. II (1972), edited by S. M. Nikol'skiĭ, 1974, 303 pp.
STEKLO/128WS $88 $26

Problems in the constructive trend in mathematics. VI (1973), edited by V. P. Orevkov and N. A. Šanin, 1976, 272 pp.
STEKLO/129WS $130 $39

International conference on mathematical problems of quantum field theory and quantum statistics. II, Fields and particles. Mathematical questions of quantum statistics (1975), edited by V. S. Vladimirov, reprinted 1982, 450 pp.
STEKLO/136WS $120 $36

***C*-types of *n*-dimensional lattices and 5-dimensional primitive parallelohedra (with application to the theory of coverings) (1976)**, S. S. Ryškov and E. P. Baranovskiĭ, 1978, 140 pp.
STEKLO/137WS $80 $24

Theory of numbers, mathematical analysis, and their applications (1976), edited by S. M. Nikol'skiĭ, 1979, 289 pp.
STEKLO/142WS $109 $33

Algebra, theory of numbers and their applications (1978), edited by S. M. Nikol'skiĭ, 1980, 283 pp.
STEKLO/148WS $132 $40

Limits of indeterminacy in measure of *T*-means of subseries of a trigonometric series (1978), D. E. Men'šov, 1981, 56 pp.
STEKLO/149WS $33 $10

Multiple trigonometric sums (1980), G. I. Arhipov, A. A. Karacuba, and V. N. Čubarikov, 1982, 126 pp.
STEKLO/151WS $64 $19

The geometry of positive quadratic forms (1980), edited by S. S. Ryškov, 1982, 258 pp.
STEKLO/152WS $114 $34

Spectral theory of automorphic functions (1981), A. B. Venkov, 1983, 163 pp.
STEKLO/153WS $88 $26

Theory of numbers, mathematical analysis, and their applications (1981), edited by N. N. Bogolyubov and K. K. Mardzhanishvili, 1983, 248 pp.
STEKLO/157WS $92 $28

Analytic number theory, mathematical analysis, and their applications (1981), edited by N. N. Bogolyubov and K. K. Mardzhanishvili, 1984, 247 pp.
STEKLO/158WS $97 $29

Mathematical Surveys and Monographs

Geometric asymptotics, V. Guillemin and S. Sternberg, reprinted 1977, 474 pp.
SURV/14WS $76 $23

Symplectic groups, O. Timothy O'Meara, reprinted 1982, 122 pp.
SURV/16WS $47 $14

Partially ordered abelian groups with interpolation, Kenneth R. Goodearl, 1986, 336 pp.
SURV/20WS $82 $25

Basic hypergeometric series and applications, Nathan J. Fine, reprinted 1989, 124 pp.
SURV/27WS $47 $14

Selected Tables in Mathematical Statistics

Five sets of tables. Tables of the cumulative noncentral chi-square distribution, G. E. Hayman, Z. Govindarajulu, and F. C. Leone; **Tables of the exact sampling distribution of the two-sample Kolmogorov-Smirnov criterion D_{mn} ($m \leq n$)**, P. J. Kim and R. I. Jennrich; **Critical values and probability levels for the Wilcoxon rank sum test and the Wilcoxon signed rank test**, F. Wilcoxon, S. K. Katti, and R. A. Wilcox; **The null distribution of the first three product-moment statistics for exponential, half-gamma, and normal scores**, P.A.W. Lewis and A. S. Goodman; **Tables to facilitate the use of orthogonal polynomials for two types of error structures**, K. B. Stewart, reprinted 1973, 403 pp.
TABLES/1WS $34 $10

Four sets of tables. Probability integral of the doubly noncentral *t*-distribution with degrees of freedom *n* and noncentrality parameters δ and λ, W. G. Bulgren; **Doubly noncentral *F* distribution–Tables and applications**, M. L. Tiku; **Tables of expected sample size for curtailed fixed sample size tests of a Bernoulli parameter**, C. R. Blyth and D. Hutchinson; **Zonal polynomials of order 1 through 12**, A. M. Parkhurst and A. T. James, 1974, 388 pp.
TABLES/2WS $40 $12

The distribution of the size of the maximum cluster of points on a line, Norman D. Neff and Joseph I. Naus, 1980, 207 pp.
TABLES/6WS $26 $8

The product of two normally distributed random variables, William Q. Meeker, Jr., Larry W. Cornwell, and Leo A. Aroian, 1981, 256 pp.
TABLES/7WS $33 $10

AMS Translations—Series 2

Eleven papers on analysis, 1963, 412 pp.
TRANS2/34WS $43 $13

Nine papers on logic and group theory, 1967, 256 pp.
TRANS2/64WS $45 $14

Sixteen papers on number theory and algebra, 1969, 264 pp.
TRANS2/82WS $47 $14

Twelve papers on algebra, algebraic geometry, and topology, 1969, 275 pp.
TRANS2/84WS $48 $14

Sixteen papers on logic and algebra, 1970, 276 pp.
TRANS2/94WS $43 $13

Ten papers on algebra and functional analysis, 1970, 254 pp.
TRANS2/96WS $42 $13

Five papers on logic and foundations, 1971, 288 pp.
TRANS2/98WS $47 $14

Five papers on logic and foundations, 1972, 275 pp.
TRANS2/99WS $43 $13

Six papers in analysis, 1973, 250 pp.
TRANS2/101WS $57 $17

Ten papers in analysis, 1973, 252 pp.
TRANS2/102WS $56 $17

Some problems of mathematics and mechanics, 1976, 265 pp.
TRANS2/104WS $72 $22

Twelve papers in logic and algebra, 1979, 250 pp.
TRANS2/113WS $47 $14

Twelve papers in analysis, I. S. Belov, È. R. Cekanovskiĭ, E. M. Dyn'kin, V. M. Faĭvyševskiĭ, V. P. Gluško, G. M. Henkin, S. V. Hrušč̆ev, M. M. Malamud, B. S. Mitjagin, T. V. Paškova,

Code	List	Sale

B. S. Pavlov, M. A. Pekker, O. M. Smeljanskiĭ, A. E. Tumanov, and S. A. Vinogradov, 1980, 202 pp.
TRANS2/115WS $55 $17

Sixteen papers on differential equations, Ju. V. Egorov, A. V. Fursikov, D. M. Galin, Ju. S. Il'jašenko, T. F. Kalugina, V. Ju. Kiselev, A. I. Komeč, A. A. Lokšin, N. O. Maksimova, O. A. Oleĭnik, V. M. Petkov, P. R. Popivanov, E. V. Radkevič, C. V. Rangelov, D. A. Silaev, A. N. Šošitaĭsvili, M. A. Šubin, A. I. Suslov, and M. I. Višik, 1982, 339 pp.
TRANS2/118WS $97 $29

Twelve papers in algebra, V. A. Dem'janenko, A. I. Mal'cev, A. Ju. Ol'šanskiĭ, S. A. Ovsienko, B. I. Plotkin, A. V. Roĭter, B. M. Šain, Hsieh Shengkang, A. I. Širšov, I. S. Slavutskiĭ, A. A. Šmelev, and Wang Yuan, 1983, 139 pp.
TRANS2/119WS $43 $13

Code	List	Sale

Four papers on ordinary differential equations, M. G. Kreĭn and V. A. Jakubovic, 1983, 168 pp.
TRANS2/120WS $47 $14

Tukey Citation Index

Volume 1: The Statistics CumIndex, James L. Dolby and John W. Tukey, 1973, 498 pp.
TUKEY/1WS $55 $17

Volume 2: Index to Statistics and Probability: The Citation Index, John W. Tukey, 1973, 1269 pp.
TUKEY/2WS $124 $37

Volumes 3 and 4: Index to Statistics and Probability: Permuted Titles, Ian C. Ross and John W. Tukey, 1975, 2384 pp.
TUKEY/3/4WS $141 $42

Code	List	Sale

Volume 5: Index to Statistics and Probability: Locations and Authors, Ian C. Ross and John W. Tukey, 1973, 1092 pp.
TUKEY/5WS $111 $33

Volume 7: The Library and Information Science CumIndex, Frederick G. Kilgour, 1973, 722 pp.
TUKEY/7WS $61 $18

Vestnik of the Leningrad University (Mathematics) Journal

Volumes 1–16 (1974–1984), per volume
VEST/1, 2, 3, 4, 5, 6, 7, 8, 16/WS $237 $71

Hurry, Sale Ends July 16, 1992!

Send VISA and MasterCard orders to:
American Mathematical Society
P.O. Box 6248
Providence, RI 02940-6248

Send orders with remittance to:
American Mathematical Society
Annex Station, P.O. Box 1571
Providence, RI 02901-1571

Charge by phone in the U.S. and Canada
800-321-4AMS (321-4267)
Please specify Warehouse Sale to ensure proper discount.

❑ Check enclosed ❑ VISA ❑ MasterCard

Ordered by: _____

Mail to (if different) _____

Card Number _____

Expiration Date _____

Signature _____

Customer code: _____

Order Code	Sale Price	Qty.	Item Total	Order Code	Sale Price	Qty.	Item Total

All orders must be prepaid. Canada residents, please add 7% GST. Free shipment by surface. For air delivery, please add $6.50 per title. Discount applies only to the books on the previous pages. DIRECT SALES ONLY. NOT AVAILABLE TO BOOKSTORES OR AGENTS. Orders must be sent on this Warehouse Sale form (or facsimile).

WS

Book Total	
Air Delivery	
Total	

AMS Reports and Communications

Recent Appointments

Committee members' terms of office on standing committees expire on January 31 following the year given in parentheses following their names, unless otherwise specified.

The following have been discharged by the Council with thanks: ad hoc *Sigma Xi Committee* and the *Committee on Cooperative Symposia.*

John B. Friedlander (1994) and James B. Serrin (1994) have been appointed to the *Progress in Mathematics Committee* by President Michael Artin. Continuing members of the committee are Hyman Bass (1992), chair, Peter W. K. Li (1993), and Haynes R. Miller (1993).

Joseph L. Taylor has been appointed chair of the ad hoc *Committee on Prizes and Awards* by President Michael Artin. Continuing members of the committee are Joan S. Birman, Frederick W. Gehring, Ronald L. Graham, Joseph J. Kohn, and Gian Carlo Rota.

The Council Meeting in Tampa

The Council of the American Mathematical Society met at 7:00 p.m. on Thursday, 21 March 1991, in the Board Room of the Holiday Inn, Busch Gardens, Tampa, Florida. President Artin presided. There were 18 members present.

The main business of the spring meeting of the Council is to receive the report of its Nominating Committee and to make nominations for the elections that are to take place in the fall.

The Council made the following nominations:

For election to the position of President-Elect: Ronald L. Graham and Stephen Smale.

For election to the position of Vice-President: Avner Friedman, Linda Keen, and Robert Osserman.

For election to the position of Member-at-Large of the Council: Ruth M. Charney, Carl C. Cowan, Jacob Eli Goodman, Alfred W. Hales, Rebecca A. Herb, Joshua A. Leslie, Elliott H. Lieb, De Witt L. Sumners, and Gunther A. Uhlmann.

For election to the position of Trustee: Maria M. Klawe and Charles C. Sims.

The Council heard the Annual Report from the Executive Director, William H. Jaco, and Ramesh Gangolli reported to the Council on the activities of the Strategic Planning Task Force. President Artin announced that he had asked the Committee on Committees to study the committee structure of the Society in order to rationalize that part of the governance of the Society.

The Council considered a report from its ad hoc Committee on Relations with Russian Mathematicians. There were two resolutions contained in this report which were accepted by the Council.

> This Council establishes a standing committee to consider current problems in mathematical life and mathematical institutions in Eastern Europe. The committee would be concerned both with discrimination issues particular to Eastern Europe and with studying whether to engage in cooperative ventures.

> The Council accepts in principle the recommendation to establish an AMS Library/Resource Room in the Soviet Union and asks the Executive Committee to recommend to the Council when and where, with the understanding that AMS cooperation with this activity shall continue only as long as access to and use of the facility is provided on a completely non-discriminatory basis.

Both resolutions were passed by the Council.

Finally, the Council passed the following resolution:

> The Council of the AMS requests a report from the Executive Director, to be delivered at the August 91 Council meeting, on the implementation of the policies decided by the membership in the January 1988 referendum.

As usual, the Council discussed the job crisis for young people in mathematics before adjourning at about 11 p.m.

Robert M. Fossum
Secretary
Urbana, Illinois

The Business Meeting in Orono

The Business Meeting of 8 August 1991 began about 12:25 p.m. President Artin presided.

The Secretary presented a brief report on the meeting of the Council that had taken place on 7 August 1991 (and reported on previous to this report).

The meeting adjourned at about 12:45 p.m.

Robert M. Fossum
Secretary
Urbana, Illinois

The Council Meeting in Orono

The Council of the American Mathematical Society met at 2:00 p.m. on Tuesday, 7 August 1991, at the Black Bear Inn, Orono, Maine. President Artin presided. There were 20 members present.

The Executive Director (ED) reported on the implementation of the policies adopted by the membership in the January 1988 referendum. In the report, the ED recalled the statements of the resolutions. He then went on to say:

"Most of the AMS effort of direct advocacy for mathematics research has been conducted in coordination with the Office of Governmental and Public Affairs (OGPA) of the Joint Policy Board for Mathematics (JPBM). Recently, JPBM has been restructured to have, in addition to the three representatives from each of the three participating organizations, a tenth member to serve as Chair of JPBM. This structure is hoped to bring to JPBM more efficient organization and to allow for continuity and more sustained efforts on behalf of JPBM and its oversight of OGPA.

"Since 1988, OGPA has undergone changes of directors, having had two directors and an acting director. Currently, OGPA is without a director. However, there continue to be major efforts on behalf of the public awareness/information activity of JPBM to promote the value of mathematics research and its importance to applications of mathematics and to mathematics education. In addition, OGPA now has a full-time staff person acting as a liaison with the legislative branch of government. This activity has been primarily a channel for information, both to and from the legislative branch of government. Through this activity, the Presidents of the JPBM participating organizations have provided written testimony for support of National Science Foundation (NSF) funding. The public information and legislative activities of JPBM/OGPA have been funded to continue through June 1992 and are being supervised by the Chair of JPBM. Liaison with the legislative branch of government is continuing in cooperation with the activities of OGPA.

"Direct liaisons have been established with certain boards in Washington in order to keep the Society informed and to have channels for communication. The AMS has arranged with the Board on Mathematical Sciences (BMS) and the Mathematical Sciences Education Board (MSEB) to have AMS representation at the BMS and the MSEB meetings. Conversely, both of these organizations will have representatives at Executive Committee and Board of Trustees (ECBT) meetings to report to the Society. A representative of the AMS attends (and often participates at) meetings of the Advisory Board of the Division of Mathematics at the NSF. Representatives of the AMS meet with principals of the DAVID II Report to discuss possible AMS activities that could be taken to assist in attaining the recommendations of the DAVID II Report. These discussions are continuing.

"The AMS, through its representatives, participates in two major groups that advocate support for mathematics research. One is the Council of Scientific Society Presidents (CSSP). This group monitors administrative actions and legislation that might affect the science community. They work with representatives from federal agencies and with legislative staff, offering advice and advocating for science. The President of the Society is the AMS representative and this contact has been valuable and in keeping with the spirit of the 1988 Referendum. The other group is the Coalition for National Science Funding (CNSF). This is a coalition of a number of professional organizations and other organizations that work to sustain federal support of science and engineering. They particularly advocate for support of the NSF budget and its doubling over the near term. The math community is represented on the board of directors of CNSF and the President has provided written testimony on behalf of mathematics through this group's efforts.

"In addition to serving as an advocate for increased support for mathematics research, the AMS seeks federal, corporate, foundation, and private funding for activities it undertakes in support of mathematics research. Federal funding is obtained for support of the AMS Summer Research Conferences, Summer Institutes, Summer Seminars, and Symposia on Mathematical Biology. In addition, federal funds have been provided for support of e-MATH, travel to international conferences, and support of mathematicians in developing countries. Through recent efforts of the new AMS Development Office, corporate and private foundation funds have been received for support of Society activities. The new Development Office is a major step in the Society's efforts to increase funding for support of mathematics research. Increased development activity is expected.

"A report has recently been delivered to the Society by its Strategic Planning Task Force (SPTF). This report recommends a strategic direction for the Society and a number of goals that the Society should attain over the next 3–5 years. One such goal is to "articulate and advocate an agenda that promotes the vitality and quality of mathematics and its development through mathematics research." Flowing from this goal will be various objectives and strategies that will provide the Society with an action plan designed to increase the fraction of nonmilitary funding for mathematics research and increase total research support."

Ex-President Browder also reported to the Council on this issue. His remarks were:

"This report is in response to the request of the Council for a report on the effects of the referenda, and the actions taken by the officers of the Society in response to them.

"The first referendum called for inaction (with respect to solicitation for "star wars" research) and the inaction called for has been carried out. No officers of the Society have been involved in soliciting funds for research on "star wars" projects.

"The second referendum asserted possible deleterious effects of military funding of research and asked the officers to work toward increasing the nonmilitary fraction of mathematical research funding, as well as increasing the total funding available.

"Representations have been made to increase NSF funding of mathematics in personal contacts between officers of the Society and of NSF. The AMS has joined the Coalition for National Science Funding, a broad based organiza-

tion which advocates increased NSF appropriations from Congress. Lisa Thompson of the OGPA sits on the board of directors, representing JPBM. Such an increase of NSF funding might tend to increase the non-DOD fraction of math research funding, unless of course, the DOD support of mathematics increased faster.

"In Spring 1990, an ad hoc consortium, including ACM, IEEE, APS, and others was formed, to advocate the channeling of funds liberated from military projects by the end of the Cold War, into supporting scientific research, (the "peace dividend"). The AMS participated in the initial meeting of this group, and Ed Connors became a member of the steering committee. The onset of the Gulf Crisis two months later sent this project into suspended animation. However, it is not clear how the activities of this group might have agreed with the "fraction" goal of referendum 2, if the political process had produced more funds for basic research inside the military agencies.

"In fact, appropriations and funding decisions in DOD and non-DOD areas are made by different agencies and by different committees of Congress. The budget agreement in Congress in Fall 1990 stipulates that for the next few years funds saved in defense cannot be shifted to nondefense areas, funds saved in each category can only be used to reduce the deficit.

"On the agency level, the mathematical research program officers work to convince their superiors of the value of mathematical research for these agencies, and to increase mathematics' share of the budget.

"There is a perception that some of the program officers in the DOD agencies have felt that their jobs have been made more difficult by Referendum 2 and that their work was unappreciated and rejected by the membership of the AMS. There seemed to be a noticeable coldness in relations between AMS and many of these program officers after the referenda were adopted.

"A similar unhappiness was manifested among a substantial number of AMS members, mostly members of SIAM, who felt personally offended by Referendum 2, and resigned from the AMS in protest.

"Some bafflement was expressed also by high officials of NSF, that it seemed as though AMS was rejecting the military agencies' participation in carrying out the recommendations of the first David Report to increase mathematical research funding, and AMS expected NSF to carry the burden alone.

"Referenda 3–5, being directed to the outside world, enunciating generally agreed on goals, will not be discussed here."

Among other items of information received by the Council were several involving Society activities with regard to Eastern European and Soviet Union mathematicians. The Committee on Science Policy (CSP) had recommended appointment of an ad hoc committee to investigate issues associated with needed assistance in the Eastern European and Soviet Union mathematical sciences community. Appointment of this Committee was delayed until the report of the ad hoc Committee on Relations with Russian Mathematicians was delivered. That report was presented to the March 1991 Council.

Professor Deborah Haimo, President of the Mathematical Association of America (MAA), reported to the Council on activities of MAA and joint activities that were of interest to the Council.

The Council noted the founding of the European Mathematical Society (EMS) bypassing the following resolution:

"The Council of the American Mathematical Society sends congratulations to the European Mathematical Society on the occasion of its founding on 29 October 1990. The Council is pleased to note that the aims of the European Mathematical Society are very close to those of the AMS. It looks forward to cooperation with the EMS in activities within the mathematical sciences that will further these aims."

And it noted that the African Mathematical Union was sponsoring the Third Pan-African Congress in August 1991 by passing the following resolution:

"The Council of the American Mathematical Society sends congratulations to the Third Pan-African Congress of the African Mathematical Union to be held in Nairobi in August 1991. The Council is pleased that an officer of the Society can deliver these greetings personally. It looks forward to future cooperation with the Union in furthering the mathematical sciences."

The Council agreed to the establishment of a series called *Mathematical World* to be copublished with MAA. While the series is being dominated by translations from Russian, the subcommittee of the Russian Translation Committee will remain as editors, representing AMS. MAA will select two editors to make a total editorial committee of four.

The Council discussed the significant backlog of the *Transactions*, but took no action while it awaited results of further discussions and analysis of the problem. It did pass the following resolution concerning backlog:

"This Council recommends to the ECBT that each journal should publish in its "information to authors" page a definition of backlog and a report of the backlog as that issue went to press. In addition, the backlogs of the AMS journals should be regularly published in the *Notices*."

The Council approved a restructuring of the Proceedings Editorial Committee. There is a small number of coordinating editors who comprise the Proceedings Editorial Committee. In turn, there is a larger number of associate editors who are appointed by the Editorial Boards Committee. These individuals will still be listed as editors on the masthead of the journal.

The Council approved several appointments to various editorial boards. These appointments have been noted in the *Notices*. It also approved the Nominating Committee's recommendations for appointment to the Committee to Monitor Problems in Communications.

It then considered the report of the Strategic Planning Task Force. The Executive Committee and Board of Trustees had asked the Council to discuss the report and to act on the statement of mission. Members of the Council did discuss the report. Trustee Paul Sally was granted the privilege of

the floor to announce that, contrary to published statements, the SPTF report was not unanimously endorsed by the ECBT but that in fact he had abstained during the vote on endorsement. Sally wished that his abstention be put on the record. As the report of the SPTF has appeared in the *Notices*, it will not be discussed here.

The current Mission Statement, found in the Society's Articles of Incorporation (1923), reads as follows:

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

The SPTF Report recommended a revised version of the Mission Statement. The statement was endorsed by the ECBT and recommended for adoption by the Council. The Council amended the SPTF statement slightly and adopted the following resolution:

> "The Council of the American Mathematical Society adopts the following statement of mission:
>
> "The AMS, founded in 1888 to further the interests of mathematical research and scholarship, serves the national and international community through its publications, meetings, advocacy, and other programs, which
>
> • promote mathematical research, its communication and uses,
>
> • encourage and promote the transmission of mathematical understanding and skills,
>
> • 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."

Several committee reports were received by the Council. The Council then turned its attention to the method by which working officers of the Society are to be appointed. It adopted the following method:

> "A standing committee of the EC and BT, to be called the ECBT Nominating Committee, will be created. It would consist of the fifth-year elected member of the BT, the fourth-year and second-year elected members of the EC, and the Chair of the Council's Nominating Committee. The Executive Director would be a non-voting member of the Committee.
>
> "1. Associate Secretaries: This Committee would evaluate current Associate Secretaries and receive recommendations for this position. It would report on its recommendations to the May ECBT for forwarding to the August Council meeting in the year when the term expires. When it is expected that a sitting Associate Secretary will not serve again, this Committee should attempt to nominate a replacement at least one year in advance of the end of the term so that the replacement can serve a break-in period of about one year. This Committee should consult the Secretary concerning these appointments.
>
> "2. Associate Treasurer: When considering the Associate Treasurer position, the Committee is augmented by the Treasurer. This Committee would evaluate the current Associate Treasurer and receive recommendations for this position. It would report on its recommendations to the May ECBT for forwarding to the August Council meeting in the year when the term of office expires. When it is expected that a sitting Associate Treasurer will not serve again, this Committee should attempt to nominate a replacement at least one year in advance of the end of the term so that the replacement can serve a break-in period of about one year. This Committee should consult the Secretary concerning this appointment.
>
> "3. Secretary: When considering the Secretary, this Committee is augmented by the Treasurer. This Committee would evaluate the current Secretary and receive recommendations for this position. It would report on its recommendations to the May ECBT for forwarding to the August Council meeting. When it is expected that a sitting Secretary will not serve again, this Committee should attempt to nominate a replacement at least one year in advance of the end of the term so that the replacement can serve a break-in period of about one year. This Committee should consult the President concerning this appointment.
>
> "4. Treasurer: When considering the Treasurer, this Committee is augmented by the Secretary. This Committee would evaluate the current Treasurer and receive recommendations for this position. It would report on its recommendations to the May ECBT for forwarding to the August Council meeting. When it is expected that a sitting Treasurer will not serve again, this Committee should attempt to nominate a replacement at least one year in advance of the end of the term so that the replacement can serve a break-in period of about one year. This Committee should consult the Associate Treasurer concerning this appointment.
>
> "When considering the report and making further recommendations to the Council the EC and BT will consist of one Committee and voting will be by majority (i.e., the EC and BT will together form the nominating committee for these positions)."

The Council approved a revision in its policy regarding petition tables at

sectional meetings so that petition tables will be made available at sectional meetings as the need arises.

The Council gave unanimous consent to consider a resolution proposed by the Society's Committee on Human Rights of Mathematicians concerning the closing of Birzeit University in the West Bank. The resolution was tabled by the Council.

The Council adjourned at about 6:30 p.m.

Robert M. Fossum
Secretary
Urbana, Illinois

The Business Meeting in Baltimore

The Business Meeting of 9 January 1992 began about 4:25 p.m. President Artin presided.

Before the meeting was called to order, the floor was given to Vice-President Blum who reported that the Council had approved publishing an open letter to I. R. Shafarevich along with signatures as an advertisement in the *Notices*. (This complimentary advertisement appeared on page 264 of the March 1992 issue of the *Notices*.) She read the open letter and notified the membership that it was still possible to add signatures to the letter.

The Secretary announced the results of the election of 1991. These have been published on page 152 of the February 1992 issue of the *Notices*.

The Secretary presented a brief report on the meeting of the Council that had taken place on 7 January 1992.

A motion for the Business meeting proposing a Resolution on Departmental Examinations, proposed by Robert O. Stanton, that had been submitted to the Committee on the Agenda for Business Meetings, was presented at the meeting. The resolution reads as follows:

A Resolution on Departmental Examinations

Whereas:

(1) Departmental examinations can discourage innovative teaching techniques and impede advances in education.

(2) Students for whom English is a second language are frequently put at an unfair disadvantage because of unfamiliar phrasing of the questions on a departmental examination.

(3) Because of different emphases, levels of preparation, styles of instruction, etc., departmental examinations do not fulfill the goal of a uniform measure of ability for different sections of the same course.

(4) Any individual who is regarded as sufficiently competent to be entrusted with the day-to-day teaching of a course should a fortiori be considered capable of creating appropriate examinations and grading systems.

Be it resolved that:

the American Mathematical Society considers it a principle of academic freedom that all individuals teaching university mathematics courses shall have the right to prepare their own examinations and to set their own grading scales.

The Committee on the Agenda for Business Meetings proposed that the resolution be referred to the Society's Committee on Education. This motion passed and the resolution has been forwarded to the Committee on Education.

The meeting adjourned at about 5:15 p.m.

Robert M. Fossum
Secretary
Urbana, Illinois

The Council Meeting in Baltimore

The Council of the American Mathematical Society met at 2:00 p.m. on Tuesday, 14 January 1992, in the Yosemite Room C of the San Francisco Hilton on Hilton Square, San Francisco, CA. President Browder presided. There were 32 members present.

After the results of the 1991 Election were announced and the Council thanked those members who were attending their last Council meeting, the Executive Director, William Jaco, made remarks on the Society's Operational Plan. President Artin commented on the activities of the Joint Policy Board for Mathematics' Committee on Professional Recognition and Rewards and the pilot Assessment of the Mathematical Sciences prepared for the House Committee on Science, Space, and Technology. (This pilot assessment appears in the February 1992 issue of the *Notices*.)

The Council approved participation of the Institute for Mathematical Statistics in the Annual Survey and concomitant membership on the AMS-MAA Data Committee.

Reports from many committees were received. Appointments to several editorial committees were made. The Council reappointed R. Andy Magid and Lance Small to two-year terms as Associate Secretaries, the terms to begin on 1 February 1992. It appointed Robert Daverman and Lesley Sibner to two-year terms as Associate Secretaries, these terms to begin on 1 February 1993. And it appointed B. A. Taylor to a two-year term as Associate Treasurer, the term beginning on 1 February 1993.

The Council approved the establishment of an AMS-MAA Joint Archives Committee and it approved a standing Committee on Electronic Publication with the charge to include responsibility for oversight of the scientific scope and content of e-MATH, examination with staff and the Executive Committee and Board of Trustees of ways in which the Society can best stay abreast of developments in the area of electronic publication, and study of those features which might best serve the profession.

A resolution concerning Birzeit University in the West Bank Submitted by the Committee on Human Rights of Mathematicians failed to gain a majority.

A resolution asking that an objective "to strive to increase the component of support coming from nonmilitary sources" be added to the report of the Strategic Planning Task Force was tabled.

After hearing from Vice-President Blum about the Third Pan-African

Congress, the Council agreed to encourage the AMS to pursue cooperative projects with the African Mathematical Union, and it directed the Long Range Planning Committee to study relations with the international mathematical community.

The Council then considered a motion to instruct the *Notices* Editorial Committee (NEC) to publish an open letter to Shaferevich. This motion was substituted by the last section, amended, of the report of an ad hoc committee that had been appointed by the President to consider publication of the letter. This section reads as follows:

"III. Recommendations. This committee feels that there are very valid concerns raised by the [Kra/Blum] letter. We think that these concerns would be best served by a factual, reasoned, and hopefully impartial article on the subject, written by someone who knows the details.

"As an additional compromise, the Committee recommends that the letter and its list of signatories be published as an unpaid advertisement in the *Notices* as soon as possible.

"If (now or at a future time) the NEC feels it appropriate, this committee will concur with the publication in the *Notices* of this quote from our report: "this ad hoc committee believes that NEC acted thoughtfully and responsibly in its decision not to publish the letter and that this decision was made in accord with NEC's editorial policies," provided there is also included a statement like the first sentence of these Recommendations.

"We consider this an unusual event, and do not propose that our recommendations be construed as setting any general policy."

This motion was then passed by the Council.

The Council considered general policy concerning letters to the editor published in the *Notices*. It then passed the following resolution:

> "The existence of political or social content is, in itself, not sufficient reason to reject a letter submitted for publication in the *Notices*."

Sylvia Wiegand, chair of the subcommittee of the Committee on Committees that is considering the structure of committees of the Society, discussed the progress-to-date of the committee. Her remarks were preceded by comments from President Artin.

The motion by the Secretary to conduct elections to the Nominating Committee and the Editorial Boards Committee by the method of approval voting was passed. Elections to these committees will be conducted by the approval method in the future.

It was noted that Ed Connors, who served as Director of OGPA since 1 July 1990, left at the end of his term on 30 June 1991. Richard Herman has replaced him as Director of OGPA. In addition, Herman has been elected as Chair of JPBM.

The Council adjourned at about 7 p.m.

Robert M. Fossum
Secretary
Urbana, Illinois

Miscellaneous

Personals

Alexander V. Arhangelskii, of Moscow State University, has accepted the position of Professor of Mathematics at Ohio University starting with the 1992–1993 academic year. He will teach winter and spring quarters and maintain his position at Moscow State University.

Dušan Repovš, of the University of Ljubljana, has been appointed Research Dean of the Faculty of Education at that institution.

Deaths

Leon W. Cohen, Professor Emeritus of the University of Maryland, died on February 21, 1992, at the age of 88. He was a member of the Society for 67 years.

Lawrence J. Corwin, of Rutgers University, died on March 19, 1992, at the age of 49. He was a member of the Society for 26 years. (See the News and Announcements section, p. 447.)

Sammy Daghir, a teaching fellow at SUNY at Albany, died in October 1991, at the age of 26. He was a member of the Society for 3 years.

Mahlon M. Day, Professor Emeritus of the University of Illinois, died on March 18, 1992, at the age of 79. He was a member of the Society for 54 years.

Piero L. de Mottoni, of the University of Rome, died on November 25, 1990, at the age of 47. He was a member of the Society for 12 years.

Rene De Vogelaere, of the University of California, Berkeley, died on December 14, 1991, at the age of 65. He was a member of the Society for 21 years.

Ralph M. Ford, of Auburn University, died on December 6, 1991. He was a member of the Society for 5 years.

Lawrence F. Guseman, Jr., of Texas A&M University, died on November 5, 1991, at the age of 53. He was a member of the Society for 24 years.

Ben Johnson, of Ft. Mohave, Arizona, died on December 19, 1991, at the age of 72. He was a member of the Society for 28 years.

Joseph D. E. Konhauser, of Macalester College, died on February 28, 1992, at the age of 67. He was a member of the Society for 42 years.

Jurgen Kraft, of the University of Puerto Rico, died on January 18, 1992, at the age of 38. He was a member of the Society for 11 years.

Kenneth D. Lerche, of Ellicott City, Maryland, died on July 8, 1991, at the age of 54. He was a member of the Society for 30 years.

Deane Montgomery, Professor Emeritus at the Institute for Advanced Study, died on March 15, 1992, at the age of 92. He was a member of the Society for 59 years and was President in 1961 and 1962. A tribute to Professor Montgomery is being prepared and will be appearing in a future issue of the *Notices*.

William Nelson, of the Mitre Corporation, died on April 12, 1992, at the age of 54. He was a member of the Society for 25 years.

Kaj L. Nielsen, Professor Emeritus of Butler University, died on February 21, 1992, at the age of 77. He was a member of the Society for 53 years.

John T. O'Bryan, of the Rose-Hulman Institute of Technology, died on December 18, 1991, at the age of 21. He was a member of the Society for 1 year.

Mary K. Peabody, of North Manchester, Indiana, died on December 20, 1991, at the age of 74. She was a member of the Society for 49 years.

Richard S. Pierce, a Professor Emeritus from Tucson, Arizona, died on March 15, 1992, at the age of 65. He was a member of the Society for 41 years.

William R. Scott, a Professor Emeritus from Salt Lake City, Utah, died on February 15, 1992, at the age of 72. He was a member of the Society for 52 years.

Jan Tryba, of the University of Gdansk, died on January 27, 1992, at the age of 35. He was a member of the Society for 4 years.

Hubertus J. Weinitschke, of the University of Erlangen-Nurnberg, died on December 5, 1991, at the age of 72. He was a member of the Society for 33 years.

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
Chan, Tony (U.S.A.)	Chinese University of Hong Kong	Applied Mathematics	9/92 - 6/93
Chen, S. Y. (U.S.A.)	Chinese University of Hong Kong	Differential Geometry	9/92 - 6/93
Dennis, Stanley C.R. (Canada)	Laboratoire de Méchanique des Fluides, France	Flow of Fluids	5/92- 9/92
Greene, Robert (U.S.A.)	Danish Technical University, Denmark	Differential Geometry	9/92 - 12/92
Hahn, Alexander (U.S.A.)	University of Innsbruck, Austria	Algebra	8/92 - 5/93
Mattson, H.F., Jr. (U.S.A.)	INRIA Rocquencourt	Discrete Mathematics	4/92 - 7/92
Pierce, Donald A. (U.S.A.)	Radiation Effects Research Foundation, Japan	Cancer Research and Mathematical Statistics	9/92 - 9/93
Pillay, Anand (U.S.A.)	University of Freiburg, Germany	Logic	8/92 - 1/93
Protter, Philip (U.S.A.)	University of Paris VI, France	Stochastic Analysis	5/93 - 7/93
Rogawski, Jonathan (U.S.A.)	Hebrew University of Jerusalem, Israel	Number Theory	9/92 - 6/93
Sommese, Andrew (U.S.A.)	University of Bayreuth, Germany; Max Planck Institute, Germany	Algebraic Geometry	9/92 - 10/92
Takesaki, Masamichi (U.S.A.)	University of Tokyo, Japan	Operator Algebras	9/92 - 12/92

Visiting Foreign Mathematicians

Abramovici, Flavian (Israel)	University of Calgary	Geophysics	7/92 - 6/93
Aleman, Alexandru (Germany)	University of Tennessee	Complex analysis/Operator Theory	8/92 - 12/92
Badr, Hassan (Saudi Arabia)	University of Western Ontario	Flow of Fluids	11/91 - 8/92
Baik, Seung Il (Korea)	Memphis State University	Boolean Algebra and Theory of Semi-rings	1/92 - 1/93
Bakir, Saad (Jordan)	Virginia Polytechnic Institute and State University	Quality Control	7/92 - 9/92
Barbu, Viorel (Romania)	Ohio University	Differential Equations	1/93 - 6/93
Bolondi, Giorgio (Italy)	University of Notre Dame	Algebraic Geometry	8/92 - 1/93
Castillo, Rafael Rene del Rio (Mexico)	University of Tennessee	Differential Equations	8/92 - 12/92
Cho, Yong Hwan (Korea)	University of Missouri-Columbia	Dynamical Systems	8/92 - 8/93
Cushman, Richard (The Netherlands)	University of Calgary	Hamiltonian Systems	5/92 - 8/92
Dancer, Edward N. (Australia)	Brigham Young University	Partial Differential Equations	9/92 - 12/92
Elsner, Ludwig (Germany)	University of Calgary	Matrix Theory	8/92
Exel, Ruy (Brazil)	University of New Mexico	Operator Algebras	8/92 - 6/93
Ezhov, Vladimir (Russia)	Oklahoma State University	Several Complex Variables	8/92 - 5/94
Feldvoss, Jorg (Germany)	University of Wisconsin-Milwaukee	Representation Theory	8/92 - 12/92
Feng, Keqin (China)	Université Laval	Number Theory	1/92 - 8/92
Franca, Leopoldo (Brazil)	Purdue University	Applied Mathematics	1/93 - 5/93
Galeeva, Roza (Russia)	University of Wisconsin-Milwaukee	Dynamical Systems	8/92 - 12/92

Name and Home Country	Host Institution	Field of Special Interest	Period of Visit
Guofang, Wei (China)	University of California, Santa Barbara	Differential Geometry	7/92 - 7/94
Gupta, Ramesh Chandra (Singapore)	Memphis State University	Fluid Flows	7/92 - 7/93
Heintze, Ernst Friedrich (Germany)	University of Notre Dame	Differential Geometry	8/92 - 2/93
Henderson, LeRoy (Australia)	State University of New York at Stony Brook	High Speed Aero-Dynamics	9/91 - 7/92
Herzog, Jurgen (Germany)	Purdue University	Commutative Algebra	1/93 - 5/93
Hess, Peter (Switzerland)	Brigham Young University	Partial Differential Equations	9/92 - 12/92
Isaza, Pedro (Columbia)	Syracuse University	Partial Differential Equations	5/92 - 9/92
Kang, Soon Ja (Korea)	Louisiana State University	Probability Theory	1/92 - 12/92
Kapitanskii, Lev (Russia)	Brown University	Differential Equations	9/92 - 7/93
Kawamura, K. (Japan)	University of Saskatchewan	Topology	9/92 - 8/93
Kim, Hee Sik (Korea)	University of Alabama	Partially Ordered Sets, Semirings	12/91 - 12/92
Kim, Seon Jeong (Korea)	Louisiana State University	Algebraic Geometry	1/92 - 12/92
Knarr, Norbert (Germany)	University of Notre Dame	Differential Geometry, Finite Group Theory	8/92 - 5/93
Koyama, A.	University of Saskatchewan	Topology	5/92 - 8/92
Kucery, Radan (Czéchoslovakia)	Université Laval	Number Theory	10/91 - 3/93
Kurylev, Yaroslav (Ukraine)	Purdue University	Applied Mathematics	8/92 - 5/93
Ladyzhenskaya, Olga (Russia)	Case Western Reserve University	Partial Differential Equations	1/93 - 6/93
Latushkin, Yuri (Russia)	University of Missouri-Columbia	Differential Equations, Dynamical Systems	8/92 - 8/93
Lee, Youngjo (Korea)	Oregon State University	Mixed Linear Models and Mathematical Statistics	7/92 - 9/92
Leme, Paulo Paes (Brazil)	Purdue University	Applied Mathematics	8/92 - 12/92
Li, Gang (China)	State University of New York at Stony Brook	Numerical Analysis and Scientific Computing	7/91 - 7/93
Liverani, Carlangelo (Italy)	State University of New York, Stony Brook	Dynamical Systems	9/92 - 1/93
Lobb, Lawson (Australia)	University of California, Santa Barbara	Calculus, Linear Algebra	10/92
Markus, A.S. (Israel)	University of Calgary	Functional Analysis	9/92 - 10/92
Mejía Jorge (Columbia)	Syracuse University	Partial Differential Equations	5/92 - 9/92
Merklen, Hector (Brazil)	Syracuse University	Representations of Finite-Dimensional Algebras	9/92 - 12/92
Mishchenko, Aleksander (Russia)	Brown University	Topology	7/92 - 12/92
Moore, Derek, W. (England)	California Institute of Technology	Theoretical and Computational Fluid Mechanics	4/92 - 9/92
Morimoto, Mitsuo (Japan)	University of New Mexico	Functional Analysis	1/93 - 6/93
Munkholm, Hans Jorgen (Denmark)	University of Notre Dame	Topology	8/92 - 5/93
Nash-Williams, C.ST.J.A. (England)	West Virginia University	Graph Theory, Combinatorics	8/92 - 5/93
Ostrovskii, Iosif (Ukraine)	Purdue University	Complex Analysis	9/92 - 11/92
Park, Byung-Gu (Korea)	University of Wisconsin-Madison	Statistics	1/92 - 2/93
Perelman, Grigori (Russia)	State University of New York, Stony Brook	Differential Geometry	1/92 - 6/93
Pitteloud, Yves (Switzerland)	Brandeis University	Homological Algebra	9/92 - 5/93
Rolski, Tomasz (Poland)	University of North Carolina-Chapel Hill	Stochastic Processes	7/92 - 7/93

Name and Home Country	Host Institution	Field of Special Interest	Period of Visit
Sahab, Salem (Saudi Arabia)	Idaho State University	Approximation Theory	6/92 - 9/92
Saito, Kimiaki (Japan)	Louisiana State University	Probability Theory	4/92 - 4/93
Serre, Jean-Pierre (France)	Harvard University	Number Theory	9/92 - 12/92
Shi, Jian-Yi (China)	University of Notre Dame	Algebraic Groups, Representation Theory	8/92 - 5/93
Shokranian, Salahoddin (Iran/Brazil)	Purdue University	Automorphic Forms	8/92 - 12/92
Steinberg, David M. (Israel)	University of Wisconsin-Madison	Statistics	8/92 - 7/93
Szekeley, Laszlo (Hungary)	University of New Mexico	Graph Theory	8/92 - 6/93
Tafel, Jacek (Poland)	University of Calgary	Mathematical Physics	8/92 - 10/92
Tempelman, Arkady (Lithuania)	Pennsylvania State University	Probability-Ergodic Theory	7/92 - 6/93
Thandapani, E. (India)	University of Saskatchewan	Difference Equations	6/92 - 7/92
Vahidi-Asl, Mohammad Q. (Iran)	The Johns Hopkins University	Probability	9/92 – 6/93
Wang, Feng (China)	State University of New York at Stony Brook	Computational Mathematics and Applied Mathematics	7/92 - 6/93
Werner, Dirk (Germany)	University of Missouri-Columbia	Functional Analysis	1/93 - 8/93
Yan, Keren (China)	State University of New York, Stony Brook	Operator Theory	9/92 - 1/93
Yang, Yumin (China)	State University of New York at Stony Brook	Computational Fluid Dynamics	8/91 - 8/92
Zeng, Yanni (China)	Brown University	Linear Partial Differential Equations	9/92 - 7/93

New Members of the AMS

ORDINARY MEMBERS

M M Abu-Jaudeh, Saint Paul's College, Lawrenceville, VA
Mario Bonk, Braunschweig, Germany
Howard Edward Brandt, Adelphi, MD
Bela Brindza, Kossuth Lajos Univ, Debrecen, Hungary
Maurizio Carlucci, Rome, Italy
Martha Ayers Alvey Carter, Beavercreek, OH
Zhaolin Cheng, Shandong Univ, Jinan, People's Republic of China
Donna Lee Copenhafer, Brentwood, TN
Thomas G Davis, West Palm Beach, FL
Alan Davison, Altamonte Springs, FL
Christopher V Devol, Aiken, SC
Harvey Dubner, Ridgewood, NJ
Anita Louise Fagerman, West Lafayette, IN
Craig Alan Feinstein, Silver Spring, MD
Robert G Flower, Alburtis, PA
Dennis S Friday, National Institute of Standards & Technology, Boulder, CO
Zoltan Furedi, Univ of Illinois, Urbana, IL
Carl L Gardner, Duke Univ, Durham, NC
Kalpana A Godbole, Michigan Technological Univ, Houghton
Adnan M Haider, Alexandria, VA
Leonard B Hearne, Washington, DC
Lisa Claire Jeffrey, Institute for Advanced Study, Princeton, NJ
Eric S Klein, City College (CUNY), New York, NY
Alfred G Kohler, Fresh Meadows, NY
Saisankar Kolli, Univ of Louisville, KY
Alexander Kozhevnikov, Univ of Haifa, Israel
Brian Andrew LaMacchia, Cambridge, MA
Steven E Levy, Washington, DC
Edward Kirby Lewis, New York, NY
Thomas Ezra Love, Univ of Pennsylvania, Philadelphia
Joseph F Lucke, Allentown, PA
Laurence Thomas Maloney, New York Univ, NY
Joseph M Martel, Orem, UT
Isaak E Mayzlin, Providence, RI
Christine A McMillan, Univ of Virginia, Charlottesville
Wayne H Meyer, Milan, IL
John M Miller, The Woodlands, TX
David John Naples, Saint Edward's Univ, Austin, TX
David Scott Obrosky, Univ of Pittsburgh, PA
T Offermann, Honolulu, HI
Yun Peng, Johns Hopkins Univ, Baltimore, MD
Hermes Augusto Puyau, Buenos Aires, Argentina
Buddhavarapu Sailesh Ramamurtie, Georgia State Univ, Atlanta
Chris Larson Rasmussen, College Park, MD
Igor Reider, Univ of Oklahoma, Norman
Claudiu Cristian Remsing, Rhodes Univ, Grahamstown, Republic of South Africa
David L Rodgers, Mathematical Reviews, Ann Arbor, MI
Matthew David Rotelli, Blacksburg, VA
Kristin A Schleich, Univ of British Columbia, Vancouver, Canada
William A Schneeberger, Durham, NC
Margaret Seebohm, Livermore, CA
Gregory M Sobko, Santee, CA
Warren G Staley, Tucson, AZ
Yoel Steinberg, Brooklyn, NY
Andrew Peter Termena, New Carlisle, OH
Ann E Trahanovsky-Orletsky, Hampton, VA
Dietrich A Uhlenbrock, Univ of Wisconsin, Madison
Panagiotis Vezyreas, Willimantic, CT
Marlos A G Viana, Univ of Illinois at Chicago
Song Wang, Dublin, Republic of Ireland
Senny Widjaja, Corvallis, OR
Jody Stegall Williams, Atlanta, GA
Xiaohua Xing, Univ of Massachusetts, Amherst
Ming Wei Xu, Academia Sinica, Beijing, People's Republic of China
George Zweig, Los Alamos, NM

RECIPROCITY MEMBERS

Asociación Matemática Española
Delors Herbera

Deutsche Mathematiker-Vereinigung e. V.
Hans-Dietrich O F Gronau
Viktor M H Schroeder
Thomas Helmut Sonar
Manfred Tasche

Irish Mathematical Society
Gerard John Murphy
Donal P O'Donovan

Mathematical Society of Japan
Masafumi Murai

Société Mathématique Suisse
Martin Flucher

Sociedade Portuguesa de Matemática
Mohammad Rostami

Wiskundig Genootschap
Abraham Broer

NOMINEE MEMBERS

American University
Joyce B Higginbotham

Arizona State University
Weiqiang Xie

Auburn University
Edwin H Smith

Bowling Green State University
Michael Steven Dugan

Brigham Young University
Elizabeth A Newman
David LeGrande Smith
Merrill Teemant
Julie K Thompson
Tana Jo Wilson

California Polytech State University
Philip Laurence Banks
Matthew W Williams

California State University Hayward
Jane E Brecha
Yvonne Y Fok
Johnson Chua Lim
Patrick E Serpa
Cheryl L Vega

California State University Northridge
Sheri L Berger
Karen Jean Boydston
Henry Nelson Browne
Marshall Copelan
William J Drumm
Barbara J Jones
Scott Allan Kelley
Michael Jay King
Steven K Knight
Rebecca Lynn Levi
Janette M Marquand
Kobina Biney Mends
Allen Arthur Pinero
Bamdad Samii
Michael John Semenoff
Karen Lee Irvine Tait
Ilmar Arno Yitsut
Kathleen J Young

Cleveland State University
Jack Chia-Chieh Chen
Robert S Clark
Constance Jeanne Gardner
Laura Jane Urbanski

College of Charleston
Dorothea M Broome
Brenda Chapman
Marcus Cheung
Michelle L Eleazer
Douglas R Holmes
Erin K McNelis
Shannon Moore

College of William & Mary
Heather D DeSimone
Maria Sally Frances Relova
James Eric Tyson
Melissa L Young

Cornell University
Richard A Levine

Dartmouth College
Gabriele Maria Germann

Duke University
Po-Jen Cheng
Anne-Marie Filip
Joel Stephen Foisy
Kevin Bruce Foltinek
Alexandre I Kabanov
Kevin Jay Kesseler
Christopher Thomas Michael
Ioannis Vlassopoulos

East Carolina University
Charles Wavley Pearson

George Mason University
James Turtora

Grand Valley State University
Thomas Martin Kieft
Oktay Kurbanov
Joel R Meulenberg

Haverford College
Eugenie Lee Hunsicker

Hofstra University
Micheline A Schreiber

Indiana State University
Bing W Lau

Indiana-Purdue University, Fort Wayne
Joni E Davis
Sharon M Hathaway

Inst for Advanced Study
Ann S Almgren
Leticia Barchini
Max J Bezard
Gilles D Courtois
Toshiyuki Kobayashi
Jun Murakami
Page Starr
Nanhua Xi

Johns Hopkins University, Baltimore
Lowell E Abrams
Dena S Cowen
Hung Ding
Erik E Endres
Saundra G Hampson
Masanari Kida
Deborah E Moyer
Zoran Z Petrovic
Damian A Smiroldo
Lillian Sorak

Louisiana Tech University
Keith M Fletcher
Penny J Hix

Marshall University
Patricia Lynn Coulter
Kathryn J Freidel
David James French
D Shane Jonas
Mary A Sengewalt

Mathematics Sciences Res Inst
Nimish A Shah

McGill University
Sami Emmanuel Alajaji
Phuc V Bi
Mokhtar Boucheikhchoukh
Rebecca A Crabb
Hassan Daghigh
Tim R Hammond
Olga G Kharlampovich
Yin Li
Nilani Liyanage
Charles Martin
Robert Milson
Konstantinan Vasilakos
Jiabin Zhao

McMaster University
Daniel Egloff

Memphis State University
Jiannong Wang

Mississippi State University
Marion Beroujon Harris

Naval Postgraduate School
Annette P Cornett

Nicholls State University
Courtney L Adams
David A Hebert
Laura A Lavigne
Catherine L Melancon
Jennifer Austin Rodriguez
Timothy G Waldrip
Maureen D Watson

North Carolina State University
Alan Douglas Hoffler

North Georgia College
Tisha Rochell McConnell
Andy O Miller
Frank Douglas Nicoletti
Wendy Leigh Roper
Sonya E Smith

Northeastern University
Min Chen

Northern Michigan University
Katie L Davidson
Stacy Jo Sanders

Oakland University
Carol L Lang

Ohio State University, Columbus
Bogdan Bucicovschi
Yuqing Chen
Kan Yuk Andy Lau
Tony J Maric
Mark C McClure
Linghua Peng
Xiaofeng Peng
Tibor Szabo
Irina A Vaindiner
Dmitry A Vompe
Carla C van de Sande

Oregon State University
Dave Carsen Plaehn

Portland State University
Hun Bak
Yanbing Lu
James Dale McGlothin
Matei Perussi

Purdue University, Calumet
James Calabrese

SUNY at Albany
Michael D Romero

SUNY at Stony Brook
Paul David Friedman
Steven J Kraseski
James G Kuczmarski
Patrick A Lezark
Peng Lu

SUNY, College at Brockport
William Carl Frank
James Richard Gears
Christa L Miller

SUNY, College at Geneseo
Theresa Girardi
Phuonghang Thi Huynh

San Diego State University
Paul Martin Lannen

Simon Fraser University
Janez Ales
Antonio Cabal-Rodriguez
Tai-Yu Chen
Roger R Coroas
Guanghua Deng
Shahriar J Fariborz
Pavol Gvozdjak
Susan Marshall
Raphael A Okojie
Darren Stanley
Jingdong Yu

Southern Methodist University
Robert Roy Ferdinand
Randy C Taylor
Analee Witt

Southern Oregon State College
Mary Ann Agnes Eder Evia

Southwest Missouri State University
Jean M Andress
David R McWilliams
Tamara L Smithee

St Olaf College
Karen M Brown
Patrick T Haertel
Kristen E Nelson
Eric Juergen Rawdon
Robert D Rosell

Texas Christian University
Monroe B Harden

Trenton State College
Karen Consalvi

University of Akron
Doreen E Maxwell

University of Alabama-Birmingham
Margaret Shull Bierwirth
Louis Hucon Ephraim
Patresa Darlene Goode
Kiwon Kim Lee
William D McRae
Ramya Ramaswamy
Mohammed Reza Riasati

University of Arizona
Ahmad Alkhatib
Martha T Case
Cheryl L DeLorme
Mohamed Lemine El Hadrami
Hiroshi Hamada
Xiaoyong Han
Greg Holinberg
Li Liu
Kamlesh M Patel
Amy F Rabb-Liu
Chunwoo Yang

University of California, Irvine
Frank Dell Kronewitter

University of California, Los Angeles
Jonathan Foster Binkley
Alexander Frederic Brown
Daniel K Clegg
Janet Cowden
Christopher P Custer
Giulio DellaRocca
Eknath P Ghate
Angela R Granger
Michael W Hardt
Abdellah Hssaine
Myungjoo Kang
Deborah L Kilb
Jah Shiu Liu
David Richard Nowicki
Oswaldo R B Oliveira
Greg C Steele
Timothy J Surenoonk
Michael Alan Zeitzew

University of Hawaii
Son Yong Kim

University of Houston
Mary Jane Ferguson
Sarah Helen Ferguson
Lorenzo Hector Juarez
Xuewn Li
Scott F Powers
Francisco Javier Sanchez
Jurgen Kurt Singer
Cornell Leroy Wooten
Dexuan Xie
Canfang Zhai
Zhuangzhi Zhang

University of Illinois at Urbana-Champaign
Jenna Caldwell
Heng Huat Chan
Geumlan Choi
Brian Thomas Habing
Meesoon Han
Joanna Y Lee
Jennifer Ruth Martin
Scott Raymond Meeth
Steven Theodore Vahl
Kathleen Mary Vrba
Jennjung Wu
Mingqing Xiao
Taeil Yi

University of Kansas
Michael Davidson

University of Laval
Youssef ElFrom
Mohammed Elhakimi
Francois Grondin

Osvaldo Pio Hossian

University of Maryland, College Park
Paul Robert Harris
Georgia A Martin
David Austin Pierce
Valentino Zocca

University of Michigan
Charles A Pehlivanian

University of Missouri, Columbia
Wilhelm Michael Sticka

University of Montana
Nikki Rochelle Ash
Chunyu Chai
Roslyn Marie Denny
Douglas Edward Galarus
Weizhong He
Zhigang Zhang
Weixin Zhou

University of N C at Chapel Hill
Deidre D Goodwin
Jennifer L Laveglia
David William Lyons
Mir Zia Mahmood
John R Peach
Natalie M Priebe
Christine Scharlach
Danny J Turner II

University of N C at Greensboro
Manuel J Sanders III
Steven G Wicker

University of Nebraska at Omaha
Patrick W Prince

University of New Mexico
Changhui Dong

University of North Texas
Jesse William Byrne

University of Notre Dame
Meeyoung Kim

University of Oklahoma
Paul Andrew Buckelew
Cary Evan Crawford
Rita A Freeman
Jay L Hall
David E Harrelson
Dubravko Ivansic
Caryn L Latham
Hong Li
Yong Li
Muhammad A Sharif
Jagat K Sheth
Mustafa Uzel
Stanislav M Vasilev
Xiangdong Xie
Fushen Zhang
Bingjun Zhou

University of Ottawa
Yuexiu Zhang

University of Pittsburgh, Pittsburgh
Frederick K Douglas
Anastasios Liakos
Joseph Herman Magnotta
Becky Ann Skerkoski
Thamban Illath Valappil

University of Regina
Suqin Ao

University of Rhode Island
Christos John Schinas

University of Southern California
Juergen K Amendinger
Ioana B Boca
Di Chen
Chung-Kuang Chu
Zhaohui Hao
Insook Kim
Young Mee Koh
Chen-Yao G Lao
Excelsis San Diego Magno
Kyunghee Moon
Robert F Murphy
Chiu Yeung Ngo
Susan P O'Hara
Horia Calin Pop
Vanda Pop
Ziwei Qin
Poornima C Raghu
Alejandro J Ruiz
Welf G Schneider
Min Shao
Tianning Shi
Sabine B Spranger

University of Southwestern Louisiana
Jose Chong
Zhaoyun Xing

University of Texas at Austin
Michael Alan Carlisle
Cristina Dejong Grieg
Valerie Josiane Ventura

University of Texas at San Antonio
Cynthia R Aranda
Karen Rebecca Baker
Gabriel Cano
Stephanie Lopez Cano
Tina Maria Fagan
Donna Marie Fazzini
Samuel Eric Hairston
Jodi Jean Healy
Margaret Bruce Huddleston
Conrad Douglas Krueger
Genevieve M Marsh
Paula L McKenna
Dina Lynne Meyer
Fermin Duenez Ortiz
Ricardo Jose Pina
Sandra Kay Steitle
Elizabeth Anne Tanner
Antoinette Willis
Frank Zamarripa

University of Tulsa
Karen S Cullison

University of Utah
Traci Lee Bell
Steven Christopher Morrell

University of Washington
Katherine C Caplan
Barry John Jacobson
Angela A Pasquale

University of Western Ontario
Serge John David D'Alessio

University of Windsor
Shuxin Zhang

University of Wisc, Madison
John Stuart Jordan

University of Wisc, Stevens Point
Donald R Smith

University of Wyoming
Laila M Bakir
Damian William Betebenner
Lingxia Li
Brian Joseph Suchomel
Apostol Todorov Vassilev
Nicholas R Visser
Gregg Waterman
William Spencer Weber
Page Darren White

University of the South
Saurabh Dutta-Chowdhury

University of the West Indies
Robin M Antoine
Lisa Maria McShine
Karim David Rahaman
Leslie Roy Robinson

VPI & SU
Tina R Burrell
Anthony V Zangara

Virginia Commonwealth University
Kathleen L Ambruso

Wake Forest University
J Keith Yarbrough

Washington & Lee University
Brad David Martin

Wellesley College
Anne Marie Morse

Wichita State University
Angela Diane Zimmerman

Xavier University
Gregory Otis Cron

Yeshiva University
Michael Tzvi Segal

Youngstown State University
Michele DePinto
John Walter Lewis

Classified Advertisements

SUGGESTED USES for classified advertising are positions available, books or lecture notes for sale, books being sought, exchange or rental of houses, and typing services.

THE 1992 RATE IS $60 per inch on a single column (one-inch minimum), calculated from the top of the type; $30 for each additional ½ inch or fraction thereof. No discounts for multiple ads or the same ad in consecutive issues. For an additional $10 charge, announcements can be placed anonymously. Correspondence will be forwarded.

Advertisements in the "Positions Available" classified section will be set with a minimum one-line headline, consisting of the institution name above body copy, unless additional headline copy is specified by the advertiser. Advertisements in other sections of the classified pages will be set according to the advertisement insertion. Headlines will be centered in boldface at no extra charge. Classified rates are calculated from top of type in headline to bottom of type in body copy, including lines and spaces within. Any fractional text will be charged at the next ½ inch rate. Ads will appear in the language in which they are submitted.

Prepayment is required of individuals but not of institutions. There are no member discounts for classified ads. Dictation over the telephone will not be accepted for classified advertising.

DEADLINES are listed on the inside front cover or may be obtained from the AMS Advertising Department.

U. S. LAWS PROHIBIT discrimination in employment on the basis of color, age, sex, race, religion or national origin. "Positions Available" advertisements from institutions outside the U. S. cannot be published unless they are accompanied by a statement that the institution does not discriminate on these grounds whether or not it is subject to U. S. laws. Details and specific wording may be found near the Classified Advertisements in the January and July/August issues of the *Notices*.

SITUATIONS WANTED ADVERTISEMENTS from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-321-4AMS (321-4267) in the U.S. and Canada for further information.

SEND AD AND CHECK TO: Advertising Department, AMS, P.O. Box 6248, Providence, Rhode Island 02940. AMS location for express delivery packages is 201 Charles Street, Providence, Rhode Island 02904. Individuals are requested to pay in advance, institutions are not required to do so. AMS FAX 401-455-4004.

POSITIONS AVAILABLE

ILLINOIS

SOUTHERN ILLINOIS UNIVERSITY AT CARBONDALE
Temporary Positions
1992–1993
Department of Mathematics

Temporary positions are anticipated starting on August 16, 1992 as Lecturer. Masters degree in mathematics or admission to candidacy required; Ph.D. preferred. Applicants should provide evidence of excellence in teaching and foreign applicants *must* provide evidence of ability to teach in English effectively. Preference given to applicants with research interests compatible with those of the faculty. The duties will consist of 12 hours of undergraduate mathematics instruction each semester. Closing date May 15, 1992 or until positions are filled. Send applications (including transcripts) to:

Temporary Positions
c/o Ronald Kirk, Chair
Department of Mathematics
Southern Illinois University at Carbondale
Carbondale, Illinois 62901.

SIUC is an Equal Opportunity/Affirmative Action Employer.

INDIANA

HANOVER COLLEGE
Department of Mathematics

Assistant professor (entry level position) starting September 1992. Responsibilities in general undergraduate mathematics, including introductory statistics. The successful applicant will demonstrate a dedication to superior teaching within the context of the liberal arts. Ph.D. required. AA/EOE. Please send letter of application, vita, transcripts, and at least three letters of reference to Christine Wilcox, Secretary to the Mathematics Search Committee, Hanover College, Hanover, IN 47243.

NEW JERSEY

RUTGERS-NEWARK
Department of Mathematics and Computer Science

We anticipate one or two Moses Newall Combs Assistant Professorships beginning September 1992, contingent on funding. These are three-year, non-renewable term appointments. Candidates should have recently received the Ph.D., show outstanding promise for research in mathematics, and demonstrate a commitment to effective teaching. Preference will be given to candidates with research interests within representation theory, number theory, topology, or geometry. The teaching load will be two courses per semester.

Applicants should send a curriculum vitae and arrange for at least three letters of recommendation, including one which addresses teaching, to be sent directly to John Randall, Acting Chair, Department of Mathematics and Computer Science, Rutgers University, Newark, NJ 07102.

Rutgers University is an equal opportunity/affirmative action employer.

NEW YORK

JOHN JAY COLLEGE OF CRIMINAL JUSTICE
THE CITY UNIVERSITY OF NEW YORK
Department of Mathematics

Assistant Professor, tenure-track position, September, 1992. Requirements: Ph.D. Mathematics; or expected to have it completed by September 1, 1992; demonstrated potential for research; strong commitment to teaching. Computer science, numerical analysis or operations research background preferred. John Jay College of Criminal Justice, located in Manhattan, is a senior college in CUNY. Send resume, graduate transcript, relevant reprints, dissertation abstract and three letters of reference to Sydney Samuel, Chairperson, Department of Mathematics, John Jay College of Criminal Justice, 445 West 59 Street, New York, NY 10019 by May 15, 1992. Minorities and women are encouraged to apply. AA/EOE Employer.

UNIVERSITY OF ROCHESTER
Department of Biostatistics

The Department of Biostatistics at the University of Rochester invites applications for NIH funded postdoctoral positions, beginning Sept. 1, 1992. Postdoctoral fellows will participate in the design and analysis of cancer studies, as well as conduct their own independent research. The program requires U.S. citizenship or permanent residence. Applicants must possess a Ph.D. or equivalent. Applications from women and minorities are encouraged. Contact: Martin A. Tanner, Department of Biostatistics, Box 630, University of Rochester Medical Center, 601 Elmwood Ave., Rochester, NY 14642. AA/EOE.

OHIO

INSTITUT DE CALCUL MATHEMATIQUE
KENT STATE UNIVERSITY

B. Beauzamy, P. Enflo, and P. Wang wish to develop their research group on **Quantitative estimates for polynomials in one or several variables** and they encourage applications for Ph.D. studies (Thèse) in this direction.

The topic has direct applications to Analysis (Fourier Analysis, Harmonic Analysis), to Number Theory, and Computer Science (Symbolic Computation, Massively Parallel Programming). It is supported by the *National Science Foundation* (U.S.A.), the *C.N.R.S.* (France), the Ministry of Defense (France), and *DIGITAL Eq. Corp.*

The applicants should be citizens either of the U.S. or of one of the countries of the European Community. They will have to work either in Paris or in Kent, and may have to travel between both places.

Please write to: Prof. Bernard Beauzamy, Institut de Calcul Mathématique, Université de Paris 7, 2 Place Jussieu, 75251 Paris Cedex 05, France, or to Prof. Per Enflo, Prof. Paul Wang, Department of Mathematical Sciences, Kent State University, Kent, Ohio 44242, U.S.A.

GUAM

UNIVERSITY OF GUAM
Division of Mathematical Sciences

The University of Guam solicits applications to establish a list of eligibles for the following non-tenure or tenure track, full-time position (one-, two-, or three-year appointment):

Instructor to Associate Professor (Computer Science)

Applications will be accepted until the position is filled and review of applications will begin on May 20, 1992.

Candidates with an earned Ph.D. in computer science will be given preference. Candidates must have at least a Master's Degree in Computer Science with teaching experience at the tertiary level. The successful candidate must have a strong commitment to qualify teaching of both students in mathematics and computer science, and a demonstrated interest in the implementation of a degree program in computer science. Applicant must be a U.S. citizen or permanent resident prior to employment. This status is necessary for both tenure or non-tenure track appointments. Rank and salary will be commensurate with qualifications and experience.

Requests for official application forms and other information may be directed to the Personnel Services Division, UOG Station, Mangilao, Guam 96923. Send completed application form, updated resume or curriculum vitae, official graduate transcripts (sent directly from awarding institution/s), copies of undergraduate transcripts, and three letters of reference or placement file to:

University of Guam
Prof. Tower Chen, Chair
Computer Science Search Committee
c/o Personnel Services Division
UOG Station, Mangilao, Guam 96923

For more information, call (671) 734-9109/9535 or call Dr. John Rider toll free at 1-800-821-9233. UOG is an Equal Opportunity Affirmative Action Employer.

KOREA

SEOUL NATIONAL UNIVERSITY
Global Analysis Research Center
Postdoctoral Positions

The Global Analysis Research Center expects to have several postdoctoral positions beginning Fall 1992. Applications are welcome in all fields of mathematics. Applicants must have a Ph.D. in Mathematics earned or anticipated by 9/1/92. These positions are available for a one-year period. Applicants should send a vita, list of publications, a statement describing current and planned research, and ask two people to send letters of recommendation by **July 31, 1992.** All communications should be addressed to: Search Committee, Global Analysis Research Center, Department of Mathematics, Seoul National University, Seoul, 151-742, Republic of Korea.

MEXICO

UNIVERSIDAD AUTONOMA
METROPOLITANA-IZTAPALAPA CAMPUS

The Department of Mathematics invites applications for four tenure-track positions at a senior level to start at any time after January 1, 1993. For two of these positions, preference will be given to specialists in any branch of theoretical and applied statistics. Qualifications: Ph.D. and demonstrated strong research record and teaching experience. It is expected that the candidate will be able to teach in Spanish after one year's residence in Mexico. We offer competitive salaries to suitably qualified applicants. The university will arrange Mexican visas and work permits for those hired.

To apply, send curriculum vitae and arrange for at least three letters of reference to be sent to Professor Richard G. Wilson.

Departamento de Matematicas
Av. Michoacan Y La Purisima S/N
APDO. Postal 55-534
C.P. 09340 Mexico, D.F. Mexico

The Universidad Autonoma Metropolitana Istapalopa Campus is a publicly funded institution located in the south-east of Mexico City with a student body of 15,000 and a mathematics department of 50 full-time tenured faculty. Normal teaching load is 3-4 trimester courses per year.

SWEDEN

UPPSALA UNIVERSITY
Department of Mathematics

The Department invites applications for three to five expected tenure positions as lecturers. The starting dates for the appointments are negotiable within the interval fall semester 1992 to fall 1993. We seek candidates in all areas of Mathematics, but in particular in areas that are complementary to those of the current faculty. The traditional strength of our Department is Analysis where our Faculty has the highest international standard. We thus encourage mathematicians whose interest lie, for instance, in algebra, geometry, topology, and logic to apply. Should we receive many excellent applications in a certain area, we will make every effort to create a research group in that particular field.

The lecturer position entails a 12 hour a week teaching duty. However, for mathematicians actively involved in research, funding from the Swedish Natural Science Research Institute is available. If such funding is received, the teaching load is reduced to six hours a week.

The salary is negotiable, with a lower starting level of about USD 40,000.

The University of Uppsala is one of the oldest in Europe and has a college town atmosphere comparable to those of Oxford and Cambridge. Uppsala is located 65 km north of Stockholm, about a 25 minute drive away from the international airport and about 55 minutes away from the Mittag-Leffler Mathematical Institute.

Applications, including a curriculum vitae and a list of publications, should be sent by September 1, 1992, to

Chairman
Department of Mathematics
Uppsala University
Box 480
S-751 06 Uppsala
SWEDEN

POSITIONS WANTED

Professor/lecturer, teaching and research, Ph.D., specialities, Topology, Algebra, also broad competence in other fields, Fluent in English. Long teaching experience at undergraduate and graduate levels including supervising thesis research, location immaterial, available immediately, references and resumé upon request. Respond to Applicant Code 48, *AMS Notices*, P. O. Box 6248, Providence, RI 02940-6248.

PUBLICATIONS FOR SALE

FERMATICA, a newsletter for Fermat's Last Theorem enthusiasts, issue No 3, "The Cubic Challenge." Please send $1.95 to Fermatica, P.O. Box HH24, LEEDS, Yorks, LS8 3TB, England to receive your copy.

MATH SCI PRESS, 53 Jordan Rd., Brookline, MA 02146, 617-738-0307. **Geometric Structures and Nonlinear Physics**, $95. **Geometric Computing Science**, $85, both by R. Hermann. To appear: **Lie Theory and Generalized Function Algebras**.

PUBLICATIONS WANTED

Wanted: Mathematical books, journals, reprints, ephemera. Contact R. K. Dennis, Math. Dept., White Hall, Cornell U., Ithaca, NY 14853-7901. Tel: 607-255-4027, FAX: 607-255-7149. email: dennis@mssun7.msi.cornell.edu

NATIONAL UNIVERSITY OF SINGAPORE

DEPARTMENT OF MATHEMATICS

Applications are invited for teaching appointments at the **Lecturer** or **Senior Lecturer** level from candidates who are able to teach in one or more of the following areas:

Pure Mathematics
Applied Mathematics
Operations Research
Statistics

Candidates should possess a PhD degree in Mathematics or a relevant field and have a strong commitment to teaching and research.

Gross annual emoluments range as follows:

Lecturer	**S$50,390 64,200**
Senior Lecturer	**S$58,680 100,310**

(US$1.00=S$1.61 approximately)

The commencing salary will depend on the candidate's qualifications, experience and the level of appointment offered.

Leave and medical benefits will be provided. Depending on the type of contract offered, other benefits may include: provident fund benefits or an end-of-contract gratuity, a settling-in allowance of S$1,000 or S$2,000, subsidised housing at nominal rentals ranging from S$100 to S$216 p.m., education allowance for up to three children subject to a maximum of S$16,425 per annum per child, passage assistance and baggage allowance for the transportation of personal effects to Singapore. Staff members may undertake consultation work, subject to the approval of the University, and retain consultation fees up to a maximum of 60% of their gross annual emoluments in a calendar year.

The Department of Mathematics is a department in the Faculty of Science. There are eight faculties in the National University of Singapore with a current student enrolment of some 15,000. All departments are well-equipped with a wide range of facilities for teaching and research.

All academic staff have access to the following computer and telecommunication resources: an individual microcomputer (an IBM AT-compatible or Apple Macintosh); an IBM mainframe computer with 16 MIPS of computing power; an NEC SX supercomputer with 650 MFLOPS of computing power; departmental laser printers; a wide spectrum of mainframe and microcomputer software; voice-mail. A campus-wide network, which is based on the high speed optical fibre based FDDI technology, links up all the academic staff and student microcomputers, UNIX workstations and provides access to the mainframe computer, the supercomputer, UNIX hosts, the on-line library catalogue, Internet and BITNET.

Application forms and further information on terms and conditions of service may be obtained from:

The Director
Personnel Department
National University of Singapore
10 Kent Ridge Crescent
Singapore 0511

The Director
North America Office
National University of Singapore
55 East 59th Street
New York, NY 10022, U.S.A.
Tel: (212) 751-0331

Enquiries may also be sent through **BITNET** to: **PERPL@NUS3090**, or through **Telefax**: **(65) 7783948**

NANYANG TECHNOLOGICAL UNIVERSITY
NATIONAL INSTITUTE OF EDUCATION

ACADEMIC APPOINTMENTS IN MATHEMATICS & MATHEMATICS EDUCATION

The Nanyang Technological University (NTU) is a full and comprehensive university. Courses that are offered currently at NTU include Accountancy, Arts, Business, Computer Technology, Education, Engineering (Civil, Electrical & Mechanical) and Science. The National Institute of Education (NIE) as part of the University is responsible for the training of teachers of all subjects at pre-school, primary, secondary and pre-university levels. It aims to achieve excellence in teacher training and research in arts, science, education and physical education. It offers courses that range from diploma to degree and post-graduate levels.

Applications are invited for Faculty appointments in the Division of Mathematics of the School of Science from candidates who must possess a relevant PhD degree. Preference will be given to those who are able to teach in more than one of the areas listed and with proven ability in research. Candidates for Mathematics Education positions should also have a professional teaching qualification and at least 2 years of relevant qualified teaching experience.

Algebra • Analysis
Geometry • Operations Research
Teaching of Primary/Secondary Mathematics

Salary and Conditions of Service
Gross Annual Emoluments range as follows:

Professor	: S$108,870 - S$146,970
Associate Professor	: S$ 88,650 - S$122,870
Senior Lecturer	: S$ 58,680 - S$100,310
Lecturer	: S$ 39,350 - S$ 64,200

The commencing salary will depend on the candidate's qualifications, experience, and the level of appointment offered.

Leave, medical and provident fund benefits will be provided.

Candidates wishing to be considered should write or fax to:

Director of Personnel
NANYANG TECHNOLOGICAL UNIVERSITY
Nanyang Avenue
Singapore 2263
Fax: 791 9340

giving their Curriculum Vitae and the names and addresses of Three Referees.

MATHEMATICAL SCIENCES RESEARCH INSTITUTE

1000 CENTENNIAL DRIVE, BERKELEY, CALIFORNIA 94720

The Institute solicits applications for membership during the 1993-94 year, which begins on September 7, 1993. In 1993-94 two programs will be featured. Although these areas will be emphasized, applications from candidates in all fields will be welcome.

DIFFERENTIAL GEOMETRY. A full-year program with greater activity in the Fall term. The following two areas will be emphasized:

Riemannian Geometry/Geometric Structures. (Main Area) Topics will include:
1. Curvature and topology; 2. Minimal submanifolds and harmonic maps; 3. Spectral geometry (including analytic torsion and Quillen metrics); 4. Spaces of Riemannian manifolds (compactness, collapse, F-structures, etc.); 5. Geometric inequalities (including isoperimetric and isosystolic inequalities, filling radius, simplicial volume, etc.); 6. Spaces of non-positive curvature (structure at infinity, rigidity, buildings, etc.); 7. Einstein spaces and reduced holonomy; moduli; 8. Conformal, affine, and symplectic geometry; Thurston geometries.

Geometry and Physics. (Secondary Area) Topics will include:
1. Gauge field theory, Donaldson theory, Floer homology, the Chern-Simons functional, monopoles, elliptic cohomology;
2. Gravity and twistor theory; 3. Riemannian geometry in infinite dimensions; quantum field theory.

The program committee consists of: W. Ballmann, R. Bott, R. Bryant, C. Gordon, M. Gromov, K. Grove, B. Lawson (chairman), R. Schoen.

DYNAMICAL SYSTEMS AND PROBABILISTIC METHODS FOR PDE'S. The aim of the 1994 program will be to bring together mathematicians, applied mathematicians, physicists, numerical analysts and experimentalists working in related areas, to explore common interests. The program will include workshops devoted to specific scientific areas, such as water waves and nonlinear optics. Topics in the program will include:

1. The emergence of statistical methods, as well as dynamical systems methods, in the analysis and numerical study of evolutionary PDE's; 2. Recent developments in infinite dimensional KAM problems, in the stability, scattering and long-time asymptotics of nonlinear waves, and in the use of renormalization methods for evolutionary PDE's; 3. Fundamental successes, such as the theory of completely integrable soliton equations and the theory of inertial manifolds.

The program committee consists of: P. Deift (co-chairman), P. Holmes, J. Hyman, D. Levermore, D. McLaughlin (co-chairman), C. Wayne.

POSTDOCTORAL FELLOWSHIPS

We anticipate making approximately 20 awards of postdoctoral fellowships. The stipend for 1992-93 is $30,000 and it will be at least that for 1993-94. In addition there is an award for round trip travel. The candidate's Ph.D. should be 1988 or later. Candidates are asked to solicit three letters of recommendation. Most awards are for a year, but a shorter period is possible. The deadline for applications is November 30, 1992.

RESEARCH PROFESSORSHIPS

These awards are intended for midcareer mathematicians; the applicant's Ph.D. should be 1987 or earlier. There is an earlier deadline for applications: September 30, 1992. Please see the separate announcement of these awards elsewhere in this issue of the Notices. Candidates may apply for both a General Membership and a Research Professorship (but only one award will be made per candidate).

GENERAL MEMBERSHIPS

Applications are invited for part or all of 1993-94. Letters of recommendation are encouraged but not required. It is generally expected that members at this level will come with partial or full support from other sources. The deadline for applications is November 30, 1992.

FURTHER REMARKS

Starting with applications for 1993-94, MSRI is introducing application forms. If you are interested in applying, you should request an application form. Write to: Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley CA 94720, or send email to: `info@msri.org` with the message: `get program app.ascii` (or `app.TeX`, if you prefer). Women and minority candidates are especially encouraged to apply.

Candidates are asked to make sure that their application materials and letters of reference arrive by the deadline (September 30, 1992 for Research Professorships and November 30, 1992 for the others). Late applications cannot be assured a complete consideration. Awards will be announced by early December, 1992 for Research Professorships and by mid-February, 1993 for the others.

In 1994-95 MSRI will feature two programs: Automorphic Forms, and Low Dimensional Dynamical Systems.

The Institute is committed to the principles of Equal Opportunity and Affirmative Action.

RESEARCH PROFESSORSHIPS

at the MATHEMATICAL SCIENCES RESEARCH INSTITUTE
1000 CENTENNIAL DRIVE, BERKELEY, CALIFORNIA 94720

The Mathematical Sciences Research Institute (MSRI) announces the availability of Research Professorships for the 1993-94 year.

These awards are intended for midcareer mathematicians; the applicant's Ph.D. should be 1987 or earlier. An award for a full academic year will be limited to a ceiling of $30,000 and normally will not exceed half the applicant's salary. Appointments can be made for a portion of the year; the $30,000 ceiling and half salary limit would then be prorated. It is anticipated that between six and ten awards will be made. In addition to the basic stipend, there will be an award for round trip travel to MSRI.

In 1993-94 MSRI will feature two programs: Differential Geometry, and Dynamical Systems and Probabilistic Methods for PDE's. Please consult the general MSRI announcement for 1993-94 elsewhere in this issue of the Notices. Research Professorships are directed to applicants in all fields of the mathematical sciences. There are also General Memberships, which normally offer smaller awards. An applicant may apply for both (but only one award will be made per applicant). Women and minority candidates are especially encouraged to apply.

Beginning with applications for 1993-94, MSRI is introducing application forms. If you are interested in applying, you should request an application form. Write to: Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley CA 94720, or send email to: `info@msri.org` with the message: `get program app.ascii` (or `app.TeX`, if you prefer). Candidates are asked to make sure that their application materials and letters of reference arrive by the deadline of September 30, 1992 for Research Professorships. Late applications cannot be assured a complete consideration. Awards will be announced in early December, 1992. Send applications to the address shown above.

The Institute is committed to the principles of Equal Opportunity and Affirmative Action.

UNIVERSITY OF CAMBRIDGE

Isaac Newton Institute for Mathematical Sciences

ROSENBAUM VISITING FELLOWSHIPS

Applications are invited for Rosenbaum Visiting Fellowships at the Isaac Newton Institute for Mathematical Sciences. Four Fellowships of six-months duration will be awarded annually out of funds generously provided by the Paul and Gabriella Rosenbaum Foundation. There will be one Fellowship associated with each of the four scientific programmes run by the Institute. The programmes planned for 1993–94 are:

Computer Vision
(July to December 1993)
Random Spatial Processes
(July to December 1993)
Geometry and Gravity
(January to June 1994)
Cellular Automata, Aggregation and Growth
(January to June 1994)

The stipend of a Fellow will be $17,500 for the six-month tenure and travel expenses may be provided. To be eligible, candidates must have a Ph.D. and be U.S. citizens or permanent residents or have resided in the U.S. for a minimum of four years.

Applications, including a *curriculum vitae*, list of publications and the names of two referees, should be sent by 30 September 1992 (in the case of the July to December 1993 programmes) or 31 March 1993 (in the case of the January to June 1994 programmes) to:

Deputy Director, Dr. Peter Goddard
Isaac Newton Institute for Mathematical Sciences
20 Clarkson Road
Cambridge CB3 0EH, U.K.

(from whom further details of the programmes can be obtained)

THE SWISS FEDERAL INSTITUTE OF TECHNOLOGY
LAUSANNE
L'ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE (EPFL)

invites applications for a position of an

ASSISTANT PROFESSOR IN DIFFERENTIAL GEOMETRY
for its Department of Mathematics

• •

The new professor should be a young and active researcher whose research area is in Riemannian geometry or Riemann surface theory. He will participate in the teaching program of the Mathematics Department. The position is limited to three years, a prolongation to six years is not excluded.

Women are particularly welcome.

Deadline for application: 31 May 1992
The successful candidate will enter into service: Autumn 1992 or to mutual agreement.

For further information concerning the position, please write to:

Secrétariat général de l'Ecole Polytechnique Fédérale de Lausanne
CE-Ecublens—1015 LAUSANNE, SUISSE

The University of Sydney
AUSTRALIA

Faculty of Science

LECTURER - FIXED TERM

School of Mathematics and Statistics
Reference No: B17/14

Applications are invited for appointment to the position of Lecturer in the School of Mathematics & Statistics. The School has active research groups in the following areas: Algebra, Analysis, Nonlinear Analysis, Applied Mathematical and Computational Modelling, Statistics, Topology and Geometry, Category Theory and Combinatorics, Computational and Discrete Mathematics.

Strong preference will be given to candidates whose research interests are in the areas of Algebra, Analysis and Topology and whose appointment would strengthen existing research groups in the School. Candidates must have a PhD, a strong research record and a demonstrated commitment to excellence in teaching.

Courses in mathematics are given at all undergraduate and postgraduate levels and include computer-based courses. Both research and teaching are supported by a large network of workstations, including several high-performance processors and colour graphics systems.

The appointment will be for a fixed term of up to five years. The position is available immediately and the appointee will be expected to commence duties as soon as possible. Assistance with relocating expenses to Sydney will be provided. Further information from Dr D. Taylor (612) 692 4222 or email taylor_d.maths.su.oz.au.

Salary: Lecturer Level B: A$39,463-A$48,688 p.a.
(top of salary scale unavailable until July 1992.)

Method of application for academic position: Three copies of the application, quoting reference no., and including curriculum vitae, list of publications and the names, addresses and fax nos., of at least three and no more than five referees.
Applications to be sent to: Assistant Registrar (Appointments), Staff Office(KO7), The University of Sydney, N.S.W. 2006 AUSTRALIA, Fax (61 2) 692 43416 **by 5 June 1992.**

88112

Equal employment opportunity
and no smoking in the workplace are University policies

UNIVERSITY OF CAPE TOWN

Dept of Mathematics:

Professor/Associate Professor/ Senior Lecturer/Lecturer

Applications are invited for two vacant posts in the Department of Mathematics.

Candidates in all fields of Mathematics are invited to apply. For the Chair, the University seeks to secure the services of a mathematician of international repute, whose presence and activities will also be of benefit to mathematicians or other scientists outside of his/her immediate speciality.

The ranks of the successful applicants will be decided upon the basis of qualifications and experience.

The remuneration packages include attractive staff benefits such as non-contributory medical aid, a housing subsidy in certain circumstances, and a pension scheme. Further details are available on request.

Further information may be obtained from CSIRS, Suite 350, 4801 Massachusetts Avenue, NW Washington DC 20016.

Applicants should submit a full curriculum vitae and the names, addresses and telephone numbers of three referees not later than 30 June 1992 to the Appointments Officer, University of Cape Town, Rondebosch 7700, Republic of South Africa; telephone (21) 650-2192; fax (21) 650-2138. (Late applications will be considered.) Candidates should indicate in their letters of application for which post/s they wish to be considered.

The policy and practice of the University of Cape Town are to oppose discrimination on grounds of gender, race or creed in any sphere of university life. UCT has consistently protested, and continues to protest, against apartheid laws and practices and is committed to working towards a just future for our country. Information on this is available on request.

C73006/1660-0

WEB DEVELOPMENT CORPORATION

WEB Development Corporation invites applications for the position of:

RESEARCH ASSOCIATE

An ideal candidate should have experience in pattern recognition, signal processing or related fields, as well as extensive programming expertise.

A Ph.D. degree in Mathematics, Computer Science or Electrical Engineering is required.

WEB Development is a small research laboratory near Philadelphia whose current activities span computer science, cognitive science, optics and physical chemistry.

Please send resume with two references to:

Dr. Mahmut Guner
WEB Development Corporation
Longwood Corporate Center South
415 McFarlan Road
Kennett Square, PA 19348

The Unified Computation Laboratory

Modelling, Specifications, and Tools

EDITED BY CHARLES RATTRAY AND ROBERT G. CLARK

This book is concerned with the theory and techniques required in the construction and implementation of complex software.

(The Institute of Mathematics and its Applications Conference Series, New Series)

June 1992 480 pp.; 68 illus.
853684-4 $85.00

Reliable Numerical Computation

EDITED BY M.G. COX AND S. HAMMARLING

This essential reference for all numerical analysts is completely up-to-date with the latest developments on the Lanczos algorithm, QR-factorizations, error propagation models, parameter estimation problems, sparse systems, and shape-preserving splines.

1991 368 pp.; 33 illus.
853564-3 $75.00

Introducing Einstein's Relativity

R.A. D'INVERNO

The objectives of this book are to familiarize students with the basic ideas and equations of Einstein's theory, and to cover three main topics: black holes, gravitational waves, and cosmology.

1992 400 pp.; 213 illus.
859653-7 cloth $75.00
859686-3 paper $39.95

Disorder in Physical Systems

A Volume in Honour of John Hammersley

EDITED BY G.R. GRIMMETT AND D.J.A. WELSH

This volume surveys the current state of research in random phenomena.

1990 392 pp.; 26 illus.
853215-6 $75.00

Probability and Random Processes

Second Edition

GEOFFREY GRIMMETT AND DAVID STIRZAKER

From reviews of the first edition: "This new textbook on probability and stochastic processes should quickly become established as one of the best texts available." —*The Times Higher Education Supplement.*

March 1992 416 pp.; 19 illus.
853665-8 paper $35.00
853666-6 cloth $67.50

Probability and Random Processes

Problems and Solutions

GEOFFREY GRIMMETT AND DAVID STIRZAKER

This book contains 675 problems in probability and random processes, together with their solutions

April 1992 376 pp.; 1 illus.
853448-5 paper $18.95

Patterns and Waves

The Theory and Applications of Reaction-Diffusion Equations

PETER GRINDROD

This textbook introduces the theory of certain classes of nonlinear partial differential equations known collectively as reaction-diffusion equations.

(Oxford Applied Mathematics and Computing Science Series)

1991 256 pp.; 69 illus.
859692-8 paper $39.95
859676-6 cloth $75.00

Oscillation Theory of Delay Differential Equations

With Applications

I. GYORI AND G. LADAS

This monograph on delay differential equations includes applications to a variety of scientific problems.

(Oxford Mathematical Monographs)

September 1991 384 pp.
853582-1 $85.00

The Mathematical Revolution Inspired by Computing

EDITED BY J.H. JOHNSON AND M.J. LOOMES

This conference volume examines the impact of computers on mathematics.

(The Institute of Mathematics and its Applications Conference Series, New Series 30)

1991 344 pp.; illus.
853658-5 $55.00

Integral Equations

JIRO KONDO

All the main classes of integral equations including Volterra, Fredholm, and nonlinear integral equations are covered in this textbook.

(Oxford Applied Mathematics and Computing Science Series)

October 1991 464 pp.; 31 illus.
859691-X paper $35.00
859681-2 cloth $80.00

Advances in Numerical Analysis

***Volume I*: Nonlinear Partial Differential Equations and Dynamical Systems**

EDITED BY WILL LIGHT

1991 224 pp.; 29 illus.
853438-8 $52.00

***Volume II*: Wavelets, Subdivision Algorithms, and Radial Basis Functions**

EDITED BY WILL LIGHT

May 1992 224 pp.; 5 illus.
853439-6 $55.00

Algebraic Computing with REDUCE

MALCOLM A.H. MACCALLUM AND FRANCIS J. WRIGHT

This book provides a comprehensive introduction to the versatile REDUCE software.

September 1991 320 pp.
853443-4 paper $24.95
853444-2 cloth $65.00

Cryptography and Coding II

EDITED BY CHRIS MITCHELL

This conference proceedings covers both cryptography and coding theory .

(The Institute of Mathematics and its Applications Conference Series, New Series 33)

1992 320 pp.; 73 illus.
853393-4 $87.00

Variational Methods in Mechanics

TOSHIO MURA AND TATSUHITO KOYA

The recent success and popularity of the finite-element method, crucial to solving mathematical problems in many branches of engineering today, is based on the variational methods discussed in this textbook.

March 1992 336 pp.; 73 illus.
506830-0 $39.95

Linear Algebra

STERLING K. BERBERIAN

This textbook provides a rigorous introduction to the main concepts of linear algebra, including the basic theory of vector spaces and linear maps and more advanced topics.

1992 376 pp.; 48 illus.
853436-1 $39.95

NOTICE TO NATURALIZED CITIZENS FROM, OR WHO HAVE RESIDED FOR A SIGNIFICANT PERIOD OF TIME IN, THE FOLLOWING COUNTRIES:

Afghanistan, Albania, Angola, East Berlin, Bulgaria, Cambodia (Kampuchea), Cuba, Czechoslovakia, Estonia, Ethiopia, German Democratic Republic (East Germany), Hungarian People's Republic (Hungary), Iran, Iraq, Democratic People's Republic of Korea (North Korea), Laos, Latvia, Libyan Arab Republic, Mongolian People's Republic (Outer Mongolia), Nicaragua, People's Republic of China, Poland, Rumania, Southern Yemen, Syria, Union of Soviet Socialist Republics, Democratic Republic of Vietnam (North Vietnam), South Vietnam, Yugoslavia, the Kurile Islands and South Sakhalin (Karafuto).

YOU MAY HAVE BEEN THE VICTIM OF UNCONSTITUTIONAL DISCRIMINATION BASED ON YOUR NATIONAL ORIGIN

If you are a naturalized United States citizen and your country of origin is included above, or you resided in one of these countries for a significant period of your life, the Department of Defense (DoD) or a DoD contractor may have unlawfully denied you a security clearance or employment, promotion, fellowship or scholarship that required a security clearance, or asked you to apply for a Limited Access Authorization, as a result of DoD's enforcement of a regulation which denied security clearances to newly naturalized United States citizens from these countries or who resided in these countries for a significant period.

The DoD and DoD contractors acted pursuant to a regulation that became effective on January 2, 1987. Although DoD rescinded the regulation on February 12, 1988, it may have been applied after that date. The United States District Court for the District of Columbia has declared the regulation unconstitutional and permanently enjoined the DoD from enforcing it. Huynh v. Cheney, 87-3436 TFH (D.D.C. March 14, 1991).

If you are a naturalized citizen and you believe you have been adversely affected by the enforcement of the regulation on or after January 2, 1987, you may have certain legal rights. For further information, you should contact the United States Department of Justice Office of Special Counsel for Immigration Related Unfair Employment Practices (OSC), by calling 1-800-255-7688 or (202) 653-8121; 1-800-237-2515 or (202) 296-0168 (TDD device for the hearing impaired); or by writing to OSC, P.O. Box 65490, Washington, D.C. 20035-5490. The OSC will provide information and help you process a claim free of charge. The opportunity to pursue these rights is subject to certain time limits, so if you believe the regulation was applied to you, contact the Office of Special Counsel as soon as possible.

NEW FROM BIRKHÄUSER

RIEMANNIAN GEOMETRY

M. DO CARMO, *Institute of Pure and Applied Mathematics, Rio de Janeiro, Brazil*
Translated from the Portuguese by **F. FLAHERTY,** *Oregon State University, Corvallis*

"It is the best text for a beginning graduate course in differential geometry that I have ever seen, in any language whatsoever. The text itself is alive...good clear, engaging writing...delightful to read."
-Herman Gluck, University of Pennsylvania
"It is an exceptionally interesting book, nicely organized, clearly written, and very well translated."
-William Firey, Oregon State University
"Finally a translation of do Carmo's Brazilian classic. The style is pedagogically ideal. Concepts are motivated and there are ubiquitous examples and exercises. I believe this to be the best introductory text on Riemannian geometry."
-Robert Gardner, University of North Carolina

CONTENTS:
Differential Manifolds • Riemannian Metrics • Affine Connections/Riemannian Connections • Geodesics/Convex Neighborhoods • Curvature • Jacobi Fields • Isometric Immersions • Complete Manifolds/Hopf-Rinow and Hadamard Theorems • Spaces of Constant Curvature • Variations of Energy • The Rauch Comparison Theorem • The Morse Index Theorem • The Fundamental Group of Manifolds of Negative Curvature • The Sphere Theorem • References • Index.

1991 300 pp. Hardcover
ISBN 0-8176-3490-8 $39.50
Mathematics: Theory and Applications

INFINITE DIMENSIONAL MORSE THEORY AND MULTIPLE SOLUTION PROBLEMS

by **KUNG-CHING CHANG,** *Peking University, Beijing*

This research level monograph is the first book to present various critical point theorems in a unified framework. The author employs Morse theory as a tool to study multiple solutions to differential equations arising in the calculus of variations.

Critical groups for isolated critical points or orbits, which exceed the information provided by the Leray-schauder index, are introduced.

CONTENTS:
Introduction • Infinite Dimensional Morse Theory • Critical Point Theory • Applications to Semilinear Elliptic Boundary Value Problems • Multiple Periodic Solutions of Hamiltonian Systems • Applications to Harmonic Maps and Minimal Surfaces • Appendix • Indexes

1992 450 pp. (approx.) Hardcover
ISBN 0-8176-3451-7 $69.50 (tent.)

FUNDAMENTALS OF THE THEORY OF OPERATOR ALGEBRAS

VOLUME III: Elementary Theory - An Exercise Approach

and

VOLUME IV - SPECIAL TOPICS: Advanced Theory - An Exercise Approach

R. KADISON, *University of Pennsylvania,* and **J.R. RINGROSE,** *University of Newcastle*

The many readers of the highly acclaimed treatise on which these volumes are based will enthusiastically welcome the authors' decision to share with them their detailed solutions to the stimulating and penetrating exercises that appeared in the first two volumes. With clarity, thoroughness, and depth, these solutions supplement the basic theory and provide an invaluable tool for students and researchers in mathematics and theoretical physics and engineering. They provide models which test understanding and suggest alternate methods and styles for producing further solutions and extending knowledge in such areas as functional analysis and quantum physics.

VOLUME III: 1991 278 pp. Hardcover
ISBN 0-8176-3497-5 $34.50
VOLUME IV: 1992 594 pp. (approx.)
Hardcover ISBN 0-8176-3497-3 $49.50 (tent.)

ADVENTURES IN STOCHASTIC PROCESSES

by **SIDNEY RESNICK,** *Cornell University*

Accessible to beginners, this serious approach to applied probability features the basic stochastic processes that are necessary ingredients for building models of a wide variety of phenomena exhibiting time varying randomness. Ideally suited as a first year graduate text.

CONTENTS:
Preliminaries: Discrete Index Sets and/or Discrete State Spaces • Markov Chains • Renewal Theory • Point Processes • Continuous Time Markov Chains • Brownian Motion • The General Random Walk • References • Indexes

1992 500 pp. (approx.) Hardcover
ISBN 0-8176-3591-2 $64.50 (tent.)

Birkhäuser
Boston Basel Berlin

GROUP THEORETICAL METHODS AND THEIR APPLICATIONS

ALBERT FÄSSLER, *Ingenieurschule Biel, Switzerland* and the late **EDUARD STIEFEL**

The book is written at a level appropriate to scientists wishing to apply the concepts to symmetry problems or to familiarize themselves with group theory in an applied setting. Illustrated with over 50 figures, the book presents theory, examples, and applications, interacting with each other in a didactically refreshing and unconventional way, while maintaining mathematical integrity and accuracy. The applications are written with the non-expert in mind. The book is highly recommended to a wide variety of practicing scientists. Its use of algorithmic concepts in many instances will make it particularly valuable to students of any field in which symmetry problems play an important role.

1992 296 pp. 57 illus. Hardcover
ISBN 0-8176-3527-0 $49.50

INTRODUCTION TO THE GALOIS CORRESPONDENCE

M. FENRICK, *Mankato State University, Minnesota*

This textbook is intended to serve as an introduction to the study of the Galois correspondence. The book is self contained in that it is only assumed that the student has a certain level of mathematical sophistication and has studied some elementary linear algebra. The necessary background theory of groups and rings is covered in the first chapter, thus providing a firm foundation for the study of the Galois correspondence itself. At each stage of development concrete examples have been given, and many of these examples include exercises which involve verifying facts, thus giving the student the chance to confirm understanding of the example. In addition, there are numerous exercises, of varying degrees of difficulty, at the end of each section.

1991 189 pp. Hardcover
ISBN 0-8176-3522-X $49.50

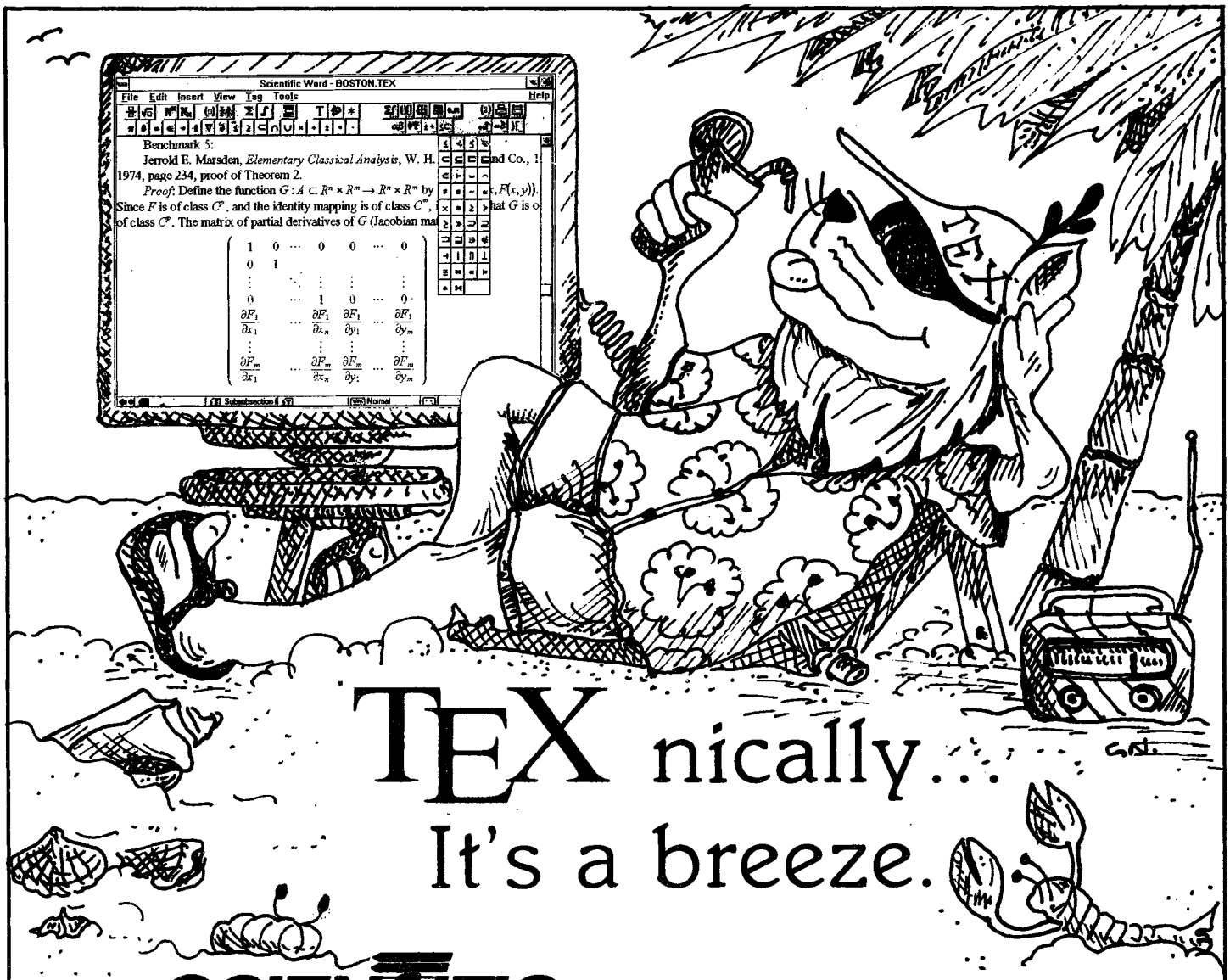
Three Easy Ways to Order!

Call: Toll-Free 1-800-777-4643.
In NJ call (201) 348-4033. Your reference number is **Y592.**

Write: Birkhäuser, Order Fulfillment -Dept. Y592, P.O. Box 2485, Secaucus, NJ 07096-2491.

Visit: Your Local Technical Bookstore or urge your librarian to order for your department.

Payment can be made by check, purchase order or credit card. Please enclose $2.50 for shipping ($1.00 for each additional book) and add appropriate sales tax if you reside in NY, NJ, MA, VT, or CA. Canadian residents please add 7% GST. Prices subject to change without notice.



TEXnically... It's a breeze.

SCIENTIFIC word

It will have you typing mathematics in minutes. It's so easy, you can compose and edit directly on the screen without being forced to think in TEX.

And it gets even better! With Windows 3.0, you simply use the mouse to click on symbols and objects such as fractions, brackets, etc., and they appear in your document. Or, you can enter the same symbols with keyboard shortcuts.

Scientific Word is a front end to TEX. It includes a Windows version of LATEX and a Windows previewer. It stores files in ASCII LATEX format and imports most existing LATEX documents.

So chill out! Let **Scientific Word** make your life a breeze. All you need is a PC with Windows 3.0 or higher, running in standard or enhanced mode...and **Scientific Word**.

Call **800-874-2383**

to order your copy today. Ask about our 30 day money-back guarantee and our educational discount.....**It's that easy.**

TCI

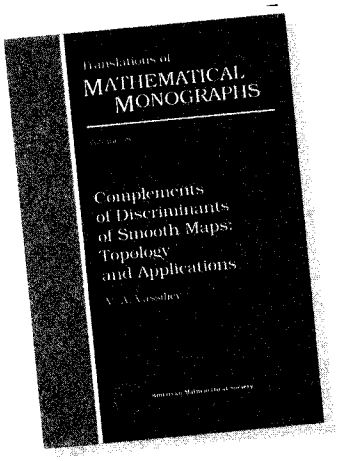
SOFTWARE RESEARCH, INC.

1190 Foster Road • Las Cruces, NM 88001
TEL: (505) 522-4600 • FAX: (505) 522-0116
TELEX: 317629

American Mathematical Society

New Titles!

Translations of Mathematical Monographs



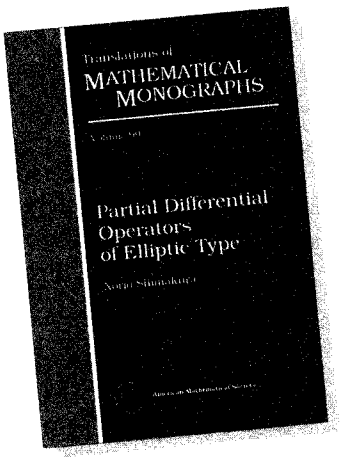
Complements of Discriminants of Smooth Maps: Topology and Applications

Volume 98

V. A. Vassiliev

A major contribution to the field of algebraic topology, this book provides the first comprehensive report on recent developments. Vassiliev, whose results have proved especially fruitful in recent research in knot theory, is a major leader in the field. This book will interest mathematicians in differential and homotopy topology and complexity theory, as well as physicists interested in string theory and Feynman diagrams. It makes a great textbook for graduate courses in topology, catastrophe theory, and, to a more limited extent, complexity theory.

1991 *Mathematics Subject Classifications*: 55, 57
ISBN 0-8218-4555-1, 208 pp. (hardcover), June 1992
Individual member $98, List price $164, Institutional member $131
Your ordering code is MMONO/98NA



Partial Differential Operators of Elliptic Type,

Volume 99

Norio Shimakura

Shimakura's book presents a comprehensive study of the theory of elliptic partial differential operators. Beginning with the definitions of ellipticity for higher order operators, Shimakura discusses:

- the Laplacian in Euclidean spaces • elementary solutions
- smoothness of solutions • Vishik-Soboloev problems
- the Schauder theory • degenerate elliptic operators.

Originally in Japanese, Shimakura's book is written for an undergraduate course or first-year graduate course in partial differential equations and is of interest to researchers as well.

1991 *Mathematics Subject Classifications*: 35
ISBN 0-8218-4556-X, 288 pp. (hardcover), June 1992
Individual member $79, List price $132, Institutional member $106
Your ordering code is MMONO/99NA

All prices subject to change. Free shipment by surface; for air delivery, please add $6.50 per title. *Prepayment required.* **Order from:** American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, or call toll free 800-321-4AMS in the continental U.S. and Canada to charge with VISA or MasterCard. Canada residents, please include 7% GST.

AMERICAN MATHEMATICAL SOCIETY

Application for Membership 1992

(January–December)

Date .....19.....

Please read the reverse side of this form to determine what membership category you are eligible for. Then fill out this application and return it as soon as possible.

Subscriptions to the Notices *and the* Bulletin *(New Series) are included as part of your membership.*

.....
Family Name *First* *Middle*

Please indicate below the way your name should appear in the Combined Membership List.

.....
Family Name *First* *Middle or Initial*

Place of Birth .....
City *State* *Country*

Date of Birth .....
Day *Month* *Year*

If formerly a member of AMS, please indicate dates .....

Check here if you are now a member of either MAA ☐ or SIAM ☐

Degrees, with institutions and dates .....

.....

.....

Present position .....

Firm or institution .....

.....
City *State* *Zip/Country*

Primary Fields of Interest (choose five from the list at right)

....

Secondary Fields of Interest (choose from the list at right)

....

Address for all mail

.....

.....

.....

Telephone number(s) .....

Electronic address .....

.....
Signature

Prepayment Methods and Mailing Addresses

All payments must be in U.S. Funds.

Send checks, money orders, UNESCO coupons to American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571

To use VISA or MasterCard, fill in information requested and mail to American Mathematical Society, P.O. Box 6248, Providence, RI 02940-6248 or call (401) 455-4000 or 1-800-321-4AMS.

For Foreign Bank Transfers: The name and address of the AMS bank is Rhode Island Hospital Trust National Bank, Account #000-753-111, One Hospital Trust Plaza, Providence, RI 02903, U.S.A.

VISA ☐ *MasterCard* ☐ ....
Account number *Expiration date*

Fields of Interest

If you wish to be on the mailing lists to receive information about publications in fields of mathematics in which you have an interest, please consult the list of major headings of the 1991 Mathematics Subject Classification below. Select no more than five category numbers and fill in the numbers where indicated on the left. These categories will be added to your computer record so that you will be informed of new publications or special sales in the fields you have indicated.

00 General
01 History and biography
03 Mathematical logic and foundations
04 Set theory
05 Combinatorics
06 Order, lattices, ordered algebraic structures
08 General algebraic systems
11 Number theory
12 Field theory and polynomials
13 Commutative rings and algebras
14 Algebraic geometry
15 Linear and multilinear algebra; matrix theory
16 Associative rings and algebras
17 Nonassociative rings and algebras
18 Category theory, homological algebra
19 *K*-theory
20 Group theory and generalizations
22 Topological groups, Lie groups
26 Real functions
28 Measure and integration
30 Functions of a complex variable
31 Potential theory
32 Several complex variables and analytic spaces
33 Special functions
34 Ordinary differential equations
35 Partial differential equations
39 Finite differences and functional equations
40 Sequences, series, summability
41 Approximations and expansions
42 Fourier analysis
43 Abstract harmonic analysis
44 Integral transforms, operational calculus
45 Integral equations
46 Functional analysis
47 Operator theory
49 Calculus of variations and optimal control; optimization
51 Geometry
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

M2NO

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 $78, for those whose annual professional income is $45,000 or more, the dues are $104.*

*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 $66 and for those whose annual professional income is above $45,000, the dues are $88.*

*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 $156.*

*For either **students** or **unemployed individuals,** dues are $26, and annual verification is required.*

*The annual dues for **reciprocity members** who reside outside the U.S. and Canada are $52. 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 ($78 or $104).*

*The annual dues for **external members,** those who reside in developing countries which do not have any mathematical society, are $55.*

*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.*

1992 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 ..... ☐ $78 ☐ $104

CMS Cooperative rate ..... ☐ $66 ☐ $88

Joint family member (full rate) ..... ☐ $78 ☐ $104

Joint family member (reduced rate) ..... ☐ $58 ☐ $84

Contributing member (minimum $156) ..... ☐

Student member (please verify)[1] ..... ☐ $26

Unemployed member (please verify)[2] ..... ☐ $26

Reciprocity member (please verify)[3] ..... ☐ $52 ☐ $78 ☐ $104

External member ..... ☐ $55

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 Gesellschaft 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 Matemática Argentina
- ☐ Unione Matematica Italiana
- ☐ Vijnana Parishad of India
- ☐ Wiskundig Genootschap

.....

Signature

Order Form

For VISA or MasterCard orders, send to:
American Mathematical Society
P.O. Box 6248
Providence, Rhode Island 02940-6248
(800) 321-4AMS (321-4267)

For orders with remittances, send to:
American Mathematical Society
P.O. Box 1571, Annex Station
Providence, Rhode Island 02901-1571
(401) 455-4000

Ordered by: _____

Mail to (if different): _____

QTY	CODE	AUTHOR and TITLE	PRICE
			$
		☐ Air Delivery	
		Total due (**All orders must be prepaid in U.S. funds**)	$

Charge by phone in the continental U.S. and Canada
800-321-4AMS (321-4267)

☐ Check or Money Order ☐ VISA ☐ MasterCard

Card Number

Card Expiration Date _____ Signature _____

Shipping and Handling

Free shipment by surface; for air delivery, please add $6.50 per book.

NOTI

Please send information about
- ☐ AMS individual membership
- ☐ AMS institutional membership
- ☐ AMS corporate membership
- ☐ AMS institutional associate

Prices are subject to change without notice.

Books are sent via surface mail (UPS to U.S. addresses and printed matter elsewhere) unless air delivery is requested. The shipping and handling charges for air delivery book orders are shown in the table. **Journal back numbers**, *Mathematical Reviews* indexes and review volumes are sent via surface mail to any destination unless air delivery is requested. Postage for surface mail is paid by the AMS. Air delivery rates, which will be quoted upon request, must be paid by the purchaser. **Software:** Nonindividual customers need not prepay provided a Purchase Order number is given with the order. Software/books are sent via UPS to U.S. addresses and via U.S. postal service air parcel post to addresses outside the U.S. Add shipping and handling for Software/Books: $8 per order in the U.S. and Canada; $35 per order air delivery outside the U.S. and Canada; please add 7% GST to all orders totalling over $40 shipped to Canada.

Customers in these areas should request price information from and direct their orders to the following distributors:
Japan: Maruzen Co. Ltd., P.O. Box 5050, Tokyo International 100-31, Japan. Tel. Tokyo 272-7211, Telex J26516
India: Allied Publishers Pvt. Ltd., 15, J. N. Herdia Marg., Ballard Estate, Bombay 400038, India

Staple here

Fold here

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST-CLASS MAIL PERMIT NO. 554B PROVIDENCE, RI

POSTAGE WILL BE PAID BY ADDRESSEE

Customer Services
AMERICAN MATHEMATICAL SOCIETY
P. O. Box 6248
Providence, RI 02940-9943

Fold here

Change of Address

Members of the Society who move or who change positions are urged to notify the Providence Office as soon as possible.

Journal mailing lists must be printed four to six weeks before the issue date. Therefore, in order to avoid disruption of service, members are requested to provide the required notice well in advance.

Besides mailing addresses for members, the Society's records contain information about members' positions and their employers (for publication in the *Combined Membership List*). In addition, the AMS maintains records of members' honors, awards, and information on Society service. Information of the latter kind appears regularly in *Notices*.

When changing their addresses, members are urged to cooperate by supplying the information requested below. The Society's records are of value only to the extent that they are current and accurate.

If your address has changed or will change within the next two or three months, please fill out this form, supply any other information appropriate for the AMS records, and mail to the address given below.

Name: _____ Customer code: _____

Change effective as of: _____

Old mailing address: _____

NEW mailing address: _____

New position: _____

If mailing address is not that of your employer, please supply the following information:

New employer: _____

Location of employer: _____

City State/Province Country Zip Code

Telephone number(s): _____

Electronic address(es): _____

Recent honors and awards: _____

Personal items for publication in *Notices*: _____

Mail completed form to:

Customer Services, AMS, P.O. Box 6248, Providence, RI 02940

or send the above information by email to:

amsmem@math.ams.com or cust-serv@math.ams.com.

Staple here

Fold here

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST-CLASS MAIL PERMIT NO. 554B PROVIDENCE, RI

POSTAGE WILL BE PAID BY ADDRESSEE

Customer Services
AMERICAN MATHEMATICAL SOCIETY
P. O. Box 6248
Providence, RI 02940-9943

Fold here

The American Mathematical Society Announces Two New Titles in its Contemporary Mathematics Series

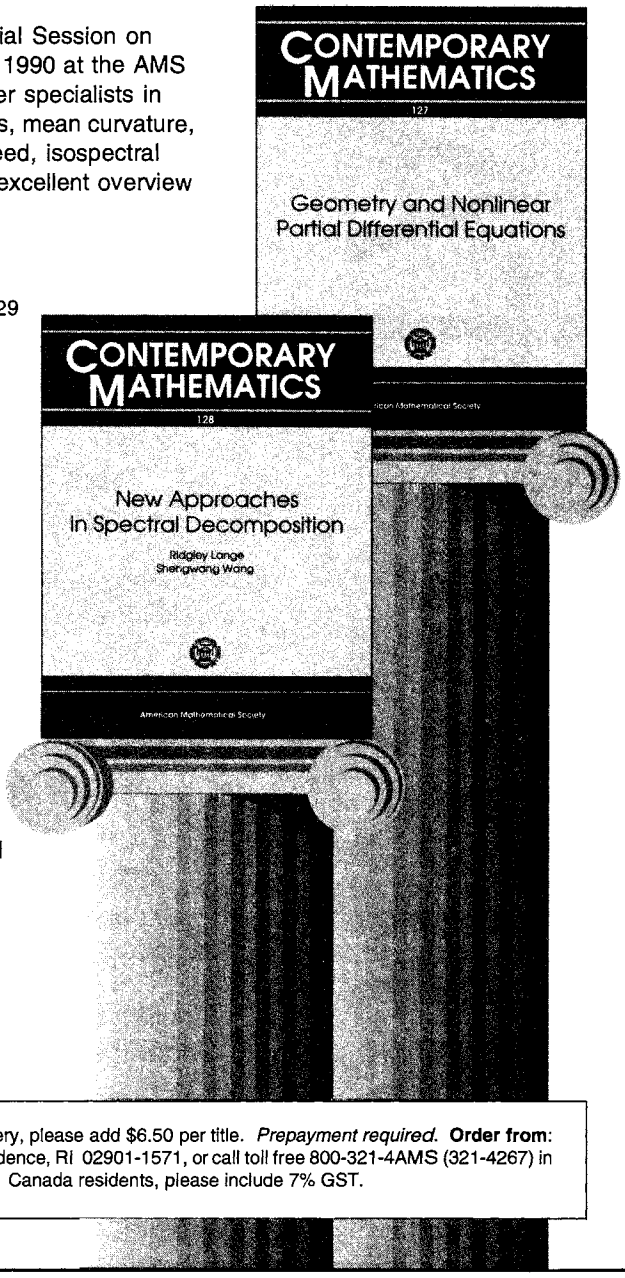
Geometry and Nonlinear Partial Differential Equations

Vladimir Oliker and Andrejs Treibergs, Editors

Volume 127

This volume contains the proceedings of an AMS Special Session on Geometry, Physics, and Nonlinear PDEs, held in March 1990 at the AMS meeting in Fayetteville. The conference brought together specialists in Monge-Ampere equations, prescribed curvature problems, mean curvature, harmonic maps, evolution with curvature-dependent speed, isospectral manifolds, and general relativity. The book provides an excellent overview of the frontiers of research in these areas.

1991 *Mathematics Subject Classification*: 35, 53.
ISBN 0-8218-5135-7, 154 pages (softcover), April 1992
Individual member $22, List price $36, Institutional member $29
Your ordering code is CONM/127NA



New Approaches in Spectral Decomposition

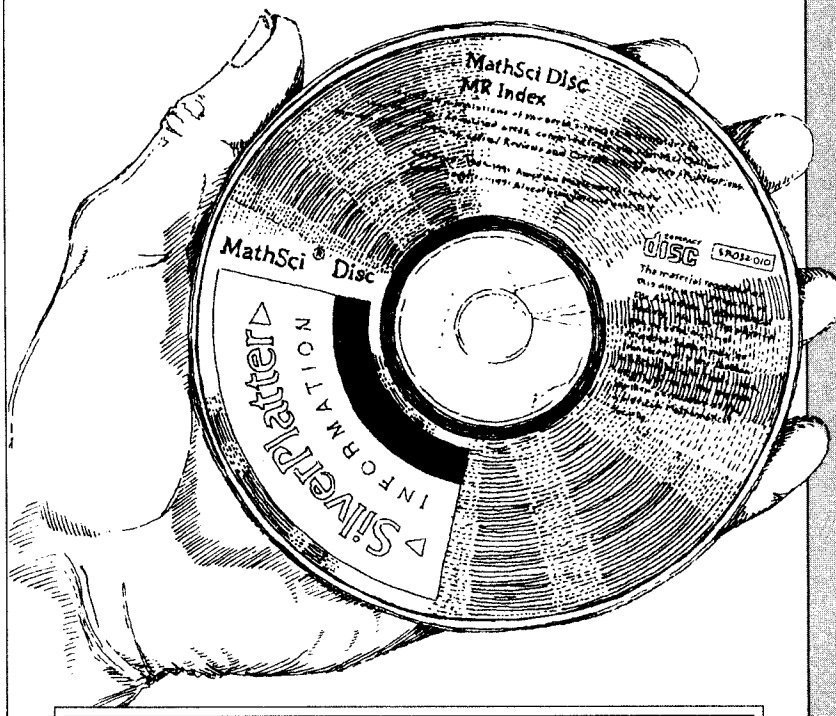
Ridgley Lange and Shengwang Wang

Volume 128

The book begins with a discussion of criteria for decomposable and related types of operators and an analysis that relates and distinguishes among them. Perturbation theory of decomposable and other operators, applications to classical Hilbert space operators, quasisimilarity, and a new class of weakly decomposable operators are also discussed. The book closes with an exposition of some classical theories on invariant subspaces for subdecomposable and hyponormal operators, and a presentation of the parallel spectral theory of commuting systems.

1991 *Mathematics Subject Classification*: 47; 46
ISBN 0-8218-5139-X
272 pages (softcover), May 1992
Individual member $26, List price $44
Institutional member $35
Your ordering code is CONM/128NA

All prices subject to change. Free shipment by surface: for air delivery, please add $6.50 per title. *Prepayment required.* **Order from**: American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, or call toll free 800-321-4AMS (321-4267) in the continental U.S. and Canada to charge with VISA or MasterCard. Canada residents, please include 7% GST.



MathSci Disc

MathSci Disc® —the mathematics reference collection from the American Mathematical Society—now comes to you on three compact discs.

- The first disc—updated every six months—provides you with *Mathematical Reviews* and *Current Mathematical Publications* coverage from 1988 to the present.
- The second disc includes everything in *MR* from 1980 to 1987.
- The third disc, **MR Index (1940–1979)**, is new for 1992. **MR Index** gives you an index to *Mathematical Reviews* published from 1940–79.

Powerful and easy to use.

- Search by author, title, or over 20 other fields.
- Over 1,000,000 records and references will be yours. Imagine trying to find shelf space for all that in print.

How can you put fifty years of mathematics right in the palm of your hand and keep $2800 in your pocket?

Special Offer!

When you buy an **MR Index**, a $700.00 annual credit may be applied toward lease fees for the current **MathSci Disc** for 4 years. Order by September 1992 to take advantage of this special offer.

Call today!

American Mathematical Society
Database Services
Post Office Box 6248,
Providence, RI 02940 USA
1 800-321-4267 (North America)
1 401-455-4166 (elsewhere)
mathsci@math.ams.com (Internet)
1 401-455-4004 (fax)

MathSci is also available online or on magnetic tape.

Call or write for more information.

SPRINGER FOR MATHEMATICS

W.A. Adkins and **S.H. Weintraub**, both of Louisiana State University, Baton Rouge

ALGEBRA

An Approach via Module Theory

Designed for a first-year graduate-level course in algebra. Beginning with an introduction to group theory and ring theory, the book develops the basics of module theory. It then uses module theory to investigate bilinear, sesquilinear and quadratic forms. Finally, a discussion of ring theory and multilinear forms leads to a chapter on group representations, using module theory to powerful effect.

1992/APP. 534 PP., 2 ILLUS./HARDCOVER
$39.95(TENT.)/ISBN 0-387-97839-9
GRADUATE TEXTS IN MATHEMATICS,
VOLUME 137

H.T. CROFT, Cambridge University, England; **K.J. FALCONER**, Bristol University, England; **R.K. GUY**, University of Calgary, Alberta, Canada

UNSOLVED PROBLEMS IN GEOMETRY

Presents a collection of geometrical problems that are easy to state and understand, but are as yet unsolved. The problems cover a wide variety of topics including chapters on convex sets, polyhedra, packing and covering, tiling, and combinatorial problems. The 148 sections each describe a problem or group of related problems along with a discussion of its background and a list of references.

1991/198 PP., 66 ILLUS./HARDCOVER
$39.95/ISBN 0-387-97506-3
PROBLEM BOOKS IN MATHEMATICS
UNSOLVED PROBLEMS IN INTUITIVE MATHEMATICS II

J.H. SILVERMAN, Brown University, Providence, RI; **J. TATE**, University of Texas, Austin, TX

RATIONAL POINTS ON ELLIPTIC CURVES

Emphasizes the number-theoretic aspects of elliptic curves. The first part proves the fundamental theorems of the field: The Nagell-Lutz theorem, Mordell's theorem, and Hasse's theorem. The remainder of the book discusses special topics and newer developments.

1992/250 PP., 35 ILLUS./HARDCOVER
$29.95/ISBN 0-387-97825-9

T.-Y. LAM, University of California, Berkeley

A FIRST COURSE IN NONCOMMUTATIVE RINGS

Intended for a one-semester course in basic ring theory. Includes the Wedderburn-Artin theory of semisimple rings, Jacobson's theory of the radical, representation theory of groups and algebras, prime and semiprime rings, primitive and semiprimitive rings, division rings, ordered rings, local and semilocal rings, and perfect and semiperfect rings. Also includes numerous exercises testing the understanding of the general theory in the text are also included.

1991/397 PP./HARDCOVER/$49.00
ISBN 0-387-97523-3
GRADUATE TEXTS IN MATHEMATICS,
VOLUME 131

F.C. HOPPENSTEADT, Michigan State University, East Lansing, MI; **C.S. PESKIN**, Courant Institute, New York University, NY

MATHEMATICS IN MEDICINE AND THE LIFE SCIENCES

Introduces the subject of mathematical modeling in the life sciences to students of mathematics, the physical sciences, and engineering who are curious about biology. Also useful to students in life sciences and medicine who seek an understanding of biological mechanisms and dynamics through the use of mathematics. Particularly useful to premedical students, as it introduces them to an assortment of phenomena involving genetics, epidemics, and the physiology of the heart, lung and kidney.

1992/252 PP., 73 ILLUS./HARDCOVER
$39.95/ISBN 0-387-97639-6
TEXTS IN APPLIED MATHEMATICS, VOLUME 10

S. ROMAN, California State University, Fullerton, CA

CODING AND INFORMATION THEORY

An introduction to the subjects of information and coding theory at the graduate or advanced undergraduate level. Assumes a basic knowledge of probability and linear algebra. The first quarter is devoted to the basics of information theory, including a proof of Shannon's famous Noisy Coding Theorem. The remainder of the book is devoted to coding theory and has a decidedly algebraic flavor. An appendix reviews relevant topics from modern algebra.

1992/496 PP., 31 ILLUS./HARDCOVER
$49.95/ISBN 0-387-97812-7
GRADUATE TEXTS IN MATHEMATICS,
VOLUME 134

H.-O. PEITGEN, H. JHRGENS and **D. SAUPE**, all of the University of Bremen, Germany

FRACTALS FOR THE CLASSROOM

Part I: Introduction to Fractals and Chaos
Part II: Complex Systems and Mandelbrot Set

PART I: 1992/450 PP., 289 ILLUS./HARDCOVER/$29.00/ISBN 0-387-97041-X
PART II: 1992/APP. 384 PP., 141 ILLUS./HARDCOVER/$29.00/ISBN 0-387-97722-8

SPRINGER 1842 1992 150 FOR SCIENCE

Three Easy Ways to Order:

Call Toll Free 1-800-SPRINGER (NJ call 201-348-4033) or FAX 201-348-4505. Please mention S213 when ordering by phone.
Write to Springer-Verlag New York, Inc., Dept. #S213, P.O. Box 2485, Secaucus, NJ 07096-2491.
Visit your local scientific bookstore or urge your librarian to order for your department.

Payment can be made by check, purchase order, or credit card. Please enclose $2.50 for shipping ($1.00 additional books) & add appropriate sales tax if you reside in NY, NJ, MA, VT, or CA. Canadian residents please add 7% GST.

Remember...your 30-day return priviledge is always guaranteed!

5/92 REFERENCE #: S213