NOTICES OF THE AMERICAN MATHEMATICAL SOCIETY

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Calendar of AMS Meetings and Conferences

This calendar lists all meetings which have been approved prior to the date this issue of *Notices* was sent to the press. The summer and annual meetings are joint meetings of the Mathematical Association of America and the American Mathematical Society. The meeting dates which fall rather far in the future are subject to change; this is particularly true of meetings to which no numbers have been assigned. *Programs* of the meetings will appear in the issues indicated below. *First* and *supplementary* announcements of the meetings will have appeared in earlier issues.

Abstracts of papers presented at a meeting of the Society are published in the journal *Abstracts of papers presented to the American Mathematical Society* in the issue corresponding to that of the *Notices* which contains the program of the meeting, 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. Note that the deadline for abstracts for consideration for presentation at special sessions is usually three weeks earlier than that specified below. For additional information, consult the meeting announcements and the list of organizers of special sessions.

Meetings

Meeting #		Date	Place	Abstract Deadline	Program Issue
860		October 20–21,1990	Amherst, Massachusetts	Expired	October
861		November 2–3, 1990	Denton, Texas	Expired	October
862		November 10–11,1990	Irvine, California	Expired	October
863	†	January 16–19, 1991 (97th Annual Meeting)	San Francisco, California	October 10	December
864	*	March 16–17, 1991	South Bend, Indiana	January 3	March
865	*	March 22–23,1991	Tampa, Florida	January 3	March
866	*	June 13–15, 1991	Portland, Oregon	March 26	May/June
867	*	August 8–11, 1991 (94th Summer Meeting)	Orono, Maine	May 29	July/August
868	*	October 12–13, 1991	Philadelphia, Pennsylvania	August 1	October
869	*	October 25–26, 1991	Fargo, North Dakota	August 1	October
870	*	November 9–11, 1991	Santa Barbara, California	August 1	October
871	*	January 8–11, 1992 (98th Annual Meeting)	Baltimore, Maryland	October 2	December
		March 27–28, 1992	Springfield, Missouri		
		March 13–14, 1992	Tuscaloosa, Alabama		
		June 29–July 1, 1992 (Joint Meeting with the London Mathematical Society)	Cambridge, England		
		January 13–16, 1993 (99th Annual Meeting)	San Antonio, Texas		
		August 15–19, 1993 (96th Summer Meeting) (Joint Meeting with the Canadian Mathematical Society)	Vancouver, British Columbia		
		January 12–15, 1994 (100th Annual Meeting)	Cincinnati, Ohio		
		January 10–13, 1996 (102nd Annual Meeting)	Orlando, Florida		

* Please refer to page 1128 for listing of Special Sessions.

† Preregistration/Housing deadline is November 16

Conferences

January 14–15, 1991: AMS Short Course on Probabilistic Combinatorics and Its Applications, San Francisco, California.

Deadlines

	November Issue	December Issue	January Issue	February Issue
Classified Ads*	October 5, 1990	November 2, 1990	December 6, 1990	January 10, 1991
News Items	October 9, 1990	November 2, 1990	November 28, 1990	January 2, 1991
Meeting Announcements**	September 24, 1990	October 22, 1990	November 28, 1990	January 2, 1991

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

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

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SUBSCRIPTION INFORMATION
Subscription prices for Volume 37 (1990) are $113 list; $90 institutional member; $68 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—$11; to India—$22; expedited delivery to destinations in North America—$24; elsewhere—$49. Subscriptions and orders for AMS publications should be addressed to the American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571. All orders must be prepaid.

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

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

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From the Executive Director ...

A DEVELOPMENT PROGRAM

Activities taking place within the administration of the Society indicate significant new initiatives. A commitment has been made for an Associate Executive Director responsibile for developing and administering programs sponsored by the Society. In addition, the Society is establishing a professional development staff to plan and administer a fund raising effort. These events indicate a more pro-active role for the AMS in addressing the concerns of the mathematical sciences community.

The Society has supported its activities and service to the community primarily through its publication program. Indeed, over seventy percent of the Society's annual revenue is from the publication program. (Dues account for about nine percent of revenue, as does federal funding for symposia, summer research conferences, etc. The remaining ten percent, or so, of revenue comes from meetings, other products, and sale of services.) Historically the Society has done well with operational income and has a sound financial position. Now, however, there is a broader perception of the Society's responsibilities that requires a more active role in lending its prestige and resources in support of the mathematical sciences enterprise. As the AMS plans its activities to fulfill its mission and to serve its membership and the mathematical sciences community, it must look beyond traditional resources and find other sources of funding.

It is important to realize that a development program involves much more than fund raising. It also involves planning, goal setting and program development. The AMS Long Range Planning Committee is charged with determining the role and identifying long-term goals within the Society's basic mission. The Committee's deliberations should lead to a clear statement of what the Society hopes to accomplish. The specifics of how the Society plans to accomplish its goals require careful planning and program development. The Society is attempting to focus and articulate how it can best serve the mathematics community. This formative period is very significant and exciting. It is important that this excitement and dedication to the activities and programs of the Society be shared by both the leadership and the membership and be transmitted to all potential supporters.

It is clear that a call has been made to government, universities and the mathematical sciences community to act together to ensure a healthy mathematical research enterprise. The Society holds a pivotal position among these entities through its collective representation of a large and important segment of the mathematical sciences community and its role as advocate and spokesperson for the profession. It is quite natural, and it is the responsibility of the Society, to be at the forefront in addressing the concerns of the mathematical research enterprise. The coming months should bring more reports on these activities and a statement of goals. The governing bodies and the administration of the Society have made a serious commitment to development. However, success in development requires credible goals, a well articulated needs plan, good strategy and, above all, organizational and volunteer leadership.

William Jaco

Letters to the Editor

Human Rights of Mathematicians Still Violated in the USSR

I write this to warn mathematicians against too much enthusiasm on the occasion of current changes in the Soviet Union. So far they affect the communist practice somewhat less than it may seem from the outside. I want to exemplify this by continuing purposeful violations of Human Rights of Mathematicians, of which the genuine origin and aim are quite transparent. Some time ago a number of high-ranking K.G.B. officials repeatedly stressed in the Soviet mass media that a top priority of their department now is 'a fight for every Soviet citizen'. Being applied to mathematicians among other scientists, this Aesop language euphemism clearly indicates that K.G.B. is doing its best (or, to remember its habits, rather its worst) to prevent a growing brain-drain from the USSR (which process indeed looks like an exodus recently). Now–a very few typical examples, of which a number could be multiplied by every second Soviet mathematician.

1. We are not free to send manuscripts of papers to the West. A number of copies of manuscripts sent to my Western colleagues have returned back 'from nowhere', being equipped with an anonymous inscription stating that 'manuscripts should be sent via an institution only'. Nevertheless, even an official joint permission granted by the Institute of Mathematics and the regional censorship OBLLIT to send a paper to the West does not really mean that it will reach its destination. A paper sent by me this way to the Israel J. Math. last June has merely 'disappeared'.

2. We are not free to receive mail from our Western correspondents. In 1988-1989 *Notices* came to me precisely two months late (say, a January issue - on March 15, etc.) and last four or five issues came three months late. Seemingly, someone aims–and quite successfully–at making Soviet mathematicians unable to meet Ads deadlines while trying to apply for a position in the U.S. or elsewhere. Mathematical papers sent to us from the West often are missing, to say nothing about invitations to attend conferences which merely come too late (if ever). Amusingly enough, a recent invitation to a Matrix Theory Conference in Haifa came to me merely without an 'enclosed application form'. The express mail travels especially slowly (seemingly, it deserves special attention). I assume full responsibility for saying that a perlustration and confiscation of letters to and from the West are flourishing in the USSR whatever be said on that occasion by our authorities in mass media.

3. We are not free to travel abroad and hence the normal contacts with our Western colleagues are still impossible. In spite of all the propaganda statements that a visa practice in the USSR already meets international standards (including the recent Vienna agreements), this is far from being so. Having at hand an invitation to visit King's College London, I even failed to obtain application forms at the Novosibirsk Visa Department OVIR last March. (Since officials there do not need to give any explanations the only one I received was a playful advice 'not to believe everything the newspapers claim' and instead 'to wait for a complete democratization in the USSR before applying for travel abroad'.)

I mentioned here only the practice affecting the professional activity of a mathematician, to say nothing about the case that under any Marxist-Leninist regime (the present one is not an exception) the intellectuals apriori form an oppressed section of the society; this is a seperate question.

In view of all the above said, it seems to me highly desirable that neither the American Mathematical Society nor any other mathematical society in the Free World engage in any official joint project with a Soviet governmental organization until after the Human Rights of Mathematicians everyday abuses in the USSR are over. As a member of the AMS, I put forward a proposal to make a corresponding move by the Society.

Vladimir Pestoff
Tomsk State University, USSR
(Received by Editor May 11, 1990)

Policy on Letters to the Editor

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

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

The committee reserves the right to edit letters.

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

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

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

Renewing U.S. Mathematics

A Plan for the 1990s

The following is Appendix B, "Recent Research Accomplishments and Related Opportunities," of the so-called David II report. The main body of the report was reprinted in the September 1990 issue of *Notices*, pages 813–837. The Executive Summary was reprinted in the May/June 1990 issue of *Notices* on pages 542-546. Appendix A of the report is the Executive Summary of the 1984 Report, "Renewing U.S. Mathematics: Critical Resource for the Future". The main body of the 1984 Report was reprinted in the August 1984 issue of *Notices*, pages 435-466; therefore, Appendix A of this report will not be reprinted in *Notices*.

This report was prepared by the Committee on the Mathematical Sciences: Status and Future Directions, under the Board on Mathematical Sciences, Commission on Physical Sciences, Mathematics, and Applications, of the National Research Council.

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Appendix B: Recent Research Accomplishments and Related Opportunities

This appendix describes research achievements in the mathematical sciences and outlines prospects and opportunities that these achievements open up. The richness and diversity of these achievements, which span core mathematics and a wide range of applications, point to the vigor, creativity, and depth and breadth of current research in the mathematical sciences. The unification and cross-fertilization of areas within core mathematics, increased reaching out to applications (which often uncovers unusual and unexpected uses of mathematics), and the growing role of the computer are all themes that are illustrated in these descriptions.

It should be emphasized that this list is only a selection that is not intended to be complete or comprehensive, nor is it intended to be an agenda for the future. Many important achievements and opportunities are not discussed for lack of space. If past patterns continue, a number of new achievements that we cannot visualize now will open up yet newer opportunities. It is interesting and significant to note how many of the achievements described in this appendix were not even suggested in the appendix "Ordering the Universe: The Role of Mathematics" in the 1984 Report.

The committee would like to thank the following individuals for their assistance in preparing this appendix:

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The following topics are discussed:

1. Recent Advances in Partial Differential Equations
2. Vortices in Fluid Flow
3. Aircraft Design
4. Physiology
5. Medical Scanning Techniques
6. Global Change
7. Chaotic Dynamics
8. Wavelet Analysis
9. Number Theory
10. Topology
11. Symplectic Geometry
12. Noncommutative Geometry
13. Computer Visualization as a Mathematical Tool
14. Lie Algebras and Phase Transitions
15. String Theory
16. Interacting Particle Systems
17. Spatial Statistics
18. Statistical Methods for Quality and Productivity

19. Graph Minors
20. Mathematical Economics
21. Parallel Algorithms and Architectures
22. Randomized Algorithms
23. The Fast Multipole Algorithm
24. Interior Point Methods for Linear Programming
25. Stochastic Linear Programming
26. Applications of Statistics to DNA Structure
27. Biostatistics and Epidemiology

Synopsis of Topics

In the first section, "Recent Advances in Partial Differential Equations," the items discussed are formation of shocks in non-linear waves, recent advances in elliptic equations, free boundary problems, and finally some remarkable advances in exactly solvable partial differential equations. "Vortices in Fluid Flow" (Section 2) continues some of these general themes to discuss vortex motion in fluid flow, a phenomenon of great importance in many applications, including the accurate tracing of hurricanes, the study of blood flow through the heart, the efficient mixing of fuel in internal combustion engines, aircraft flight, and the manner in which radiotelescopes sense distant galaxies through the motion of galactic jets.

"Aircraft Design" (Section 3) illustrates the use of computational fluid dynamics, a technique that has matured so that it is now seen as the primary aerodynamic design tool for any problem. Analogous computer models are described in Section 4, "Physiology," which discusses computational fluid models of the heart and other organs. Modern medical scanning techniques using X-rays or nuclear magnetic resonance depend critically on algorithms deriving from the mathematics of the Radon transform. Recent progress in emission tomography is based on some newly developed algorithms of a very different sort that have probabilistic elements; these developments are described in Section 5, "Medical Scanning Techniques." Finally, "Global Change" (Section 6) discusses the key role played by computational fluid dynamics in global circulation models that are used in the analysis of climate change on a worldwide scale.

Section 7, "Chaotic Dynamics," shows how ideas of Poincaré on aperiodic orbits for ordinary differential equations, complemented by ideas from topology, differential geometry, number theory, measure theory, and ergodic theory, plus the ability of modern computing facilities to compute trajectories, have led to a body of core mathematics that has many interesting and important applications.

"Wavelet Analysis" (Section 8) outlines how classical ideas growing out of Littlewood-Paley and Calderón-Zygmund theory have been developed within core mathematics and then have led to new and very efficient numerical tools for analysis of a wide variety of problems. Algorithms based on wavelet analysis promise to significantly speed up communications and signal-processing calculations. The discussion titled "Number Theory" (Section 9) centers on a classic area of core mathematics that is actively and vigorously moving forward, spurred on in part by the resolution of the Mordell conjecture in the early 1980s. Advances of great significance for the future include new results on the local-to-global problem in number theory and in arithmetic algebraic geometry, and significant progress on Fermat's last theorem. Section 10, "Topology," notes important advances in major problems in low-dimensional topology, including remarkable connections with Yang-Mills theory, and recent advances in knot theory that involve a striking and unexpected connection with von Neumann algebras and mathematical physics.

Section 11, "Symplectic Geometry," is devoted to important recent developments in that field, including the use of nonlinear elliptic equations to establish a form of the Heisenberg uncertainty principle, the discovery of new kinds of symplectic structures, and a basic advance in the understanding of regions of stability for area-preserving maps of the plane.

"Noncommutative Geometry" (Section 12) describes a broad spectrum of very interesting developments involving a link between analysis and geometry and how the ideas of differential geometry extend to a noncommutative setting. This is an excellent example of cross-fertilization between areas within core mathematics and the building of an internal unification.

The availability of powerful computers is stimulating research in core mathematics. Section 13, "Computer Visualization as a Mathematical Tool," indicates how computer graphics can be used as a tool in minimal surface theory and other areas of geometry to enhance understanding and provide experimental evidence stimulating conjectures.

The exposition in Section 14, "Lie Algebras and Phase Transitions," displays the rich and deep interaction between this topic in statistical mechanics and a number of areas of mathematics, including especially the Kac-Moody Lie algebras. "String Theory" (Section 15) discusses another topic in physics that relies heavily on developments from core mathematics. Section 16, "Interacting Particle Systems," indicates how systems similar to those discussed in the context of phase transitions can have applications in the study of biological systems, image processing, and for medical and defense purposes. "Spatial Statistics" (Section 17) describes an area that addresses some overlapping problems and uses new statistical tools for handling data in multidimensional arrays. Section 18, "Statistical Methods for Quality and Productivity," discusses problems, opportunities, and new methods for addressing important problems of national interest and significance.

"Graph Minors" (Section 19) surveys some recent results in graph theory, which open up new avenues for research especially important in the design of algorithms. Section 20, "Mathematical Economics," describes some important recent developments and discusses how several parts of core mathematics, especially differential topology, have played key roles in the analysis of general equilibrium theory for incomplete markets, a new departure that is a better model for real markets than the now classic model for complete markets.

The next group of topics have as a common general theme the search for new and efficient algorithms. "Parallel Algorithms and Architectures" (Section 21) concerns the design of algorithms to take advantage of parallel architectures, a problem not only for computer scientists but also for mathematicians working in large-scale computation. Here the idea is to see how problems that seem to be inherently sequential can be parallelized. Section 22, "Randomized Algorithms," describes recent progress in the development of these new kinds of algorithms. Such algorithms are useful in primality testing, with resulting consequences for cryptography, in sorting and searching algorithms, in the design of distributed computing systems, and in many other areas. The subject of Section 23, "The Fast Multipole Algorithm," is a new, very efficient algorithm for computing interactions in many-particle systems. This algorithm will have many applications in the modeling of high-powered electron beam devices and in molecular dynamics, which affects theoretical studies of chemical kinetics.

The next two sections discuss recent advances in algorithms for numerical optimization; Section 24 is devoted to the new and very important interior point methods for linear programming, which provide an alternative to the classic simplex methods and are beginning to have a significant practical impact in the design of telecommunications networks and the solution of large-scale logistics planning and scheduling problems. Section 25 discusses yet another approach—stochastic linear programming, a technique that allows one to include non-deterministic elements in the formulation and solution of a problem. Thereby real problems that involve uncertainties in future behavior or availability of resources can be better modeled.

Sections 26 and 27 discuss an array of applications of mathematics in various additional areas. "Applications of Statistics to DNA Structure" includes as an application the statistical analysis of options for cutting the DNA sequence to aid in the mapping processes, and analyzing the evolutionary process at the genetic level. "Biostatistics and Epidemiology" is devoted to the use of statistics in epidemiology, including survival analysis, analysis of incidence rate and relative risk, and deconvolution techniques for estimating infection rates and incubation periods from observed data.

1. Recent Advances in Partial Differential Equations

An important trend of the last 15 years has been the great progress made in understanding nonlinear partial differential equations (PDEs). Many physical phenomena are described by partial differential equations, e.g., fluid flow, electromagnetic fields, gravity, and heat. Roughly speaking, linear partial differential equations govern small vibrations or small disturbances from equilibrium, while nonlinear equations govern large disturbances. The real world is nonlinear. Since the mid-1970s, understanding of nonlinear equations has grown much deeper. Finally, in the last few years, some of the most important equations from geometry, physics, and engineering have been successfully studied. Many other equations are still too hard, and much more work is needed. Among the important problems solved recently are the following.

Formation of Shocks in Nonlinear Waves

In one space dimension, a small, smooth initial disturbance will be propagated by any truly nonlinear wave equation into a shock after a finite time. In more than four space dimensions, such shocks do not have to form. In three dimensions, "most" wave equations lead to shocks, but only after an exponentially long time. Moreover, an important class of equations (those satisfying a natural geometric property called the "null condition") do not build up shocks. Very recently there have been significant advances for one of the most important nonlinear equations, Einstein's equations for gravitational waves. At large distances and after a long time, one has a detailed picture of how gravitational waves behave. Very difficult and interesting questions remain in the study of Einstein's equations. Of special interest is the formation of black holes.

Elliptic Equations

Another important class of partial differential equations arises in geometry, when one tries to construct surfaces with prescribed curvature. These equations are called nonlinear elliptic differential equations. A general theorem on regularity of solutions of elliptic equations with boundary conditions was recently proved, making it possible to treat boundary conditions that arise inevitably in real problems. This result is a basic step forward in the analysis of partial differential equations.

Important progress has been made also on some singular elliptic equations, namely those having "critical nonlinearity." If the nonlinear term in such an equation were made slightly weaker, then the equation could be regarded as a small perturbation of a linear problem, but at the critical nonlinearity this becomes impossible. An outstanding equation of this kind occurs in the Yamabe problem, in which one is asked to deform a curved manifold until it has constant (scalar) curvature.

A complete solution to this problem has recently been established.

Free Boundary Problems

An iceberg melting in the sea, the flow of oil and water through a reservoir, and crystal growth are examples of free boundary problems governed by partial differential equations. For the melting iceberg, the temperature flow in the iceberg is governed by one parabolic partial differential equation, the temperature flow in the water around the iceberg by another, and the boundary between ice and water is given by a third equation. The three equations are coupled. What makes the problem very hard is the fact that the domains where the differential equations are satisfied keep changing with time, and are not known ahead of time. Recently proposed techniques have already led to new regularity theorems for free boundary problems and promise further results.

Exactly Solvable Partial Differential Equations

Remarkably, a number of nonlinear PDEs can be solved exactly. These equations admit stable solutions (solitons) that persist even after interaction with other solitons. Recently, equations for solitons have been used to solve the Schottky problem, an outstanding open problem in the theory of Riemann surfaces.

The method used to solve soliton equations may be illustrated by the case of the Korteweg-deVries (KdV) equation, which describes the propagations of water waves in a long, narrow channel. At a single instant of time, we imagine the shape of the water wave to be frozen and rigid. We then bombard the rigid shape with imaginary quantized test particles. By studying how the test particles are scattered, one can reconstruct the shape of the wave. Thus, the scattering data provide an alternative description of the wave at a fixed time. Instead of asking how the shape of the wave changes with time, we can therefore ask how the scattering data evolve with time. When rewritten in terms of scattering data, the KdV equation becomes amazingly simple, and the complete solution may be written down by inspection. In particular, the highly stable behavior of solitons is explained for the case of the KdV equation.

More recently, a number of physically interesting PDEs have been solved completely by analogous methods, including the Kadomtsev-Petviashvili (K-P) equation for weakly two-dimensional water waves, and the sine-Gordon and nonlinear Schrödinger equations. Explicit solutions of the K-P equation successfully predicted the results of experiments in water tanks, and a combination of theoretical and numerical analysis has been applied to model the behavior of a Josephson junction. Remarkable connections have been discovered between explicit solutions for nonlinear waves, exact solutions of statistical mechanics problems in two dimensions, and the Jones polynomials for knots, some of which are discussed below in sections on phase transitions and topology.

2. Vortices in Fluid Flow

Intense swirling or vortex motion is a primary feature of many problems, including the accurate tracing of hurricanes and studies of blood flow through the heart, efficient fuel mixing in carburetors, aircraft flight, and the manner in which radiotelescopes sense distant galaxies through the motion of galactic jets.

Governing much of this flow is a complicated set of nonlinear partial differential equations called the Navier-Stokes equations; these equations are derived from Newton's laws of motion and include the frictional effects of viscosity. Intuition suggests that this frictional effect is extremely small in air or rapidly moving water, and this is confirmed by experiments. The simpler partial differential equations obtained when this coefficient vanishes are called Euler equations. These are accurate enough for studying the movement and accumulation of vortices.

Recent ingenious large-scale computer simulations using these equations reveal unexpectedly that the sheets where vorticity typically accumulates clump and concentrate in an amazing fashion. In response to these discoveries, a new mathematical theory of "oscillations and concentrations" has developed using potential theory and fractal (Hausdorff) measures. New kinds of "solutions" for the Euler equations are being introduced. One outgrowth of this theory is an explicit criterion to check whether numerical calculations for the vortex sheets actually converge to solutions of the Euler equations. Convergence has been verified for many calculations of importance.

The vortex sheets in the applications just described involve fluid moving at rapid speed but still much less than the speed of sound. Completely different phenomena transpire when the vortex sheets are supersonic, as they are for the new space planes and for galactic jets in astrophysics. One recent success in the alliance between large-scale computing and modern mathematical theory is the discovery of a new mechanism of nonlinear instability for supersonic vortex sheets. Recent large-scale simulations have demonstrated that all supersonic vortex sheets exhibit nonlinear instability, belying the predictions of stability made in the 1950s and 1960s.

One of the most important problems in fluid dynamics, an extension of the study of vortices, is the understanding of turbulence, which occurs when the frictional effect is extremely small but not negligible. Understanding turbulence requires the mathematical analysis of solutions of the Euler and the Navier-Stokes equations in the limit of small viscosity. This analysis is ongoing.

3. Aircraft Design

Within the last five years, full simulations of a whole aircraft have appeared. Such a computation usually starts with steady Euler equations that accurately describe the flow outside the boundary layer. Such flows are smooth until the Mach number, M, comes close to 1. For Mach numbers in the transonic range—that is, less than but close to 1—small shocks are generated from a typical airfoil that dramatically increase the drag. It is a mathematical theorem that in almost all cases such shocks cannot be avoided. Since the cruising efficiency of a plane is roughly proportional to ML/D, where L is lift and D is drag, it is imperative for manufacturers to design aircraft that minimize shocks. Of course if M exceeds 1, there is no avoiding or even minimizing shocks, and we have the inefficiency of the Concorde. In the past 15 years, great effort has been put into designing two-dimensional airfoil cross-sections that at some cruising speed or range of cruising speeds with M less than 1 have minimal shocks. When a wing cross-section is chosen, the flow at design conditions is computed and compared with wind tunnel results.

To extend the computation to the whole aircraft, new computational capabilities have been added. The complex geometrical configurations demand new methods not only for discretizing the equations but also for handling the enormous volume of data. Currently the challenge is to resolve higher-dimensional shocks and vortex sheets to predict viscous effects as described in the previous section. The most useful end product of simulations is a determination of how surface pressure varies with such parameters as Mach number and the angle of attack. Varying parameters on the computer is much more economical than doing enormous numbers of experiments in a wind tunnel.

The simple model provided by the Euler equations is remarkably good, airplane flight being basically stable. But key elements are missing. Despite considerable effort, there is still no good mathematical model for the turbulent boundary layer, and when one is found it will increase the size of the computation at least as much as by adding a dimension. An ultimate goal of design is to pick an optimal pressure distribution and then find the aircraft shape that corresponds to it. Such inverse problems also increase drastically the computational needs. The hope is that computer hardware speedups and algorithmic improvements will combine to make these goals achievable.

One area of particular note is the design of aircraft engines. A typical example is a turbomachinery compressor simulation where instantaneous temperature contours are calculated. This computation is based upon time-dependent Navier-Stokes equations. Simulations show viscous wakes created by the blades and how some of the blades chop or break these wakes into different pieces, creating an extremely complex flow pattern. This flow pattern would be difficult or impossible to describe and adjust without dependable mathematical models coupled with computer simulations.

For very-high-altitude high-speed conditions, numerical simulations are also being used for vehicle design. At these altitudes, air can dissociate into its atomic constituents and even eventually ionize, creating a situation that is extremely difficult to simulate in ground-based experimental facilities. As a result, numerical flow simulations, with the appropriate air chemistry models added, are currently being used as an integral part of the design process for many high-speed or atmospheric entry vehicles.

The best summary of the situation has been given by Goldhammer and Rubbert:

> The present state-of-the-art has progressed to the point where the design engineer no longer considers Computational Fluid Dynamics (CFD) to be an irritant imposed on him by a seldom seen researcher, but rather CFD is regarded as the primary aerodynamic design tool for any problem, and the wind tunnel is treated as more of an evaluation and confirmation tool.[1]

4. Physiology

In the realm of physiology mathematical modeling has come into its own over the last ten years. Today there are computational models of the heart, the kidney, the pancreas, the ear, and many other organs. Many of these models rely on fluid dynamics.

Physiological fluid dynamics has a long and illustrious history. Leonardo da Vinci first described the vortices that form behind heart valves and that enable the valves to avoid backflow by closing while the flow is still in the forward direction. Leonhard Euler first wrote down the partial differential equations for blood flow in arteries. With the recent flowering of computer technology and numerical algorithms, there is unprecedented opportunity to simulate the fluid dynamic functions of the human body at a level of detail sufficient to be of use in the understanding and treatment of disease.

For instance, blood flow in the heart is governed by coupled equations of motion of the muscular heart walls, the elastic heart valve leaflets, and the blood that flows in the cardiac chambers. Computer solutions allow one to study both normal and diseased states, and lead to the design of prosthetic devices such as artificial valves and artificial hearts. The methods used have a very general character since they are applicable to any problem in which a fluid interacts with an elastic medium of complicated geometry. Among these are the flow of suspensions, blood clotting, wave propagation

in the inner ear, blood flow in arteries and veins, and airflow in the lung. Like much of computational fluid dynamics, this work pushes computer technology to its limits, and future progress is strongly tied to the further development and availability of supercomputers.

Early research began with the development of a two-dimensional computer model of the left side of the heart. The model was designed for computer experiments on the mitral valve, which has the appropriate symmetry for two-dimensional studies. The computer experiments were successfully compared with physiological experiments, such as those studying the optimal timing of the atrial contraction in relation to that of the ventricular contraction. The computer model was trustworthy enough to use for parametric studies leading to optimal designs of prosthetic cardiac valves.

With supercomputers, it has become possible to extend this work to three dimensions. This raises the prospect of additional applications such as flow through the aortic valve, the mechanical consequences of localized damage to the heart wall, interactions of the right and left ventrical, flow patterns of blood in the embryonic and fetal heart, the fluid dynamics of congenital heart disease, and the design of ventricular-assist devices or even total artificial hearts.

A general-purpose three-dimensional fiber-fluid code has already been developed that solves the equations of motion of a viscous incompressible fluid coupled to an immersed system of elastic or contractile fibers, using the vector architecture of the Cray. The fiber-fluid code has been tested on problems involving an immersed toroidal tube composed of two layers of spiraling fibers. In one of these tests, the fibers were contractile (i.e., muscular) and peristaltic pumping was achieved by sending a wave of muscle contraction around the tube. With a sufficiently strong contraction, a small region of entrained fluid was seen being convected along at the speed of the wave.

A three-dimensional fiber-based model of the four-chambered heart and the nearby great vessels is now under construction for use with the general-purpose fiber-fluid code described above. It includes the right and left ventricles, realistic aortic and pulmonic valves complete with sinuses and the beginnings of their respective arteries, and preliminary versions of the mitral and tricuspid valves.

5. Medical Scanning Techniques

Significant progress in inverse problems in medicine has occurred in the last five years. CAT scanning itself is no longer a research topic but is an established, fixed technology. The new advances have occurred in magnetic resonance imaging (MRI) and in emission tomography, which are similar to CAT scanning from a superficial mathematical viewpoint in that they each involve indirect measurements of a three-dimensional quantity or image of interest and then use mathematical inversion of the measured quantities to reconstruct the actual image.

In MRI a large magnet and surrounding coil measure the resonating magnetic field inside the patient, due to an unknown density of hydrogen atoms, which act like little spinning magnets. The mathematics used to reconstruct the hydrogen density uses the inverse Fourier transform applied to the measured signal. This allows the determination of the density of magnetic spins, or the concentration of hydrogen atoms inside the patient, which in turn gives an image of the interior tissue similar to but much better than a CAT scan. Bones appear black instead of white because, while they have a high X-ray attenuation density, they have a low hydrogen density, being largely calcium. Just as in CAT scanning, mathematics is one of the chief technologies in MRI, the main feature being fast and accurate inversion of the Fourier transform.

The new mathematics of emission tomography (ET) is very different from that of either CAT or MRI and involves a nonlinear inversion procedure. In ET a compound such as glucose is introduced into the body with the carbon atoms in the glucose being radioactive isotopes of carbon. Counts of radioactivity are measured in a bank of detectors surrounding the body. One mathematically inverts the detected count data and reconstructs the emission density; i.e., one finds where the radionuclide was deposited by the body's metabolism. A beautiful and elegant new algorithm produces an emitter-density that to a first approximation maximizes the probability of seeing the actual observed counts. This statistically based maximum likelihood algorithm has the great advantage that it addresses the main limitation of ET, namely that it is count-limited. The mathematics involves no Fourier transforms, but instead the convergence of a nonlinear iteration scheme. Given the universality of mathematics, it should not be surprising that the algorithm is new only to ET: it is a known algorithm that first arose in the 1960s in a problem in decryption of Soviet codes. Emission tomography has so far been mainly used not as a clinical tool, but to study metabolism in the human being.

6. Global Change

Of the many environmental issues that have received public attention in recent years, perhaps the most far-reaching is the possible effect of human activity on the earth's climate. The greenhouse theory holds that recent modification of the atmospheric gaseous composition will result in a gradual warming of the earth's surface as well as a cooling of the upper atmosphere, leading to an unprecedented (in historical times) modification of the earth's climate. However, natural climatic changes can

mask this increase, and there is a critical need to study quantitatively the magnitude of the greenhouse effect within a global climate model under various scenarios, past, present, and future.

The basic theoretical principles rest on the notion of an equilibrium climate, where incoming solar radiation, which is absorbed in the atmosphere and at the surface of the earth, must equal the thermal energy radiated out into space. This balance determines the average temperature at the surface of the earth. The greenhouse effect occurs when the outgoing radiation is partially absorbed by particles and molecules in the upper atmosphere, or troposphere, principally the top 10 to 15 kilometers.

Three-dimensional general circulation models provide a means of simulating climate on time scales relevant to studies of the greenhouse effect. These models, which numerically solve a nonlinear system of partial differential equations, are being used to compute differences between a climate forced by increases in greenhouse gases and a control or current climate. The underlying equations are Euler's equations, with simplifications to take into account the thinness of the atmosphere relative to the distances across the surface of the earth. Long-term predictions must account for thermal adjustment of the oceans, over a time scale of decades, and models need to be devised that are suitable for this purpose. It is important to track not only mean surface temperatures, but also spatial and temporal changes in temperature variability, which can have equally important consequences. These studies will require accurate codes and precise estimates of sensitivity to forcing by the various greenhouse gases on a variety of time scales. As in other geophysical flow calculations, reliable turbulence models are needed in order to estimate turbulent transport.

At a more theoretical level, a basic goal should be to identify the "minimal" dynamical description of the atmosphere-ocean-land that could, on the time scale of decades, provide reliable estimates of climatic change. Methods from dynamical systems theory (see the next section) can be used to reduce the dimension of the system and thereby isolate an "attractor" involving only the dynamical variables essential to greenhouse studies. Detailed but economical calculations of climate sensitivity might then be accessible, giving a new understanding of the influence various incremental combinations of greenhouse gases have on the equilibrium climate.

7. Chaotic Dynamics

The early observations of trajectories of celestial objects appeared to indicate periodic or, at worst, quasiperiodic behavior that could easily be accounted for in mathematical terms. But at the turn of the twentieth century, Poincaré realized that the behavior of trajectories of celestial bodies could be immensely complicated, displaying a "chaotic" motion, forever oscillating yet irregular and aperiodic. Moreover, Poincaré identified a crucial property of systems with chaotic trajectories—sensitive dependence on initial data, which is of particular importance for scientists because very small errors in the measurement of the current system state would result in very unrealistic long-term predictions.

In 1963, a detailed numerical examination of a specific system of differential equations from meteorology revealed unexpected chaotic trajectories. This work not only pointed out the presence of chaotic trajectories in a specific non-Hamiltonian system but also suggested new directions of research in the theory of dynamical systems. Mathematicians and scientists have come to recognize that the amazingly complicated behavior that Poincaré spoke of, and that was demonstrated in these calculations for new kinds of attractors, was in fact present in a wide variety of practical nonlinear systems from ecology, economics, physics, chemistry, engineering, fluid mechanics, and meteorology.

The advent of the computer was essential to these developments, but equally important were the deep mathematical insights. Indeed, the theory of dynamical systems has a rich mathematical tradition, one that involves many areas of mathematics: topology, number theory, measure and ergodic theory, and combinatorics have all been essential to the understanding of dynamical systems, especially the ones exhibiting chaotic behavior. For instance, in dynamical systems with two or more attractors (that is, several types of long-term behavior depending on the initial state), the ability to predict long-term behavior requires a detailed knowledge of the boundary between these different kinds of initial states. These boundaries can be extremely complicated and strange—"fractals." These fractal basin boundaries are currently under investigation by scientists, who need to understand physical systems, and by topologists who see fascinating mathematical structures occurring in a natural way.

A further important development was the realization that regularities can be expected whenever chaos arises through an infinite series of "period doubling bifurcations" as some parameter of the system is varied. Ideas explaining these regularities eventually led to rigorous proofs of the phenomenon. The first rigorous proof carried out the detailed analysis on a computer using a procedure called interval analysis: all calculations are performed with error bounds, so that results lie in intervals. The computer adds or multiplies intervals in which the correct results lie so that all errors are perfectly bounded.

In the analysis of dynamical systems, there is a great need to compute dynamical entities other than chaotic attractors. Mathematicians are now beginning to create new numerical methods for computing the stable and unstable

manifolds of which Poincaré spoke. In a related vein, identification of "inertial manifolds" for partial differential equations is a promising route in the quest to reduce the essential dynamics of an infinite-dimensional dynamical system to that of an appropriate finite-dimensional one. Finally, mathematical investigations of dynamical systems without the concern of immediate applicability, such as work describing complicated flows on spheres, have yielded important insights.

8. Wavelet Analysis

Wavelet analysis, a recent and exciting development in pure mathematics based on decades of research in harmonic analysis, is now addressing important applications in a wide range of fields in science and engineering. There are opportunities for further development of both the mathematical understanding of wavelets and their ever-expanding applications.

Like Fourier analysis, wavelet analysis deals with expansions of functions, but in terms of "wavelets." A wavelet is a given fixed function with mean 0, and one expands in terms of translates and dilates of this function. Unlike trigonometric polynomials, wavelets are localized in space, permitting a closer connection between some functions and their coefficients and ensuring greater numerical stability in reconstruction and manipulation. Every application using the Fast Fourier Transform (FFT) could be formulated using wavelets, providing more local spatial (or temporal) and frequency information. In broad terms, this affects signal and image processing and fast numerical algorithms for calculations of integral operators (not necessarily of convolution type).

Wavelet analysis is an outgrowth of 50 years of mathematics (Littlewood-Paley and Calderón-Zygmund theory) during which harmonic analysts, having realized the difficulties inherent in answering the simplest questions involving the Fourier transform, developed simpler flexible substitutes. Independent of this theory within pure mathematics we have seen variations of this multiscale (multiresolution) approach develop (over the last decade) in image processing, acoustics, coding (in the form of quadrature mirror filters and pyramid algorithms), and in oil exploration. As a companion to the FFT it has been used in analyzing rapidly changing transient signals, voice and acoustic signals, electrical currents in the brain, impulsive underwater sounds, and NMR spectroscopy data, and in monitoring power plants. As a scientific tool it has been used in sorting out complicated structures occurring in turbulence, atmospheric flows, and in the study of stellar structures. As a numerical tool it can, like the FFT, reduce considerably the complexity of large-scale calculations by converting dense matrices with smoothly varying coefficients into sparse rapidly executable versions. The ease and simplicity of this analysis have led to the construction of chips capable of extremely efficient coding and compression of signals and images.

9. Number Theory

There has been impressive progress in number theory in the past five years on several fronts, which in turn has opened up exciting new opportunities. One achievement has been a significant advance in our understanding of what is known as the "local-to-global" principle of certain algebraic curves. The idea of the "local-to-global" principle, which is contained in the classical theorem of Hasse-Minkowski, has to do with a single homogeneous quadratic equation (in many variables) and its solutions. To illustrate it, take a simple case

$$a \cdot W^2 + b \cdot X^2 + c \cdot Y^2 + d \cdot Z^2 + e \cdot WX + f \cdot YZ = 0,$$

where the coefficients a, b, c, d, e, f are integers. With these coefficients fixed, the question one wishes to resolve is, Are there integer values of the variables W, X, Y, and Z (not all zero) that "solve" the above equation, i.e., for which the left-hand side is zero? The Hasse-Minkowski theorem answers yes, if and only if (1) there is a positive integer D such that for each integer N there are integer values of W, X, Y, Z (depending on N) having greatest divisor D and satisfying the constraint that $a \cdot W^2 + b \cdot X^2 + c \cdot Y^2 + d \cdot Z^2 + e \cdot WX + f \cdot YZ$ is a multiple of N; and (2) there are real numbers W, X, Y, Z that "solve" the above equation.

There are reasons (which aid one's intuitive grasp of such problems) to think of the criteria (1) and (2) as asserting the existence of nontrivial local solutions of the equation, while integral solutions of the equation can be thought of as global solutions. This explains the adjective "local-to-global."

The Hasse-Minkowski theorem has been an enormously fruitful theme for research in the quest of broader domains in which the "local-to-global" principle or some modification of it remains valid. One may ask, To what extent does a similar result hold for homogeneous equations of degree higher than 2? It is an old result that such a principle is false for curves of degree 3.

A substitute for the "local-to-global" principle for equations of the above type ("curves of genus one"), which would be (if precisely controlled) every bit as useful as the original "local-to-global" principle, is the conjecture of Shafarevitch and Tate. This conjecture says that, accounting for things in an appropriate way, the "failure of the local-to-global principle" is measured by a finite group. This Shafarevitch-Tate group, which measures the extent to which the local-to-global principle is not valid, is an important object in its own right: it is the

gateway to any deep arithmetic study of elliptic curves, and to the very phrasing of conjectures that guide much research in this area. The conjectures of Shafarevitch-Tate and related ones of Birch and Swinnerton-Dyer comprise some of the great long-range goals of the discipline, and a piece of them has recently been established in a very interesting context.

Another facet of number theory that has seen an enormous amount of activity is arithmetic algebraic geometry. This has figured prominently in work on the arithmetic Riemann-Roch theorem, in the unifying conjectures connecting Diophantine problems to Nevanlinna theory and to differential geometry, and in recent results giving a new and very "geometric" proof of Mordell's conjecture over function fields—a proof that may translate to an analogous new proof in the number field context.

A third significant development of the last five years consists of the conjectures and results that bring some old Diophantine questions closer to the heart of issues perceived to be central to immediate progress in arithmetic. One might mention the recent conjectures of Serre, which suggest much important work to do in the theory of modular forms. Following these ideas, using a prior ingenious construction, it has recently been shown that the Shimura-Taniyama-Weil conjecture (that all elliptic curves over Q are modular) implies Fermat's last theorem. Finally, a beautiful and simple conjecture (often called the ABC conjecture) has been formulated: there is a universal constant e such that, if A and B are nonzero integers with $C = A + B$, then $|A \cdot B \cdot C|$ is less than the e^{th} power of the radical of $A \cdot B \cdot C$, where the radical of a number is the product of the distinct primes dividing it. An essentially immediate consequence of the ABC conjecture is an "asymptotic" version of Fermat's last theorem. It is also true that a vast number of other deep consequences would follow from the same conjecture.

10. Topology

Two of the most basic problems in topology are the following.

I. Suppose one is given two manifolds (the n-dimensional generalization of surfaces) M and M'. How can one recognize whether the two manifolds are topologically the same, like a sphere and an elliptical surface, or whether they are topologically different, like a sphere and a torus (inner tube)? We seek invariants to distinguish between different manifolds.

II. Suppose that one manifold K is embedded in a higher-dimensional manifold M in two different ways. Is it possible to deform one embedding into the other? In the most basic and classical case, one studies an embedding of the circle K into ordinary three-dimensional space M. Such an embedding is a knot, and the goal is to understand when a given knot can be untied, and more generally when one given knot can be deformed into another. Again, invariants are sought to distinguish nonequivalent embeddings of K into M.

For manifolds M of dimension 5 and above, these problems were essentially solved in the late 1960s and early 1970s. Dimensions 3 and 4 are much harder, and are still far from being completely understood. Nevertheless, there has been dramatic progress on low dimensions in the last few years.

For instance, for problem (I) in 4 dimensions, the role of smoothness of possible equivalences of manifolds M and M' has come to the fore. Recently the following remarkable example was found: there is a smooth 4-dimensional manifold M that is topologically equivalent to ordinary 4-dimensional Euclidean space R^4 by a "crinkly" non-smooth map, but that cannot be transformed smoothly to Euclidean space. Perhaps even more amazingly, it has since been learned that the number of such different examples in uncountably infinite. The phenomenon occurs in no other dimension except 4. It came as a complete surprise, both because dimension-4 behavior is so different from the previously known behavior of other dimensions, and because of the remarkable source of the discovery. In fact, the key invariants used to distinguish the exotic 4-manifold from ordinary Euclidean space have their origin in the study of the Yang-Mills equations, originally introduced in particle physics. Thus, an important connection has arisen between particle physics and topology.

Important invariants for the study of problem (I) were also discovered for dimension 3. These invariants, called Casson invariants, recently shed light on a classical and fundamental problem of topology, the Poincaré conjecture. The Poincaré conjecture states that in 3 dimensions, the sphere is the only possible manifold (closed without boundary) whose simplest topological invariant, the fundamental group, is zero. The analogue of this conjecture has been proved in all dimensions except 3. The 4-dimensional case was done as part of the work described above. However, the 3-dimensional case is very difficult, and the statement may actually be false. A standard attempt to produce a counterexample was based on the so-called Rochlin invariant. The Casson invariants work shows that this line of attack cannot yield a counterexample.

Another remarkable recent development in topology concerns Problem (II), in the classical context of knots. The main invariant in classical knot theory was the Alexander polynomial, developed in the 1930s. A weakness of the Alexander polynomial is that it fails to distinguish between a knot and its mirror image. In 1984, in the course of study of questions on von Neumann algebras (a branch of functional analysis motivated by

quantum mechanics), formulas were discovered that bore a striking similarity to classical algebraic formulas from the study of knots and braids. Pursuit of this connection led to the discovery of a powerful new invariant of knots and links, now called the Jones polynomial, which has the important advantage that it distinguishes a knot from its mirror image. It is also easy to compute.

Both the Jones polynomial and the work on exotic 4-manifolds arose through mathematical problems with strong connections to physics. This led to the conjecture that a quantum field theory, an exotic variant of the laws of particle physics, could be constructed, in which the experimentally observable quantities are the invariants described. Such a quantum theory has recently been constructed, and although the work is highly plausible, it has not been rigorously proved. Finding a complete, rigorous proof of these calculations is a challenge for future research.

11. Symplectic Geometry

A fundamental development of nineteenth-century mathematics was Hamiltonian mechanics. A mechanical system composed of many particles moving without friction is governed by a complicated system of differential equations. Hamilton showed that these equations take a simple standard form when the Hamiltonian (the total energy of the system) is taken as the starting point. Hamiltonian mechanics revealed hidden symmetries in classical mechanics problems and was of tremendous importance in the discovery of statistical mechanics and quantum theory.

Today, mathematicians study Hamiltonian mechanics from a global and topological point of view. The basic object of study is a "symplectic manifold," a higher-dimensional surface on which Hamilton's procedure to pass from Hamiltonian functions to differential equations can be implemented. The study of symplectic manifolds is called symplectic geometry, and it has been revolutionized in the last few years. A major breakthrough was the use of nonlinear elliptic equations (see Section 1, "Recent Advances in Partial Differential Equations") and holomorphic curves. This yields a form of the Heisenberg uncertainty principle with many applications, including demonstrating the existence of exotic symplectic structures on Euclidean space and leading to the solution of long-standing conjectures on the number of fixed points of symplectic transformations. The solution of these conjectures is in turn closely related to the Floer cohomology of topology.

If we restrict a symplectic structure to a surface of constant energy, we get a "contact structure." Along with the recent progress in symplectic geometry has come important work on contact structures. In particular, exotic contact structures have been discovered on Euclidean space, distinguished from the standard contact structure by "overtwisting" on embedded discs. Contact geometry has been recently used to show that any open manifold free of obvious topological obstructions can be given a complex structure and embedded into complex N-dimensional Euclidean space. (This works in dimension 6 and above.) The result thus relates complex analysis, contact geometry, and topology.

There is a very substantial branch of mathematics on the border line between symplectic geometry and dynamical systems. It deals with the iteration of area-preserving maps of the plane. Such maps ϕ are the most basic examples of symplectic transformations. In addition to their theoretical importance in core mathematics, they arise in a range of applications from the orbits of asteroids to the confinement of plasmas in a Tokamak machine. As explained in the section on chaotic dynamics, iteration of ϕ can lead to highly complicated unstable behavior.

In the area-preserving case, however, the chaotic behavior coexists with a large class of orbits that are completely stable and predictable, and indeed are almost periodic. Such stable behavior occurs on a family of curves, called KAM curves, that surround those fixed points of ϕ where the map twists. The discovery of KAM curves was a major development of the 1950s and 1960s. It is an important and difficult problem to understand how the plane splits into regions of stable and unstable behavior. A particular case of this problem is to predict the size of the largest KAM curve. This is significant for applications, because the old KAM theory unfortunately could deal only with tiny curves. KAM curves of reasonable size were proved to exist in the last ten years. Recently, with computer-assisted methods, the sizes of the largest KAM curves for (presumably typical) examples of area-preserving maps have been computed to within 10%.

More generally, the state of understanding of the breakdown of stability for area-preserving twist maps used to be that KAM curves are destroyed by nonlinear resonances that occur in orbits of unfavorable "frequency." In the last few years it has been discovered that stable behavior persists even for the resonant frequencies. Although the curves of KAM theory are destroyed by resonances, there remain stable Cantor sets of fractal dimension less than 1. This is an important change in our view of how stability can arise in complicated nonlinear systems. Much remains to be done in this field. Indeed, complete understanding of area-preserving maps of the plane is a remote goal.

12. Noncommutative Geometry

A major mathematical development of the 1960s was to establish an intimate link between the field of analysis and the fields of topology and geometry. This unification

of seemingly diverse areas of mathematics set the stage for numerous interrelations and the tone of mathematics today. The development of modern index theory provided this path. As a first step, mathematicians realized that geometric invariants of manifolds could be computed as analytic invariants of certain Laplace operators and Dirac operators on these manifolds. An abstract version of these ideas has become known as K-theory

In the past five years we have seen a rejuvenation of K-theory, leading to the discovery of cyclic homology, cyclic cohomology, entire cyclic cohomology, and graded (i.e., super) KMS-functionals. These different topics all have been points of view within the new field of noncommutative geometry. Basically, the ideas of differential geometry have been shown to extend to a noncommutative setting. In particular the calculus of differential forms and the homology of currents can be extended to deal with spaces such as the leaves of a foliation, the dual space of a finitely generated non-Abelian discrete group (or Lie group), or the orbit space of the action of such a group on a manifold.

Such spaces are badly behaved as point sets and do not lend themselves to the usual tools of measure theory, topology, or differential geometry. They are better understood by means of associating a canonical algebra to each space. In the case of an ordinary manifold, this algebra is a commutative algebra of functions on the manifold, such as the algebra of essentially bounded measurable functions on the manifold (for measure theory), the algebra of continuous functions vanishing at infinity (for topology), or the algebra of smooth functions with compact support (for geometry). In the realm of noncommutative geometry, these algebras are replaced by noncommutative algebras. In special cases these algebras are von Neumann algebras or C^*-algebras; they lead to the generalization of de Rham cohomology and to its applications, K-theory and index theory.

The basic framework to study such problems is a Z_2-graded algebra, a graded derivation of the algebra, and a trace that satisfies some basic cyclicity axioms. A basic result in this area is the association of a cyclic cocycle to this structure, and the construction of a Chern character for the derivation. In the commutative case, the construction reduces to the ordinary de Rham cohomology theory and its K-theory. In the noncommutative case, the framework is more general.

13. Computer Visualization as a Mathematical Tool

In recent years computer graphics have played an increasingly important role in both core and applied mathematics, and the opportunities for further utilization are enormous. One core area where visualization has been of key significance is in the theory of surfaces. Complex problems that appeared to be intractable have been either completely or partially solved by insight gained from computer graphics.

One such example in surface theory, drawn from the study of soap films, has a long history. A loop of wire immersed in a soapy solution and then withdrawn will support a film of the soap solution characterized by its having the least area among all surfaces that have the given wire loop as boundary. Finding this minimal surface is easily expressed as a problem in the calculus of variations and thus reduced to the study of a certain partial differential equation, the minimal surface equation. While the solutions of this equation are not difficult to describe, at least in the small, the global behavior of the solutions is very delicate, and many questions remain open.

These problems actually have physical significance as well. For example, any physical soap film will not cross itself (i.e., it is embedded), but this property is difficult to determine from the standard representation of the solutions to the minimal surface equation. In fact, up until five years ago, there were only two known embedded minimal surfaces that were complete in the sense that they had no edges. These were the ordinary plane and a surface of revolution called the catenoid. In fact, it had been conjectured that these were the only complete embedded minimal surfaces in three-space.

In 1983 a new example was found of a minimal surface that had the topology of a torus punctured at three points. This surface seemed, by evidence based on the theory of elliptic functions, to be a good candidate for a counterexample to the above conjecture. However, the complexity of the defining equations made a direct attack on the embedding problem difficult. When a computer was used to make sketches of the surface, the surface was seen to have extra symmetries that had been overlooked in the purely analytic description. These symmetries not only made the surface easier to visualize, but also suggested a possible line of reasoning that eventually led to a proof that the surface was indeed embedded, thus disproving the conjecture. Moreover, features of this surface suggested a generalization that allowed mathematicians to construct an infinite family of embedded complete minimal surfaces. These new examples have invigorated the subject of minimal surfaces in general, and recent progress in the subject has been closely linked to computer graphics.

More general calculus-of-variations problems have recently been approached by computer graphics techniques, which are invaluable in formulating and testing conjectures. It is clear that our understanding of global and stability problems in the calculus of variations is being tremendously enhanced by computer graphics. As an example, in 1988 the first computer simulations and visualizations of soap bubble clusters and other optimal

energy configurations in three dimensions were computed and displayed. In particular, this allowed close study and experimentation with the geometry of the interfaces. Programs were also developed that in principle allow the interactive construction of minimal area surfaces: draw a knot in space, specify the topological type of surface of interest, and the program will compute and display a beautiful minimal surface in that class. Along similar lines, it has been possible for the first time to compute and visualize some striking crystalline minimal surfaces.

In an entirely different direction, a theory called "automatic groups" has been developed. This is the theory of that class of infinite groups that can be analyzed by finite-state automata, for example, word problems that can be solved by computer; the theory involves issues similar to those used in constructing word-processing programs. Typical automatic groups include the groups of geometry. A computer program has already been used in explorations of the limit set of certain quasi-fuchsian groups. More generally, the theory is required in order to make a catalog of hyperbolic three-manifolds by computer, an effort that is already well under way.

14. Lie Algebras and Phase Transitions

The past five or six years have seen a fascinating interplay between various branches of pure mathematics and the physical theory of phase transitions in a two-dimensional world. It should be noted that physics in two dimensions is not just a theoretical curiosity: surface phenomena and thin films are much-studied experimental realizations of the theories discussed here. The modern era started in 1944 when Lars Onsager solved the Ising model of ferromagnetism for two-dimensional lattices. The Ising model gives the simplest possible picture of a magnet: "spins" that can point only "up" or "down" sit on the sites of a space lattice and are coupled by pairwise short-range interactions favoring parallel alignment. Onsager's solution showed, for the first time, that a phase transition is accompanied by non-analytic behavior of various physical quantities; for example, the spontaneous magnetization vanishes at a rate proportional to $(T - T_c)^{\beta}$ as the temperature T approaches its critical value T_c, where β is a characteristic exponent. Subsequently, other exactly soluble statistical mechanical systems were found, leading to a large class of completely integrable two-dimensional models.

A remarkable feature found in all these models (and also in heuristic studies of polymer systems, percolation problems, and other two-dimensional systems) was that the characteristic exponents describing the critical non-analyticities were always equal to rational numbers. A deep result of the mathematical developments during the 1980s is that these rational numbers are now understood to label representations of a symmetry algebra of the system, in much the same way that the mysteries of atomic spectra in the beginning of the century were understood in terms of the representation theory of the three-dimensional rotation group.

One line of the development started with the introduction of a natural set of infinite dimensional Lie algebras (Kac-Moody algebras), central extensions of loop algebras of the classical Lie algebras. At the same time another infinite dimensional Lie algebra, the Virasoro algebra, entered physics in the dual resonance models and string theory. While the dual models lost much of their interest for physicists in the 1970s, there were important mathematical developments that grew from them: for instance, the development of a formula for the determinant of the contragradient form of a highest-weight module of the Virasoro algebra, formulas for the characters of integrable representations of the Kac-Moody algebras, and the explicit construction of these representations in terms of vortex operators.

The statistical mechanical developments started in 1984 with the realization that the conformal invariance expected for a physical system at a critical point is, in two dimensions, realized as a symmetry under two Virasoro algebras. The particular central extension (parametrized by a positive "charge" c) characterizes the physical system. The critical exponents turn out to be the highest weights of the representations of the algebra. It was shown that there are very special representations, so-called degenerate ones for $c < 1$, having special rational weights and charges, and it was argued that some of these correspond to known physical models, the Ising model in particular. Subsequently, it was shown that with the additional physical assumption of unitarity, all the $c < 1$ critical statistical systems could be classified and all their exponents computed. Translating this analysis to physical language resulted in explicit computations of the asymptotic correlation functions for the $c < 1$ theories, thus effectively showing that they are all completely soluble.

Progress in the $c > 1$ theories has since been made using the theory of Kac-Moody algebras. It was shown that these algebras occur as symmetry algebras of a two-dimensional field theory. The conformal symmetry now turns out to be closely connected to the algebra of the Kac-Moody symmetry: the Virasoro algebra is embedded in the enveloping algebra of the Kac-Moody algebra by an algebraic construction. This provides many new concrete Virasoro representations, and more importantly the so-called coset construction. It was shown that a given representation of a Kac-Moody algebra leads to a host of Virasoro representations, corresponding to subalgebras of the Lie algebra. Thus an even more general infinite family of critical statistical systems was identified on the basis of symmetry. The possibility of classifying so many, if not all, statistical mechanical systems exhibiting

critical behavior, albeit in two dimensions, would have been considered purely utopian only ten years ago.

15. String Theory

Some of the most exciting developments in recent mathematics have their origin in the physicists' string theory, the so-called "theory of everything." This development offers a classical example where a physical science required a great deal of sophisticated mathematics, much of which had, surprisingly, already been worked out by mathematicians pursuing other "pure" mathematical motivations. The physical theory returned the favor with a cornucopia of new intuitions and insights. The turnaround time for such cross-fertilization may have set speed records in this instance!

To the nonspecialist the most striking feature about string theory is that it replaces the idea that the smallest idealized physical particle might be thought of as a concentrated "point particle" with the idea of exceedingly small but extended strings. A point particle moving through space with time traces out a trajectory, called the "world line" of the particle, which summarizes its physical history. A string moving through space with time traces out a surface, called the "world sheet." The underlying mathematics of surfaces is much more sophisticated than that of curves, so the basics of string theory are much more complex than previous physical theories.

The entry of new mathematics into string theory is forced by principles of invariance—one must eliminate superfluous parameters from the description of the theory. Three such principles emerge: *parameter invariance* on the string (the labeling of positions on the string is physically irrelevant); *conformal invariance* on the world sheet (only angles and not lengths are important prior to the appearance of mass); and *gauge invariance* on the string (physical quantities will be independent of the measuring frames of reference). This last principle has already had a profound effect in physics and mathematics, being the basis of all current descriptions of electromagnetism and elementary particles. Parameter invariance calls upon the theory of an infinite-dimensional symmetry group of the circle, the diffeomorphism group. Gauge invariance calls upon the theory of the infinite-dimensional Kac-Moody algebras and groups. These rose to prominence in mathematics both for mathematical reasons and because of their use in earlier physics as "current algebras." Finally, conformal invariance calls upon a vast wealth of algebraic geometry and moduli theory for Riemann surfaces (Teichmuller theory). This is most surprising, since previously algebraic geometry had seemed largely remote from the physical world.

When matter appears and gravitational effects must be described, current string theory calls for the replacement of points in space-time by very small closed six-dimensional surfaces! In order to reproduce the physics we already know at larger length scales, the geometry of these surfaces will have to obey an analogue of Einstein's equations from general relativity. These had already been studied by mathematicians. Their work was motivated by algebraic geometry and partial differential equations, the latter being classically the main vehicle for exchange between mathematicians and physics.

Many mathematical problems for future study have been posed by string theory. The most significant appear related to the study of surfaces considered up to conformal equivalence (as in conformal invariance above), and the topology and geometry of other low-dimensional figures (three- and four-dimensional surfaces). Indeed, Witten has developed a physical dictionary of the entirety of low-dimensional geometry. This dictionary suggests, for physical reasons, a long list of deep questions and constructions. For example, in the study of knots in three-space, this physical picture contains whole new outlooks on even the most subtle recent studies of knots (including the Jones polynomial; see Section 10). On the other hand, string physics is giving more shape and direction to our study of infinite-dimensional geometry. This will be an open task for years to come.

It is eerie and uncanny, both to physicists and mathematicians, that what was considered central and important for pure or aesthetic reasons by mathematicians has proved ultimately to be the same mathematics required by physical theory. It should be emphasized that this mathematics derives from a period considered the most abstract in the history of the field.

16. Interacting Particle Systems

This area of probability deals with configurations of particles that evolve with time in a random manner. Typically, a particle moves, dies, or gives birth according to its specified law, which depends only on the state of the system in some neighborhood of the particle.

Interacting particle systems have their roots in the study of the Ising model described above but now pertain to a wide variety of applications from the study of biological systems to image processing for medical and defense purposes. The contact process, a basic model for the spread of a biological population, was introduced in 1974. In contrast to branching process models, this system allows there to be only a bounded number of individuals per unit area. This physically reasonable constraint makes the system very difficult to study analytically. The basic properties of the one-dimensional case (linear growth of the system when it survives and exponential decay of the survival probability when it dies out) were settled early in this decade, but

only very recently have the corresponding facts been proved for the important two-dimensional case.

Variations of the contact process with several types of particles are now being applied to the study of competition of species and host-parasite or predator-prey system. Other models more closely related to percolation are being applied to the study of the recent forest fires in Yellowstone. A third example is the study of the distribution and dynamics of antarctic krill. This last system is particularly interesting since it displays patterns on multiple spatial and temporal scales. The preceding are just three of a growing list of examples that show interacting particle systems are an appropriate framework for understanding the mechanism at work in various ecological phenomena.

17. Spatial Statistics

The keen interest in the development of theory and methods for spatial statistics is strongly driven by an array of applications including remote sensing, resources estimation, agriculture and forestry, oceanography, ecology, and environmental monitoring. The common thread is the characterization and exploitation of proximity. Some of the outstanding opportunities for future progress are outlined here.

In geophysical remote sensing, data arrive usually in gridded form, commonly corrupted by unwanted atmospheric effects and positional and measurement errors, often using multiple wavelength bands making the data multivariate, and almost always in large quantities. Typical questions are, How does one suppress errors, how does one combine the information from different wavelengths, how does one extract patterns, how well is one doing, how far can the data be pushed, and what would be the value of additional data? Statistical approaches to answering all such questions will be profoundly affected by proximity considerations.

Procedures for suppression of unwanted effects must often make do with weak specifications of those effects. Procedures for extracting underlying patterns from the combination of multiband information should be strongly guided by probabilistic models with sufficient richness. On the other hand, estimates of statistical precision should be as model-free as possible. These requirements present important challenges to research statisticians, with technical and computational difficulties considerably surpassing those associated with related problems in time series analysis or one-dimensional stochastic processes.

Spatial data for resources estimation and environmental monitoring are typically not obtained on regular grids and are comparatively sparse. With regard to resources estimation, while data obtained from core drilling may have good vertical resolution, the cores may be preferentially located in high-grade zones. What one usually wants is an estimate of total reserves, the frequency distribution of resource blocks, and a rational exploitation plan based on localized resource estimates, together with measures of uncertainty to guide the need for further exploration efforts. The original and still widely used statistical methodology, based fundamentally on Gaussian process modeling, is not particularly well adapted to the highly erratic nature of resources data, and considerably more research is needed to deal honestly with the particular qualities of resources data.

In environmental monitoring, highly impacted areas may be preferentially sampled. The unevenness and selectivity of environmental data present important challenges for statistical modeling and inference. Furthermore, at each monitoring location there will typically be available a time series of data with seasonal variation. What one usually wants to know is how environmental quality is changing. Since data records are usually short in relation to the amount of change that can be directly observed amidst large natural variability, a sound methodology is needed to combine information from multiple monitoring locations. Also the augmentation and rearrangement of monitoring resources require research in statistical design problems that goes well beyond the simple idealized design problems for which we have some answers.

During the last decade substantial strides have been made in the development of appropriate theory and methods for solving spatial problems using statistical tools. Thus the needed research described above has a substantial foundation on which to build. An important recent advance in spatial statistical research is the development and application of flexible spatial Markov lattice models for image processing and the application of powerful techniques such as the Metropolis algorithm for implementation of these models. Other developments include spatial smoothing techniques that adjust to the local complexity of spatial patterns, dimensionality-reduction methodology for multivariable spatial data based on spatial structure criteria, development of mathematically tractable non-Gaussian spatial field models for continuous parameter fields, non-linear non-parametric spatial interpolation methods for discontinuous spatial fields, demonstration of the theoretical links between spline methods, kriging methods, and Wiener filters, and cross-validation methodology for calibrating spatial estimation techniques and assessing their precision.

18. Statistical Methods for Quality and Productivity

During the decades since World War II the industries that have raised their productivity and the quality of

their products have survived and prospered. Those that have not have done poorly or gone out of business. Statistical methods to analyze production processes are indispensable tools for engineers to increase quality and productivity.

There are four areas of statistical methods that are particularly heavily used: (1) statistical process control, (2) statistical experimental design, (3) reliability and (4) acceptance sampling. Statistical process control consists of methods for assessing the behavior of an engineering process through time, in particular for spotting changes; the major methods in this category are control charts, a topic in need of new thinking. Most of the methods now in place go back decades and were invented in an era when computation was done by hand and when data were often assumed to be normally distributed since not doing so led to intractable computation. For example, variability in control-chart methods is often measured by the range of the data, an easy number to compute. Control-chart methods need to be rethought from the ground up.

Experimental design is a crucial technology for isolating factors that can be changed to improve processes; thus, to achieve continuous improvement of an engineering process, design experiments probing the process must be continuously run. Most research in this area has focused on understanding how the mean level of a response depends on the factors; models are used in which the variance is either constant or, if it varies, is viewed as a nuisance parameter. But for many engineering processes, variance changes and is as crucial an object as the change in mean level; this is the case, for example, in robust design. Robust design recognizes that the quality of most products depends on a large number of factors. Some factors, referred to as "control parameters," are inexpensive to control, while others, referred to as "noise parameters," are costly or even impossible to control. The goal is to design a product whose performance is insensitive, or robust, to the noise parameters.

Methods of reliability are used to study the lifetimes of components and systems and to relate these lifetimes to factors that determine performance. In this area, the research community needs to develop methods with which engineers can shift from analysis of time-to-failure measures to the analysis of measures of degradation, which are more informative. Also in this area, more work is needed on models for data from accelerated failure-time experiments.

Acceptance sampling consists of methods for inspecting a lot of a product to determine if it is acceptable; in some cases every item in the lot is tested, but more typically a sample of items is selected for testing, and inferences made about the entire lot. New attacks on methods are needed; some past work has suggested that Bayesian approaches are a fruitful avenue to follow.

19. Graph Minors

A minor of a graph is any graph obtained from a subgraph of the original graph by contracting edges. A number of interrelated results on graph minors, some in "pure" graph theory and some relevant to the design of algorithms, are among recent achievements. The results open up new avenues for research and suggest a number of problems and opportunities.

An old and completely solved question in network flow theory supposes that one is given a graph in which some vertices are called "sources" and some are called "destinations." It is to be decided whether there are, say, ten paths in the graph, running from the sources to the destinations and not meeting one another. How can one program a computer to decide this? One way is to list all the paths, and try all combinations of ten of them, but that takes far too long, even for quite a small graph. Fortunately (because this is a very important problem, with a huge number of applications) there is another algorithm more indirect but very efficient. Thus, this problem can be viewed as completely solved.

If the question is changed slightly, and it is posited instead that there are ten sources and ten destinations and one requires the first path to run from the first source to the first destination, the second path to run from the second source to the second destination, what then? This new problem is much more difficult. Even the two-paths problem (with two sources and two destinations instead of ten) is difficult, and until recently the three-paths problem was unsolved. One of the main results about graph minors is that for any number (say ten), there is an efficient algorithm to solve the ten-paths problem. ("Efficient" here is used in a technical sense, meaning "with running time bounded by a polynomial in the number of vertices of the graph.")

A second result was a proof of an old conjecture of Wagner, that in any infinite collection of graphs there will be one containing another. (A graph "contains" another if the second can be obtained from a subgraph of the first by contracting edges.) This is of interest in "pure" graph theory, but is also has algorithmic applications if it is used in combination with the algorithm described earlier. For instance, suppose that one would like to know if a certain graph can physically be constructed, using wires for edges, in such a way that no circuit of the graph is "knotted." No efficient algorithm is known to decide this. But it follows that an efficient algorithm for the problem exists, even though no one has found it yet.

One can show a similar result in great generality that has a considerable number of applications in theoretical computer science. Suppose that it is desired to design an efficient algorithm to test if a graph has a certain property. For some properties it is impossible to find such an algorithm; but suppose that no graph with the property

contains any graph without the property. (For instance, the property of being knotlessly constructible satisfies this condition.) Then there is an efficient algorithm to test if a graph has the property, although it may not have been found yet. It should be emphasized that knowing that an efficient algorithm exists, even though one has not yet been found, is an important and significant piece of information.

20. Mathematical Economics

Although mathematical discussion of the operation of markets began in the last century, the first rigorous mathematical description of the fundamental economics in the operation of markets came in the late 1940s and early 1950s. This start culminated in the famous model of general equilibrium (GE) under the hypothesis of complete markets, that all commodities can be bought and sold in markets that meet at the same time, and with perfect credit. In equilibrium, supply equals demand, and each household acts in its own interest, given its budget constraint.

However, the complete-markets model just described suffers from a major drawback. Planning for future contingencies is an essential part of the economic allocation problem, and the GE model can be interpreted as incorporating time and uncertainty by indexing the commodities by event and date. The single budget constraint, however, forces on this interpretation the unrealistic view that all trades are negotiated at once. Recent work on incomplete market models that remedy this difficulty has achieved significant progress and has opened up a number of new questions and opportunities.

In the general equilibrium model with incomplete markets (GEI), agents cannot trade all possible commodities at one time. For simplicity, suppose that there are perishable commodities that can be consumed at time zero, or under any of the S states of nature at time one. Moreover, agents may be wealthy in some states, and poor in others. At time zero, agents are also allowed to trade a limited number of assets that promise delivery in various combinations of the goods, depending on the state of nature. The stock of a firm, for example, is an asset that delivers a large quantity of goods in those states when the production plans work well, and many fewer goods otherwise.

Several very surprising properties can be shown to hold for GEI equilibrium, using tools from differential toology. First, in great contrast to the complete markets model, if there are fewer assets than states, then the GEI equilibria are "generically" inefficient. Indeed the equilibria are inefficient not only because there are missing asset markets but also because the markets that do exist are not used properly.

A more surprising attribute of the GEI model is the special properties of monetary equilibria that it permits. If there is a commodity that has no effect on utility, and is not part of the initial endowment of any agent, such a good has two of the properties of money. If the assets promise delivery in this money, then under the conditions of the inefficiency theorem there are generically S-1 dimensions of distinct equilibrium commodity allocations. Yet, if the asset market were "complete," then there would be typically only isolated equilibria.

Removing just one asset creates a jump in indeterminacy from zero dimensions to S-1 dimensions; this dimension is constant no matter how few assets there are. This result could not reasonably have been predicted, and certainly not convincingly demonstrated, without the aid of tools from differential topology. Note that without a money good, there are typically a finite number of equilibria. In the GEI model, money has a prominent role to play.

There is another application of these mathematical ideas to the GEI model. It was thought for a long time that there might not be a GEI equilibrium in any robust sense. The trick to the correct analysis of the problem was to recognize that the GEI budget constraint can be reexpressed in terms of the span of the monetary payoffs across the S states, and hence in terms of a Grassman manifold constructed from the state space. Arguments from degree theory show that the simultaneous equations defined by GEI equilibrium on this Grassman manifold generically have a solution.

21. Parallel Algorithms and Architectures

Dramatic advances in computer fabrication technology have had an equally dramatic effect on the way that we use computers. For example, the most powerful computers today actually consist of many smaller component processors (i.e., chips) that are integrated together to form a single parallel machine. In a parallel machine, the processors are usually traditional sequential machines that are working together to solve a single large problem. By collecting N processors together to work on a single task, one hopes to perform the task N times faster than with only one processor. Although it seems intuitive that N processors should be able to solve a problem N times as fast as a single processor, this is not always possible. In fact, it can be very hard to design parallel algorithms for N-processor machines that run N times faster than on a uni-processor machine.

As a very elementary example of what can go wrong when one tries to parallelize a sequential algorithm, consider the "trivial" task of adding two N-digit numbers. Addition is certainly easy to perform in N steps sequentially, but can we do it in one step with N parallel

processors? In fact, we cannot. Even worse, at first glance it would seem that we cannot solve the addition problem any faster with N processors than we can with one processor because before one can compute any digit in the sum, one needs to know if there is a carry from the next digit to the right and so on. Therefore, the addition example seems to be very discouraging at first, for if one cannot efficiently parallelize addition, then what hope can there be for efficiently parallelizing other problems?

Fortunately, it is now possible to derive fast parallel algorithms for many important scientific and engineering computing problems. For example, in the simple case of addition, there is an algorithm that takes just $\log(N)$ steps using $N/\log(N)$ processors, although, as we have just seen, it is not at all obvious that such an algorithm exists. In fact, dramatic progress has been made in the last five years in uncovering nontrivial and highly efficient methods for parallelizing important problems that seem to be inherently sequential. Examples include algorithms for arithmetic, matrix calculations, polynomial manipulation, differential equations, graph connectivity, pointer jumping, tree contraction and evaluation, graph matching and independent set problems, linear programming, computational geometry, string matching, and dynamic programming.

Much progress has also been made on the problems inherent in designing parallel machines. For example, a variety of clever communication networks have been invented for linking the processors of a parallel machine together, and fast algorithms have been developed for routing the right data to the right place at the right time. This work has been highly mathematical in nature, drawing extensively on techniques from combinatorics, probabilistic analysis, and algebra. Indeed, parallel computers commonly use combinatorial-based interconnection networks and routing algorithms. Again, many opportunities for further advances flow from these already substantial achievements.

22. Randomized Algorithms

Over the past 15 years computer scientists have come to recognize the many advantages of algorithms that toss coins in the course of their execution. For a wide variety of tasks, ranging from testing whether a number is prime to allocating resources in distributed computer systems, the simplest and most efficient algorithms currently known are randomized ones. Therefore, expanding our understanding of such algorithms is a challenge and opportunity for the future.

Almost from the beginning of the computer era, random number generators have been applied to the simulation of complex systems involving queueing and other stochastic phenomena and to the estimation of multidimensional integrals and other mathematical quantities, using various sophisticated sampling techniques known collectively as the Monte Carlo method.

A major factor in drawing the attention of computer scientists to the wider uses of randomization was the discovery, around 1975, of two efficient randomized algorithms for checking whether a number is prime. Each of these algorithms is based on the concept of a witness to the compositeness of a number. A simple illustration of this concept is based on a theorem due to Fermat, which says that if n is a prime number, then, for any integer m that is not a multiple of n, $m^{(n-1)} - 1$ is a multiple of n. If this calculation is performed for some m, and one does not get the result predicted by Fermat's theorem, then n is composite (i.e., not prime); in this case, m is called a witness to the compositeness of n. The tests mentioned are based on slightly more complicated kinds of witnesses. The effectiveness of these tests stems from theorems that show that, if n is composite, then most of the integers between 1 and $n - 1$ will serve as witnesses. An interesting aspect of these tests is that they do not provide witnesses for primality, but this weakness was rectified in work that defined witnesses for primality rather than compositeness, showing that if n is prime, most randomly chosen numbers will bear witness to that fact. There are many other randomized algorithms based on the abundance of witnesses.

Randomized techniques have also proved to be a very effective tool for algorithm construction in the areas of sorting, searching, and computational geometry. A simple illustration is the problem of listing all intersections among a set of line segments in the plane. There is a fairly obvious incremental algorithm that considers the segments one at a time and reports the intersections of each new segment with all the previous ones. If the segments are read in a particularly unfortunate order then the run time of this algorithm will be excessively long; however, it can be shown that if the segments are processed in a random order, then with extremely high probability the algorithm will be very fast.

In addition, randomization plays a crucially important role in the design of distributed computing systems, in which many geographically dispersed computers connected by suitable communication links work together as a single system. Such systems must cope with the possibility that individual computers or communication links may fail or may run synchronously at different speeds, and must ensure that the overhead of communication between processors will not become an insurmountable obstacle. Randomization is particularly effective in allocating computational tasks to the individual processors and in choosing the communication paths along which data shall flow. It can be shown in a variety of settings that random allocation of tasks to processors and data to memory modules, together with randomized routing

of messages, yields near-optimal performance with high probability.

All the applications of randomization that we have mentioned depend on the assumption that algorithms, or computer programs, have access to a stream of independent random bits. More commonly, computers use pseudorandom numbers that are generated from an initial number, called the seed, by some purely deterministic iterative process. These generators are typically subjected to certain statistical tests in order to confirm that the streams of numbers they generate have some of the properties of random sequences, even though they are generated by a purely deterministic process. Currently, a deep line of research into the properties of pseudorandom number generators is being pursued. The goal of this research is to show that, as long as the seed is random, the output of the generator cannot be distinguished from a purely random sequence by any polynomial-time computational test whatsoever.

Finally, recent theoretical research has focused on a connection between pseudorandom generators and the concept of a one-way function, which is fundamental in cryptography. A one-way function is a function that is easy to compute but hard to invert. It has been shown that any one-way function can be used to construct a rigorously justified pseudorandom number generator. Unfortunately, researchers in computational complexity theory have not yet determined whether one-way functions even exist. This is one of the many important problems remaining to be addressed.

23. The Fast Multipole Algorithm

There are great opportunities for progress in algorithms dealing with problems such as particle beams in plasma physics, underwater acoustics, molecular modeling, and even very important aspects of aerodynamics. A basic calculation of central importance in these applications is the calculating of interactions in a many-particle system. These interactions are often long-range, so all pairs of particles must be considered. Because of the latter constraint, the direct calculation of all interactions requires on the order of N^2 operations in a system with N particles. We will refer to this calculation as the N-body potential problem.

There have been a number of efforts aimed at reducing the computational complexity of the N-body potential problem. The oldest approach is that of particle-in-cell (PIC) methods, requiring on the order of $N\log(N)$ operations. Unfortunately, they also require a mesh that provides limited resolution and is inefficient when the particle distribution is nonuniform. A more recent approach is that of the hierarchical solvers, which are gridless methods for many-body simulations, having computational complexities also estimated to be of order $N\log(N)$.

The Fast Multipole Method (FMM), which has recently been developed, requires an amount of work only proportional to N to evaluate all pairwise interactions to within roundoff error, irrespective of the particle distribution. Like the hierarchical solvers, the FMM is a divide-and-conquer algorithm, based on the idea of clustering particles on a variety of spatial length scales. The method is in fact based on a combination of physics (multipole expansions), mathematics (approximation theory), and computer science, and its use in applications is growing.

There are several immediate industrial applications for the techniques being developed. The payoff should be substantial and almost immediate in the straightforward use of particle simulations. Simulations of this type are performed in the modeling of high-powered electron beam microwave devices (e.g., gyrotrons and free-electron lasers), particle beams, controlled fusion devices, and so forth.

A second immediate industrial application is in molecular dynamics, a technique for studying the properties of fluids (and other phases of matter) by computer simulation. Once initial positions and velocities are chosen for some number of representative particles, their trajectories are followed by integrating Newton's second law of motion. In early simulations, only nonpolar fluids were considered, where the amount of computation per time step is proportional to the number of particles N. In polar fluids, the situation is quite different. A coulombic term is added to the potential function and all pairwise interactions need to be accounted for, a standard N-body calculation. The FMM allows for the simulation of much larger chemical systems than was previously possible. The study of a protein molecule in water, for example, requires following the motion of tens of thousands of atoms over tens of thousands of time steps. Real gains are possible in the long term, beginning with detailed theoretical studies of chemical kinetics.

24. Interior Point Methods for Linear Programming

Many problems in resource allocation can be modeled by what is called the "linear programming" problem, in which one attempts to optimize a linear function over the vertices of a multidimensional polytope. The traditional Simplex algorithm for this problem, which works by traveling along the boundary of the polytope, has had immense value and influence during the 40 years since it was discovered. It has a significant theoretical drawback, however: its running time can, in pathological cases, grow as an exponential function of the number of variables. Much more desirable, at least from a theoretical point of view, would be an algorithm with polynomially bounded worst-case running time.

In 1976, the first such algorithm, the Ellipsoid method, was discovered. Its running time was $O(n^4L^2)$, where n is the number of variables and L is a measure of the number of bits needed to describe the input. This algorithm has the additional desirable property that it applies to more general "convex programming." Moreover, it does not require a complete description of the convex body over which optimization is to take place, but merely a "black box" subroutine that, given a point, tells whether that point is in the polytope, and if it is not, will identify a hyperplane that separates the point from the polytope. The Ellipsoid method is thus applicable to a much broader class of problems than is the Simplex method, and its existence has led to a wide variety of polynomial-time algorithms for previously open problems. For linear programming, however, researchers quickly discovered that its improved worst-case running-time bound did not correlate with better performance in practice.

Polynomial-time programming algorithms thus seemed an impractical theoretical nicety. In 1984 this was changed with the introduction of a new breed of polynomial-time linear programming algorithm, based on a clever variant of an old idea. The idea, one that had been abandoned long ago as impractical, is to cut across the interior of the polytope in searching for an optimum vertex, rather than traversing the outside as does Simplex. The difficulty in making such an "interior point" approach work lies in finding the right direction and distance to travel at each step. The solution involves the use of projective transformations and a logarithmic potential function to guide the search, and yields a running time of $O(n^{3.5}L^2)$. The theoretical improvement over the Ellipsoid method running time was not the main story, however; more important, this algorithm (along with several of its variants) appears to be competitive with Simplex when implemented with appropriate sparse matrix techniques. Moreover, it appears to have substantial running-time advantages for large and/or degenerate instances. Indeed, important practical applications have been found in the design of large telecommunication networks and in the solution of large-scale logistics planning and scheduling problems.

Since the first reports of the potential practicality of the approach, there has been a torrent of research on interior point methods. Relations between this algorithm and earlier algorithms have been extensively explored. For instance, the algorithm can be viewed as a type of "logarithmic barrier function" algorithm, or even as an application of Newton's method (in an appropriately transformed space). In the limit of infinitesimal step length, it generates a vector field inside the polytope, all of whose limiting trajectories go to the optimal vertex. In this context, it can be viewed as attempting to follow such a trajectory approximately, by taking short steps along tangent lines. This in turn suggests variants in which one steps along curves that represent higher-order power series approximations to the vector field. Other variants concentrate on approximately following a particular trajectory, the so-called "central trajectory." These latter have led to better and better worst-case running times, with the current champion having a running time of $O(n^{2.5}L^2)$, based on a clever use of recent developments in the field of fast matrix multiplication.

New algorithms and insights continue to pour forth at a rapid rate, and although it seems unlikely that this will lead to polynomial-time solutions for the much harder NP-complete problems, there is much hope that the interior point approach will greatly extend the range of problems for which useful answers can be determined.

25. Stochastic Linear Programming

Deterministic models for linear programming problems and their solutions, ever since their first appearance 40 years ago, have been keeping pace with the extraordinary advances that have taken place in computing power. At the present time, industry and government routinely solve models in which there is no uncertainty; that is, they solve deterministic linear and mathematical programs for planning and scheduling purposes, some involving many thousands of variables with a linear or nonlinear objective function and many thousands of inequality constraints. These assume, for example, that knowledge about what future technologies will be available to choose from is known with certainty. As a result, the solutions obtained from deterministic models are incomplete because they do not properly take account of future contingencies. Although it is easy to reformulate the mathematical models to include uncertainty, the resulting size of the mathematical systems to be solved becomes too enormous in most practical applications. The bottleneck to solving stochastic programs has been (and is) calculating capability.

Therefore, despite the progress made, there remains an unresolved class of decision problems of great importance: that of finding an "optimal" solution to stochastic mathematical and linear programs. Stochastic here means uncertainty about, for example, the availability of resources, foreign competition, or the effects of possible political upheavals. Since such problems concern the optimal allocation of scarce resources under uncertainty, it is of fundamental importance to include uncertainty in the problem setup. If such problems could be solved in general, it would significantly advance our ability to plan and schedule complex situations.

At the present time there is intense activity taking place in the United States and elsewhere to solve certain relevant classes of stochastic linear and nonlinear programs. Important new developments in computer hard-

ware are spurring this effort, particularly the availability of multiple vector processor mainframes and parallel processors. It is hoped that the combination of three techniques—improved ways to mathematically decompose large-scale problems into smaller ones, improved techniques of Monte Carlo (importance) sampling, and the use of parallel processors—will bring about important advances in the relatively near future.

26. Applications of Statistics to DNA Structure

A strand of DNA can be represented as a string of bases, A,C,G,T, that carries the information governing the growth and function of an organism. Great effort has therefore been expended in determining DNA sequences. Rapid sequencing methods were introduced in 1976 and were followed by an explosion in quantitative genetic information. Today over 25 million letters of sequence have been determined, in segments averaging length 1000, from a wide variety of organisms. Improvements in sequencing technology continue to be made, and the associated discoveries in basic biology are staggering.

Two kinds of maps are constructed for DNA: genetic maps and physical maps. Both types are generated from the use of restriction enzymes that cut DNA at specific patterns in the sequence, producing fragments whose lengths can be measured with some degree of inherent experimental error. It was suggested in 1980 that slight variations in DNA sequence could produce differing restriction fragment lengths that could be used as "markers"—traits—that could be approximately mapped to specific locations on specific chromosomes. The amount of data subsequently available has created a number of new statistical problems.

Physical maps give the relative locations of identifiable and clonable pieces of DNA. Availability of a physical map facilitates the complete sequencing of a DNA strand. Given the mapped locations of a complete library of clones—each having a length on the order of several tens of thousands of nucleotides—a number of laboratories in coordination could then proceed simultaneously to sequence the individual clones. We can expect statistical analysis of design options, such as number and choice of cutting enzymes, to yield benefits in the mapping process. The process of physically locating clones along the genome should be substantially facilitated by an understanding of the design parameters and sources of variation inherent in the process.

Obtaining DNA sequence data is only a first step in modern molecular biology. The sequence is next subjected to extensive analysis, to relate it to what is already understood about DNA sequences. Because evolution operates to preserve biological features of importance, including sequence features, these analyses can be very important in understanding the function of specific portions of the sequence. Use of computers to implement complex algorithms is often required; mathematical analysis of algorithms is essential, both to ensure an unambiguous, informative interpretation of the results and to ensure that a programmed algorithm will complete its operations rapidly enough.

The study of molecular evolution has developed with the ability to read DNA and protein sequences. It is just now becoming possible to sample the sequence for a gene within a defined population. This opens up many new questions. How does molecular evolution proceed, in the long term and in the short term? Constructing evolutionary trees and determining rates of evolution can both be accomplished with stochastic process models of molecular evolution. Some of the most central work goes into identifying protein coding regions or genes in DNA. Locating a gene of 600 letters that is spread out in small segments along 10,000 or 20,000 letters of DNA is a daunting but essential task, requiring sophisticated combinatorial and statistical analysis.

The science of molecular biology is currently undergoing rapid treatment. The anticipated quantity of DNA and protein sequence data makes it an area ripe for mathematical development. The nature of the science makes it necessary that mathematical and biological scientists closely communicate. Both sciences will surely benefit from such collaborative effort.

27. Biostatistics and Epidemiology

Epidemiology concerns the distribution and determinants of disease in human populations. It encompasses such varied subjects as the worldwide geographic variation in disease incidence rates, the setting of radiation exposure standards in the workplace, and the evaluation of vaccine efficacy using randomized field trials.

Two distinct study designs, cohort and case-control, are used for much of the research in chronic disease epidemiology. In cohort studies, exposures and covariables are measured on a defined population of disease-free persons, who are then followed forward in time to determine which ones develop or die from the disease of interest. The methods and concepts of survival analysis, particularly the proportional hazards regression model, have greatly affected the statistical treatment of cohort data. They provide a mathematically rigorous framework for elaboration of the key epidemiologic notions of incidence rate and relative risk. Older epidemiologic techniques are given a new interpretation in terms of classical statistical theory, while the way is paved for the development of more flexible and powerful methods of data analysis.

Case-control studies involve samples of diseased and nondiseased persons whose history of exposure is known. The demonstration that the exposure odds ratio calcu-

lated from case-control data approximates the ratio of disease incidence rates among exposed and nonexposed was of paramount importance in establishing the scientific validity of this design. More recently, biostatisticians and econometricians independently have developed methods for the analysis of case-control and other data where the sample is selected on the basis of the outcome of primary interest. Further elaboration of this methodology is needed to handle more general stratified designs and for situations where only partial information is available for a large number of the sampled subjects.

Additional work is needed also on methods of analysis of epidemiologic data with dependent outcomes, such as arise in longitudinal studies with repeated measurements on the same person over time or in genetic studies of the patterns of disease in families. Better techniques are needed for assessing the magnitude of measurement errors and to correct for the tendency of such errors to dilute the observed association between exposure and disease. Recent advances in statistical computing and in the statistical theory of quasi-likelihood analysis based on generalized estimating equations promise rapid advances in this field.

Finally, AIDS, the major epidemic of our time, poses urgent challenges to the biostatistician and epidemiologist. One problem is to estimate the past, present, and future rates of infection with HIV so as to determine the future number of AIDS cases. Another is to understand better the patterns of HIV transmission within and between various pools of susceptible individuals so as to be able to plan the optimal organization of community resources for the prevention of further infection. The collection of data related to AIDS is seldom routine and often suffers from a lack of key pieces of information, so that studies are rarely amenable to straightforward analysis. Mathematically, the problem of estimating HIV infection rates, using data on AIDS incidence rates and the distribution of time from infection to diagnosis, can be viewed as an unusual type of deconvolution problem. It is related to problems that occur in the field of image processing, where rapid progress has been made. But the lack or poor nature of key types of data makes it much more formidable.

Note

[1]Goldhammer, M. I., and Rubbert, P.E., "C.F.D. in design: An airframe perspective," *Proceedings of the 27th Aerospace Sciences Meeting*, January 9–12, 1989, Publication Number 89-0092 (American Institute of Aeronautics & Astronautics, Washington, D.C.).

American Mathematical Society

Position Open

The American Mathematical Society is seeking applications and nominations of candidates for an open position of Associate Executive Director of the Society.

Much has been written recently about concerns of maintaining the vitality of mathematics research in this country and renewing the mathematical sciences research enterprise. These concerns are often coupled with those indicating a need for reform in mathematics education. The Society is committed to lending its prestige and resources to assist in addressing these concerns. To this end, the Society is developing a plan of programmatic initiatives in the mathematical sciences.

The person filling this position will work in the Society's Providence office with the Executive Director and be responsible for the development and administration of the programmatic activities of the Society. The Associate Executive Director will assist in all phases of these initiatives and, as such, will work with the AMS Board of Trustees, Council, committees, and staff; as well as governmental agencies, corporations and foundations, professional societies, and mathematicians throughout the world.

The Society is seeking a candidate who is sensitive to the concerns of the mathematical research community and understands the need for involvement of research mathematicians in addressing the broad issues of the profession. Such a candidate should

- have earned a Ph.D. in one of the mathematical sciences
- have a good command of the English language and be capable of writing well and easily
- have an interest in administration and an ability to work harmoniously with mathematicians and nonmathematicians alike
- be familiar with national issues and activities that impact on the mathematics profession.

The initial appointment will be for two years and can be continued thereafter on an indefinitely renewable term or continuing basis.

Applications and nominations should be sent to:

Dr. William H. Jaco
Executive Director
American Mathematical Society
P.O. Box 6248
Providence, R.I. 02940

Completed applications and appropriate letters of reference received by 15 November 1990 will be assured of full consideration. It is preferable (but not essential) that duties begin no later than 1 January 1991.

The Society is an equal opportunity employer and has a generous fringe benefit program including TIAA/CREF. Salary for the position will be commensurate with the background of the appointee.

Commentary on David II

"BMS, MSEB, JPB whatever—who knows what all those acronyms mean?" asked a participant at the Joint Mathematics Meetings in Columbus in August. "They just seem to rotate their staffs around, and every so often I hear about it. But I don't know anything about what they do." The person making these remarks is a typical member of the AMS and MAA, and, as is typical, he feels rather removed from the mathematical dealings in Washington—even though he has a geographical advantage, being a faculty member at a university in DC. He wasn't sure he'd seen "Renewing U.S. Mathematics: A Plan for the 1990s," the recently published update of the so-called David Report. When told the cover was yellow, he replied vaguely, "Oh, yes, I guess I did get that."

Does this sound like your reaction to the rarefied stuff of the "Washington Presence" of mathematics? Well, you're far from alone. Many in the mathematical sciences community pay only passing attention to the Washington scene because they feel it has little to do with the problems and concerns of their own departments and institutions. Whether the update of the David Report can break this sense of isolation and affect the lives of a broad segment of the mathematical community remains to be seen. However, there are opportunities for the community to discuss the report at various meetings, and a "dissemination plan, " which is currently in the works, may help departments use the report in their own institutions.

Effects of David I

The first David Report, which appeared in 1984, is considered in some ways to have been highly effective. In fact, anecdotal evidence indicates mathematicians in Canada, Europe, and even the Soviet Union have used David I to argue for increased resources. But the hullabaloo must have sounded quite distant to many mathematics faculty, for the report's main effect in the U.S. was confined to federal funding for mathematics research. "David I had some impact on funding," says AMS Committee on Science Policy member John Polking of Rice University, "but on the whole it was really limited."

According to figures prepared by the Joint Policy Board for Mathematics, funding for mathematical sciences research nearly doubled between 1983 and 1990. If you're wondering why you didn't see a surge in the number of your colleagues who are funded, you have to realize that the largest increases went toward graduate students and postdocs, or were gobbled up by rising grant costs. The total number of researchers receiving grants increased from 1800 to only 1900, despite the report's recommendation of 2600. Also, whether or not you benefited from the increases may be a function of what field you're in. "Applied mathematics got a lot out of it," Polking says, "but core mathematics got little except an increase in graduate students."

David I might have had more effect on the community if its recommendations to universities had been followed, but, by most accounts, they were largely ignored. Polking says he disagrees with the assessment that David I had no effect at individual institutions. "Many mathematics departments were in fact able to use David I to good effect," he notes. However, rather than being part of a concerted push by the entire community, these were isolated successes.

In fact, it might be argued that the Calculus for a New Century report has affected a broader portion of the community than has David I. That report helped to spur the National Science Foundation (NSF) on to establishing a calculus reform program and caused a groundswell of activity that has made the mathematical sciences community something of a leader in undergraduate curricular reform. And, in recent years, the education directorate at NSF has enjoyed increases far larger than the research directorates. If prestige follows dollars, education may turn out to be the hot research area of the 1990s.

What's Next?

So now the update of David I, predictably known as David II, has been sent to mathematical sciences depart-

ment chairs across the country. What will be its effect? Views on that vary. Some at the Columbus meeting privately expressed the fear that David II could "fall flat on its face" and have no effect at all, while others are more hopeful. But everyone seems to agree that the key is having the entire mathematical sciences community pushing for the recommendations of the report. And the report does a good job of speaking to the needs of the broad mathematical sciences community. For one thing, it contains recommendations about restructuring departmental rewards systems to reflect a new definition of professional activity that includes educational activities, mentoring, outreach to underrepresented groups, public awareness activities, and interactions with other areas of science.

This suggestion, while not new, would mean a radical change for many mathematical sciences departments. Part of the problem of instituting such changes might be called the "Princeton effect"—the tendency to value mathematics research above all other professional activities. Princeton, and other mathematics departments of similar caliber, set the tone for how other departments with research aspirations do business. During the AMS Committee on Science Policy meeting in Columbus, one Committee member asked, somewhat facetiously, if the David II recommendations implied that the Princeton mathematics department should hire a specialist in K-12 mathematics education. Would that turn the tide away from lip service for educational activities and toward real recognition?

Of course, it could be detrimental to the mathematics reserch enterprise if the top research departments were to suddenly redirect their energies and resources in this way. How can the community strike a balance? This question was the topic of a panel discussion, "The Responsibilities of Mathematicians for the Implementation of the David II Report," held by the Committee on Science Policy at the Columbus meeting. The panelists were Judith Sunley, director of the Division of Mathematical Sciences of NSF; Robert O'Malley of Rensselaer Polytechnic Institute (soon to be at the University of Washington) and President-Elect of the Society for Industrial and Applied Mathematics; Philip Griffiths, provost of Duke University and chair of the Board on Mathematical Sciences of the National Research Council (the body that published David II); and Arthur Jaffe of Harvard University, who wrote "Ordering the Universe," an essay surveying mathematics research that appeared in David I.

In case the report's recommendations weren't pointed enough, Michael C. Reed of Duke University, chair of the Committee and moderator of the panel, tossed out these questions for the panel to chew on: Does the research community have a responsibility for K-12 education? For bringing women and minorities into the profession? If so, how should such activities be evaluated and rewarded at the departmental level? Should deparments change their hiring practices to meet these responsibilities?

As one might imagine, nobody stood up to volunteer their departments for such an experiment. If taken seriously, these are tough questions, and they can't be settled in a two-hour panel discussion, especially a discussion with such sparse attendance: being scheduled in direct competition with the Sock Hop led to a smaller audience than one would have expected. Still, the discussion was interesting, for it revealed some of the sociological schisms that show just how controversial some of the report's recommendations are.

Rewarding Interdisciplinary Research

O'Malley said he believes that interdisciplinary work of faculty members should be evaluated not just by mathematicians but also by experts from the disciplines to which mathematics is applied. He also thinks mathematics departments should hire from other areas. "It's very important to realize that we don't have to follow the traditional paths," he pointed out. "Departments should hire and tenure the best people fitting their needs. Not everyone in a math sciences deparment need have a PhD in the math sciences, nor would graduates of math sciences departments necessarily go to a similar academic department, many will go to industry or government."

On the subject of teaching, O'Malley says that faculty should not be compelled to teach in the traditional way. "Not everyone needs to emphasize proof, not all topics need to be developed from the very basics," he argued. "I think we have a challenge of letting our students proceed with a new kind of mathematics that's different from that we grew up with."

O'Malley's remarks seem to have struck a chord with Jaffe, who noted that he has spent his entire career bringing physics and mathematics closer together and that he was heartened to see strong interactions between mathematics and other disciplines. "But let me interject a word of warning," he said. "I fear that certain sociological values from other subjects could come into mathematics which we should be aware of, and might change our subject in ways we would not like." To illustrate his point, he mentioned such catchphrases as fashion, hype, advertising, narrow focus, instant gratification, and lack of rigor and precision. "These are all trends that could come to us from outside, and I think we should be careful."

Some took this comment as supporting isolationism in mathematics. One of the members of the audience, Amy Cohen of Rutgers University, seemed to be alluding to Jaffe's remarks when she noted that "the whole issue is whether it's professionally legitimate to try to encourage people to join us in our enthusiasm for mathematics.

Every time we talk about that, within five minutes we hear remarks about the lowering of standards, the sociology of other fields." Since the traditional pedagogy in mathematics emphasizes a "sink or swim" attitude, she noted, "only those who can learn by themselves are worthy of becoming our colleagues. That will do to staff some small fraction of our very best departments. It will certainly *not* do to keep the whole mathematics community vital."

Others were more sympathetic with Jaffe. "Can one argue," asked Oscar Rothaus of Cornell University, "that some of the ostensibly antisocial and uncooperative attitudes of mathematics are really essential for its health?" The audience laughed. "Every position has its pros and cons," Jaffe replied, "but I think there's something to be said for that."

A Different Environment

In her opening remarks, Sunley pointed out that the climate today is quite different from what it was when the first David Report appeared. She says the mathematical sciences community is viewed differently today than it was five or ten years ago. "I have had people tell me how wonderful it is that the mathematical sciences are finally beginning to support their graduate students in reasonable numbers," she noted. "I have had people tell me that interaction with other disciplines is significantly better than it was ten years ago." She also pointed out that many of the other scientific divisions at NSF see the mathematical sciences as "way out ahead" on educational issues.

However, she also noted that other disciplinary divisions at NSF, and perhaps other government agencies as well, feel that mathematicians have "had theirs" in increased funding over the past five years, while other disciplines have limped along with flat funding or only small increases. "Another thing that is really different," she said, "is the extent to which other disciplines feel that their research enterprises are in trouble... All of these things are important changes in the environment that one has to take into consideration when talking about implementing the recommendations" of David II. "We need to work with other disciplines to increase the total pie of dollars going into research and education in science and engineering," she advised. Simply saying that mathematics needs more funding because it has been underfunded in the past is not going to do the job, she said. "As good as the reasons for [the requested increases] may be, if we cannot find some way of increasing the total pie, those arguments are not going to be successful because we'll be drowned out by other disciplines who have a long tradition of yelling much louder and longer than we do."

Allyn Jackson
Staff Writer

A Year of UME Trends

James Fey

UME Trends, a newsletter which focuses on issues in mathematics education, was launched in 1989 as a joint effort of the American Mathematical Society, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics. At the end of the first year of publication of the newsletter, the Managing Editor of *Notices* solicited the following review.

James Fey is a professor of Curriculum & Instruction and Mathematics (joint appointment) at the University of Maryland, College Park, and director of a computer-intensive algebra curriculum development project (NSF sponsored). He received his Ph.D. from Columbia under Myron Roskoff and is currently active in teacher education and curriculum development for high school and college mathematics.

Those interested in subscribing to *UME Trends* for the 1991 volume may contact the Customer Services Department at the American Mathematical Society, P.O. Box 6248, Providence, RI 02940 (e-mail: cust-serv@math.ams.com; telephone: 800-321-4AMS. The subscription price for 1991 is $12 (subscribers outside of the U.S. must add $8 for postage).

What is the responsibility of research scientists and mathematicians for leadership in undergraduate education—especially the lower division courses like calculus that are crucial in preparation of future scientists, mathematicians, and engineers? Peter Lax (*UME Trends*, May 1990) claims that starting in the 1950s research mathematicians "ceased caring about introductory courses." They entrusted the teaching of those courses, especially calculus, to faculty and special staff whose assignment was not to reform syllabi or teaching, but to see to it that the job was done decently. According to Lax, one devastating consequence of this neglect is the deeply troubled contemporary calculus course—an out-dated syllabus that bears little relation to how practicing mathematicians use and think about the subject and mass-production teaching methods that lead to failure for at least a third of the students each year. Lax and many others contend that the crisis in calculus is a major factor in the persistent shortage of capable young Americans choosing majors in physical sciences, mathematics, and engineering.

While elementary and secondary school mathematics education have been in a state of nearly constant crisis for over thirty years, the critical fire now aimed at undergraduate mathematics curricula and teaching is a relatively recent development. There are encouraging signs that the mathematical community is responding to the challenge. At special conferences and in the regular forums of professional meetings and publications, a variety of new curricula and instructional methods have been proposed and hotly debated during the past decade. The potential effects of those innovations are being tested in hundreds of classroom experiments and over a dozen major funded projects.

In most cases the results of mathematical research are shared quickly through an extensive long-established international network of journals, meetings, and personal contacts. But the opportunities for communication of new ideas concerning undergraduate mathematics curricula and instruction, in either journals or professional meetings, are limited at best. To help remedy this situation, the Joint Policy Board for Mathematics created *UME Trends*, a newsletter to stimulate and report on efforts to improve undergraduate mathematics education.

Under the editorship of Ed Dubinsky, *UME Trends* publishes six times each year with feature articles, regular departments, news items, and signed opinion essays. The newsletter was mailed free during the first year to all members of the AMS, MAA, and SIAM. It is being mailed on request during this second year and will be available at a subsidized subscription rate during the third year. A grant from NSF partially funded the start-up and first year distribution.

A typical eight page issue of *UME Trends* contains as many as 20 different items on a broad range of topics in mathematics education. News items might announce coming conferences, funding opportunities at NSF, personnel changes in mathematical science policy positions, or journal calls for papers—each with some connection to improvement of undergraduate mathematics. The eight regular departments publish contributions under the titles: Activities of CUPM, Exchange on Teaching Innovations, Learning Software, Media Views and

Reviews, Minorities and Mathematics, NSF Beat, Research Sampler, and Status of the Profession. Feature articles have included reports on various new calculus programs, interviews with mathematicians who have been remarkably effective in undergraduate instruction, new uses of technology in mathematics testing, and developments in secondary education that have implications for undergraduate programs. Opinion essays have also frequently dealt in some way with the problems in calculus, and a section of letters from readers has emerged with its own complement of personal opinions.

There are several ways to assess the importance and quality of a publication like *UME Trends*. One might first ask whether it makes a unique contribution to the field. There can be no question that most of the material in published issues of *UME Trends* is available elsewhere—notably in *Focus*, the *College Mathematics Journal*, *Notices* and a variety of other journals and newsletters aimed at various mathematics education constituencies. The Conference Board of the Mathematical Sciences has recently initiated a publication series titled *Issues in Mathematics Education*, and the first volume in that series is titled *Mathematicians and Education Reform*.

Despite the profusion of discussion and writing about problems of mathematics education at all levels, it is probably reasonable to suppose that many mathematicians don't receive or attend to all of those publications. Futhermore, the newsletter style and timely publication schedule of *UME Trends* will probably communicate effectively to many people. Thus the fundamental question is whether the newsletter provides accurate and useful information to the audience of readers who want or need to hear the messages. To some extent, judgements on that issue will vary with the audience. My own perspective is that of a mathematics and education faculty member in a large university. My special interest is in curriculum development and research on teaching and learning at the secondary and college levels. From that vantage point it seems to me that the first eight issues of *UME Trends* have made remarkable progress in establishing a provocative and informative clearinghouse for ideas on reform of undergraduate mathematics education. The quality of the various features is uneven, but that might be more a function of our limited information and ideas than of the editor's skills. As I look at the contents of *UME Trends* thus far, I see the following strengths and weaknesses:

Regular Departments

Much of the content in each issue appears under the mastheads of the eight regular departments or as feature articles directly related to those departments. Some of the departments appear in every issue; others appear roughly every other issue. Taken as a whole, the departments certainly seem to cover the waterfront of potential information and deliberation.

The department *Activities of CUPM* has, quite appropriately, appeared in each issue of *UME Trends*. For over 35 years CUPM has worked to provide national leadership in undergraduate mathematics, acting as a stimulus and communication hub for curriculum initiatives related to undergraduate mathematics (Steen, *UME Trends*, March 1989). Its reports in *UME Trends* have described initiatives on very important questions: The undergraduate major, calculus reform, two year college curriculum and teaching problems, mathematics service courses, and undergraduate research experiences. While those reports seldom contain 'solutions' for the day-to-day problems of undergraduate mathematics education, they thoughtfully define important issues which mathematics departments must attend to, and they point the way to groups working on those issues. It is not uncommon for the CUPM reports to invite readers to contribute their own ideas to the various projects.

Among the other departments, appearing less frequently, *Learning Software* describes computer software with particularly intriguing potential to reshape teaching or curricula in undergraduate mathematics. The topics chosen by the department editor seem to address those goals well, and the expositions seem consistently clear and thoughtful. The department *Status of the Profession* has included two kinds of pieces thus far—descriptions of demographics and job prospects for future undergraduate students and appeals for the research-oriented mathematics community to give deeper commitment to mathematical education at all levels. While the mathematical community has certainly heard these messages many times before (and not responded in any striking ways), the challenges are sufficiently important that they should probably be repeated regularly. It is curious that a profession which owes much of its esteem to the power gained by reasoning with numerical information remains strangely unmoved by data suggesting that our educational efforts fall far short of important goals and that the challenges we face in the future will require creative responses to new situations.

In his introductory statement of purpose *UME Trends* editor Ed Dubinsky made an admirable promise of special attention to problems of minorities and women in undergraduate mathematics. The section *Minorities in Mathematics* has been a prominent feature of the newsletter. However, the material in those contributions has not been particularly fresh. Is this a sign that imaginative efforts to increase participation and success of minorities in mathematics are few and far-between? One can only hope that future issues will show results of broader and deeper thinking and activity in this crucial problem area. *UME Trends* attention to the problems

of women in mathematics has been very limited. Is this also indicative of general inattention to the issue or lack of fresh ideas?

One of the dominant characteristics of scientists and mathematicians is a zest for solving problems. The standard approaches to problem-solving include collection and analysis of data, formulation of theories, and experimentation to test those theories. The serious teaching and learning problems of undergraduate mathematics education are certainly as challenging as any in the discipline itself. However, those problems are seldom approached as scientific challenges. Instead, professors learn to teach through a long period of observing their own teachers and a short period of learning by doing as graduate teaching assistants and then beginning professors. Teaching tends to proceed in pretty much the same teacher-directed lecture mode from generation to generation. Innovations tend to be the products of reflection and informal experimentation by individual faculty members, and they tend not to affect other teachers very often. Thus it should not be surprising that the *UME Trends* department *Exchange on Teaching Innovations* offers very little striking insight into improving teaching effectiveness. The newsletter issues which have featured this department have included collections of short reports on teaching techniques that have been developed and tested informally by individual teachers. It seems unlikely that the solution to massive student failure in calculus will result from such "innovations" as increased collection of student homework, using claculator generated questions, or peer grading. One can only hope that the ferment in undergraduate mathematics education these days will produce deeper and more imaginative ideas for instruction over the years ahead.

On the other hand, the *UME Trends* department titled *Research Sampler* has provided an intriguing, if uneven, collection of provocative ideas for readers. For mathematicians accustomed to research on reasonably well-defined questions with results that are subject to fairly clear tests of validity, the problems of mathematics teaching and learning are frustratingly ill-defined, and definitive research results are much harder to achieve. While it might seem simple to address questions like "What is the best way to teach derivatives or, more specifically, the chain rule?" the questions quickly become complicated by further conditions: To what students? In what classroom conditions? With what technology? For what future goals? For many years research in mathematics education struggled in a largely fruitless search for general principles about the best way to teach and learn whole subjects or even specific topics. But over the past two decades mathematics educators have applied the theoretical perspectives and research methods of cognitive psychology, sociology, and cultural anthropology in search of insights to advise but not dictate design of instructional approaches. That research effort has begun to yield results in two areas with special significance for undergraduate instruction, and both areas have been described in *Research Sampler* articles.

The first research strand involves careful analysis of the conceptions and misconceptions that mathematics students bring to and acquire from their experiences in mathematics classes. In a broad array of studies we are learning that students who appear very successful by standard measures of school achievement have nonetheless formed fundamentally mistaken understandings of what we believe we have taught. The second significant research strand has shown that for students to acquire confident understanding and skill in any area of mathematics, they must be actively engaged in constructing personal representations of that knowledge. Taken together, these two important lines of research in mathematics teaching and learning challenge many long-standing traditions and common assumptions about undergraduate instruction. They suggest that students who exhibit skill in performing mathematical procedures do not necessarily have correct or useful understanding of basic ideas and that the standard lecture methods of instruction are unlikely to develop that understanding.

Two other regular *UME Trends* departments, *Media Views and Reviews* and *NSF Beat*, fill out the complement of information that might be helpful to people interested in working on the problems of undergraduate mathematics education. The first describes new and interesting print and video resources; the second frequently suggests NSF programs which might provide financial support for projects. Much of this information, like that of the other departments, is published in several other newsletters and journals. But it adds a dimension to the coverage of *UME Trends*. Putting all of these sections together, the regular departments of the newsletter provide a rich ongoing short-course in issues and opportunities at the undergraduate level.

Feature Articles and Personal Essays

Regular departments are the heart of *UME Trends*, but each issue also includes several feature articles on special topics. The vast majority of feature articles have dealt with some aspect of the calculus reform activity. Since most of the active projects in that area are fairly young, there has been little progress to report in the short life of the newsletter. Aside from occasional general articles about discrete mathematics, there has been very little attention to topics other than calculus (unless one defines discrete mathematics as the complement of calculus).

A recent study by Sol Garfunkle ("Mathematics Outside of Mathematics Departments," *Notices*, April 1990) found that while upper-division mathematics department enrollments are relatively stable, enrollments in

advanced mathematics taught by other non-mathematics departments have boomed recently. The report raises the possibility that in our recent attention to "fixing calculus" and "defining discrete mathematics" we may have lost touch with the mathematical needs and interests of a substantial family of client disciplines.

In addition to the departments and feature articles, the editor of *UME Trends* frequently invites individual mathematicians with special expertise or interest in undergraduate education to write personal position essays on some aspect of the current scene. The best of these essays make provocative and moving proposals on deep questions of curriculum and instruction. In others it seems to me that the author's personal feelings are sometimes stronger than insights or coherent arguments. The prose and arguments are sometimes too glib and occasionally insensitive on important issues. Nonetheless, taken as a whole, the essays are, as they should be, thought-provoking additions to the newsletter.

Conclusion

While speaking about ways that mathematics can be explained to popular audiences, Ken Hoffman once said that the difference between mathematicians and journalists is that mathematicians would rather be correct than interesting, but journalists would rather be interesting than correct. The task of mathematical journalism is to combine the best of both talents—to present important and correct ideas with an interesting style. *UME Trends* seeks to stimulate and inform the mathematical community about problems in undergraduate education and about opportunities to work on solutions. The first eight issues indicate that the newsletter is off to a good start. Where content of departments or feature articles is disappointing, that condition probably represents limitations in the state of our knowledge, more than the failures by authors or editors.

Problems in education are extremely complex and hard to solve in any definitive way. But the widely acknowledged shortcomings of U.S. mathematics education demand attention of the best and most energetic members in the mathematical community. If *UME Trends* contributes to enrolling new workers on this important task, it will have served a very useful purpose. Past experience justifies skepticism that large numbers of research mathematicians will sign on for the job, but the conditions have seldom been as well known or as critical as they are now.

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

Mathematics Reform: Some Short Term Suggestions

Richard J. Maher
Loyola University of Chicago

By supporting research for its own sake at the expense of teaching and student contact, mathematicians and their professional societies have fostered in many colleges and universities an atmosphere that causes teaching and course development to be sacrificed to the gods of grantsmanship and publication. Is it any surprise that we now need NSF grants to help us figure out why we lose so many calculus students? Or that many students who do last through calculus leave soon after, since we offer few innovative courses for future scientists and engineers. We have failed to nurture our own successors; the majority of our new Ph.D.'s now come from other lands. Since we do not do much better with our service courses, college students often end up with a less than favorable view of mathematics and mathematicians, a view that, unfortunately, is shared by much of our general population.

Concern about the quality of mathematics education has resulted in much planning and discussion. Long-term programs are the usual result, with progress envisioned sometime in the future. There seems to be little emphasis upon what needs to be done right now. For example, "Everybody Counts" speaks of "specific transitions... over the next two decades." Two decades is twenty years; what happens to the nearly two million students, some of whom are not yet born, that college mathematics departments will teach each term over the next twenty years? We must be concerned with students now or soon to be in the system. Many able students come to us who, given suitable motivation, might continue to study mathematics. And many diligent students for various reasons have problems in their courses. Both groups need personal contact with individuals able and willing to assist them. This need will continue for the next 12 years or so until the effects of mathematics reform at the primary and secondary levels, if it is successful, begin to be felt.

Mathematicians can engage in a number of activities to support students who are or will be enrolled in college mathematics courses over the next few years. These might include making classrooms more "user friendly," arranging assistance for students having problems in mathematics, encouraging students to continue their study of mathematics, and giving presentations to high school groups. These suggestions are not radical; they are not intended to be radical. Our discipline never has had problems deciding what goals must be met; our difficulties occur when we try to decide how to meet them.

The following paragraphs contain suggestions about "how to meet" one or more of the above goals. These suggestions are aimed at problems that exist now and will continue to exist in the immediate future. They are not all inclusive and involve only situations where increased personal contact between mathematics students and those interested in working with them can be beneficial. They do not require an excessive amount of time but they may require a level of personal commitment. Some suggestions may seem a bit different, but perhaps we need to do something a bit different; what we are doing now is not working.

A. The following comments are directed toward the large lecture courses that many departments offer.

1. We should assign our best teachers to teach large lecture courses. The best teachers not only impart knowledge in an effective fashion, they also establish rapport with

their students. They can make a difference in a student's educational experience.

2. Students in large lecture courses often need increased contact with those able and willing to help. These courses usually have quiz sections associated with them.

a) Three hour courses might meet for two 75 minute periods each week. Four hour courses might meet for two 75 minute periods and one 50 minute period each week. Quiz sections for each course might meet twice a week, once for each long lecture. The short lecture period in the four hour course might be used to develop and discuss detailed applications and illustrations.

b) Quiz sections must become active learning sessions. Students might be divided into groups of 3 to 5 and work together on problem sets with appropriate instructor/Teaching Assistant (TA) participation. (This approach has been used by U. Treisman, University of California, Berkeley, and now by, among others, J. Baldwin, University of Illinois, Chicago, with minority students and has produced encouraging results.)

3. Early attempts should be made to find students having difficulties but with the potential to succeed. They can be placed in new sections of about 15 students; three credit classes would meet for 250 minutes and four credit classes for 300 minutes each week. Section B.5 indicates some potential teacher sources.

B. It may be possible to offer additional classes at minimal expense; some class sizes might be reduced as a result.

1. Some faculty in research oriented departments may be uncomfortable with their roles; they may, for example, have been hired before their departments became research oriented. Faculty recognized as good teachers might be asked to teach an extra course each year (each term?) for remuneration in addition to the usual raise. The extra course should not be a large lecture section.

2. Use can be made of retired faculty who still are interested in teaching and who were recognized as good teachers. They need not be retired from the institutions seeking them; schools in metropolitan areas or in areas with good climates may find many retired faculty located there. Again, they should not teach large lecture sections.

3. Two year college faculty often develop insights into problems that students have with basic mathematics. Well qualified two year faculty might be hired on a continuing part time basis to staff sections of these classes.

4. Outstanding TA's often are rewarded with courses of their own. They might enjoy assignment to smaller classes where students need personal contact.

5. The teacher sources in 1–4 can be used, if appropriate, to provide instructors for the classes in A.3.

C. Tutoring needs to be available for students at all times of the day and evening. However, students also need to be encouraged, and even pushed, to use these services.

1. Student mathematics clubs or chapters of PI MU EPSILON often serve as undergraduate sources of mathematics tutors. Other sources include students planning to become mathematics teachers, majors interested in helping others, and students from other disciplines interested in mathematics. Student volunteers should be encouraged and rewarded for their services (See D.6).

2. Teaching Assistants should be available for tutoring in a variety of courses over a broad range of times. In particular, this means evenings. Furthermore, serious consideration should be given to phone-in tutoring, especially if commuter students, working students, or large campuses are involved. Information about available hours, courses, and phone numbers should be widespread.

3. Students must be encouraged to use tutors. They should be given copies of tutoring schedules. Instructors should announce the availability of tutoring on a regular basis and notices should be posted around campus, published in campus newspapers, and sent to student residences.

D. The need to recruit qualified students to major in the mathematical sciences is clear.

1. Prospective students interested in mathematics should meet with a math faculty member as a part of the usual first campus visit. Informational material should be available and a follow-up letter should come from the faculty member. Students who do not visit campus should be written at least twice.

2. Admitted students interested in mathematics should be contacted immediately; 1. might provide an appropriate contact person. A letter should follow any campus visit; a second letter also should be sent to any student not visiting campus.

3. Students who enroll should be sent a note of welcome; at orientation a specific time should be set aside for faculty contact with new students. Names should be learned, so that students can be recognized by faculty in halls, on campus, etc.

4. Majors should have their progress monitored by faculty advisors who are aware of the resources available to aid students. In addition to the usual awards ceremonies, gatherings should be held at least once or twice a year for majors and faculty; again names should be learned.

5. Both faculty and teaching assistants should be on the alert for students who express interest in mathematics or who do well in math courses. When appropriate, steps should be made to recruit them.

6. Special recognition (gatherings, awards programs, etc.) should be given to everyone involved in tutoring. Once again, names are important.

E. It is important that mathematicians have contact with high school students. Contacts with teachers and with parents are also important. Contacts may be formal or informal, but presentations given must be appropriate to the audience and the mathematician involved must be comfortable with groups of teenagers.

1. High school students should be informed of the many interesting aspects, both theoretical and applied, of our profession. They also should be made aware of the career opportunities available in the mathematical sciences.

2. High school students must be made to understand that they have little hope of majoring in science or engineering if they fail to take geometry and two years of algebra in high school; if possible, they should take more.

3. Presentations might be made to math clubs or classes, to gifted students, to groups of students from a given year, or to a gathering of students, teachers, parents, or school supporters.

a) Mathematics clubs or classes or groups of gifted students might ask for presentations on particular topics. Such presentations might include a discussion of the topic, sources for further study, and, if appropriate, reasonable applications. If no topic is suggested, care should be taken to choose a topic that the students have not encountered previously.

b) Right now, some 50% of college-bound seniors have decided on their initial major. Any presentation should encourage those interested in majors that involve the study of mathematics to pursue those majors. Other college bound students should be informed of and encouraged to take math courses related to their areas of interest; specific examples should be given.

c) Interests of high school juniors may vary widely over the next few years. A principal point in any meeting with juniors should be the advisability of taking four years of high school mathematics and then continuing the study of mathematics in college.

d) High school sophomores can be a volatile audience; they need to see that mathematics is useful and interesting and that it can affect their future. It is in this group that a desire for further study must be nourished.

e) Groups involving parents, friends, or alumni of a high school often are important forces in the school's activities; presentations to such groups can be beneficial. It cannot hurt to stress the points mentioned in 1) and 2) and to offer elementary but meaningful examples of how mathematics can be useful.

f) High school mathematics teachers are our colleagues in the learning process. Exchanges between high school teachers and mathematics faculty in an informal setting either at the high school or on campus can be most beneficial.

4. Professional ethics require us to encourage and support mathematical development in all secondary schools, not just those with "quality" students. Potential students of mathematics attend all high schools. Since women are underrepresented and since the number of minority majors and Ph.D. candidates in the mathematical sciences is abysmal, we must, in particular, encourage and support the mathematical development of these students.

The previous paragraphs have outlined ways to deal with some problems facing current and future college mathematics students. They require little if any expense; in particular no equipment or facilities are involved. Students, be they liberal arts students in a required course, social science students in a first statistics course, science or engineering students in the calculus sequence, or majors starting their study of abstract algebra, analysis, or probability, all need to know that somebody cares about what they are doing. Future college students, and their parents and teachers, also need to know that we do care. Caring does have a place in the mathematical sciences. Indeed, David II, which also offers strong support for teaching and undergraduate education, notes the role of mentoring in supporting the research of young mathematicians. Can we deny the need for some form of mentoring, which really means increased personal contact in various forms, for students enrolled in or planning to enroll in our courses?

Computers and Mathematics

Edited by Jon Barwise

Editorial notes

Mathematics research and education: the role of the computer

This fall I was surprised to realize that I had spent thirty years in American universities, as a student or faculty member. It begins to seem like a viable way of life. But over the last few years I have come to believe that a serious problem is facing research universities.* Witness: the spate of recent professor-bashing in the popular press; the growing complaints of university students about neglect by faculty; the grumbling of the faculty about students more interested in getting passports to high-paying jobs than educations; researchers leaving academia for private research labs; the mushrooming of semi-autonomous research institutes within the university; and the fact that the rate of increase of tuition at our private universities is about twice the overall inflation rate.

Expedition or guided tour?

What can the matter be? I think I know a significant part of the problem. The university is dedicated to "higher learning." But that phrase can mean two things, and in that ambiguity lies a problem.

A metaphor might help. Think of all "information," both known and unknown facts, as an ancient buried city, much of it still covered by dirt, sand, and the sea. The parts sticking out correspond to the knowledge we have acquired to date. This knowledge is somewhat disconnected: chimneys and top floors of buildings sticking out, apparently far from one another. The more uncovered buildings are disciplines, something no university can be without. The "shorelines" of these buildings, as well as new buildings, where the current excavations are taking place, represent current research activity. "Higher learning" might refer to conducting guided tours of the uncovered buildings or to uncovering new buildings.

*The piece is definitely about American research universities. It is not about four year colleges, since I have had almost no experience with them. Perhaps we will have a response from someone at such a college in the near future.

The basic problem is that American academics and their academies are two-faced. To the public and our students we present the face of an educational institution, claiming to be teaching tomorrow's leaders the knowledge of today. The other face, shown to industry and funding agencies, is that of America's research vanguard, digging away in the trenches, uncovering new facts, confronting the challenges of tomorrow with the tools of today.

Is the university's mission that of a tour company or an exploratory expedition? The answer, of course, is "Both." After all, universities do perform both functions. And when things work properly, the two functions merge with and complement one another. But things are not working properly just now.

If the truth be admitted, most of us in these institutions think of research as our vocation and as the main mission of the university. If you want proof, look at how university faculty spend their time. The more successful faculty are driven not by the desire to fill young heads with facts, but by the urge to push back the borders of humankind's massive ignorance of the universe. Or look at how tenure decisions are made. For better or worse, first-rate research is the key to tenure, not first-rate teaching. Or look at how salaries are set. How many professors have gone above scale for excellent teaching?

The evidence supports the claim that university faculty consider research to be the more important of the two tasks. But many of us have considered the research mission to be a secret that must be kept from the public. The fear, I suppose, is that the public wouldn't be willing to foot the bill for the research if it understood the proportion of money that is going to it. So, for the public good, and our own, we conspire in the misconception of the university as primarily educational institutions and go about our research in quiet.

It seems to me that this dissimulation does everyone a disservice. The faculty are put in a false position, and the students are misled as to the nature of the institution they are joining. We must make the case that the research function of the university has been absolutely crucial in the past and that it will remain so

in solving the problems of the future. The public must be made to understand this and support both missions of the university as inseparable.

Separate but equal?

Why is the problem getting worse just now? It is not because research is becoming more dominant within academia than in the recent past. Research has long been a driving force behind American universities. I believe it stems in large measure from the increasing distance between teaching and research. We cannot truthfully claim that research and teaching are inseparable when in fact they have become quite separate.

This separation is exemplified (and exacerbated) by an explosion of research institutes in the past twenty years at universities across the country. These institutes are usually established in newer fields that do not mesh with the departmental structure, fields like mathematical physics, cognitive science, astrophysics, urban studies, international studies, and the like. Drawing on faculty from various disciplines, as well as from researchers who do not fit any of the stereotypes, they are set up to break down the very disciplinary boundaries that define the departments. But curriculum setting and teaching is left to the departments.

We need to bring teaching and research back together within the university. This can be done only if we get the public to recognize that research is right there at the top of the agenda, on a par with education. But, at the same time, we must reinvigorate teaching by making the research experience a part of what we give our students. To return to our metaphor, we must view teaching not just as guiding students through the buildings uncovered in the past but as waking them up to the excitement of exploring the unknown.

To integrate teaching and research effectively would require changes in just about every aspect of the university. For one thing, we would refashion our departments to serve research needs better, thus cutting down on the need for research institutes. Departments would be more stable and less trendy than current research institutes, but not as entrenched as current departments. Departmental billets would not have a life of their own (often within certain narrow areas) when the people holding them retire. We would find mechanisms to handle job searches and tenure decisions in ways that better match research needs. All faculty would teach or otherwise take part in the education of our students. And students would be routinely introduced to research as part of their undergraduate education.

From the general to the particular

We hear a lot about problems in mathematics education. Many of the problems result from the more general problem discussed above. There is an ever widening gulf between our lives as research mathematicians and what we profess as mathematics professors. In mathematics, it is all too easy to let this problem seem unsolvable. After all, there just is a big gulf between calculus and algebra, the courses we are most often asked to teach, and the rarified air we breath on the research frontiers. As a result, the separation between undergraduate mathematics and research is acute.

The sad fact is that at many universities students are able to get a bachelor's degree in mathematics with *no* sense that mathematics is a living, growing subject. If our mathematics majors do not understand what mathematical research is, how will the general public ever come to appreciate it? And where will tomorrow's mathematicians come from? It is imperative that we bring research back into undergraduate mathematics. There are many ways in which this could be done. Summer research programs of the kind offered at Williams College are one. Jobs as faculty research assistants are another. (My own choice of field was strongly affected by being a research assistant for a logician during my senior year at Yale.) Courses taught using a version of the Moore method are another. So are undergraduate research seminars and honor theses. But in this editorial I want to discuss ways in which computers might solve the problem. Let me hasten to add, however, that they can also make it worse.

There are several computer programs designed to teach old, standard material, relieving faculty of the chore. The worst are basically automated page turners with on-line grading to help the student get through some standard text. Such programs only exacerbate the problem, increasing the distance between what the students learn and what mathematics is really like.

There are many alternatives, however. For one, we can use the computer as a tool for mathematical experimentation. By making mathematics come alive, it can serve as a powerful source of intuition and inspiration. Programs like *Mathematica* and *Maple* can provide tools with which even a freshman can explore uncharted waters, looking for patterns and then trying to understand them. Using such programs made me realize what toy examples I have always used in teaching calculus. We have in the calculus a most sophisticated tool for exploration, but we seldom encourage students to use it except in a gold fish bowl fished over by countless generations of earlier students. But there are vast regions yet to explore.

The computer can change this. By allowing the student to carry out huge calculations no one could perform with pencil and paper, students can apply what they learn to original and significant problems. And the graphic capabilities of the modern computer allow us to visualize functions and other patterns that would have been completely inaccessible when I was a student. This requires us to rethink the material we teach, both what

we need to teach and how we motivate and apply it. The process of re-evaluation is, of course, underway in projects around the country. In rethinking our curriculum in light of computers, we have an exciting opportunity to introduce students to the joys of mathematical discovery that motivate us as mathematicians.

Another application is courseware that is specifically designed with some particular subject matter in mind, courseware that opens up areas of mathematics that were previously inaccessible at an undergraduate level. Several of these have been reviewed in these pages over the past two years. I can testify from personal experience that there is a payoff in research of these efforts to use computers to reinvigorate mathematics education. The computer has things to teach us as mathematicians, as well as our students.

Another way that computers can help narrow the gap between mathematics education and mathematical research requires us to broaden our view of mathematics itself. Mathematics is not just the sum of existing subdisciplines like algebra, topology, analysis, and so on. Mathematics is the deductive study of patterns. As such, it must go where the new patterns are being discovered if it is to thrive. This requires us to be much more open minded about what counts as mathematics. In particular, much of so-called theoretical computer science is really mathematics. This part of mathematics is going to be of increasing importance in the years to come. Unless we recognize it as mathematics in our hiring decisions and our course offerings, this mathematics will be done elsewhere within the university. The result will be an increasing gulf between what gets taught as mathematics in mathematics departments, on the one hand, and very important research activity in mathematics, on the other. This can only exacerbate the tension between mathematics teaching and research in the university.

As mathematicians, we can hardly hope to solve all the problems of the university. But we can at least put our own house in order, and in doing so, point the way for other disciplines, and university administrators, to heal the rift that is weakening the research university as an effective instrument of higher learning.

This month's column

In addition to the above editorial, this month's column contains three reviews. The first, by James Milne, is a review of four word processors for the PC that have the capacity for producing TEX output. The others are a review of SPARSGEM by Charles Champ, and of Fields&Operators by Marvin Margolis.

We are still in search of people willing to write short, expository articles about the roll of computers in their work. Write to me at:

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Four Word Processors with TEX Capabilities

*J. S. Milne**

Increasingly, mathematics is being printed from TEX files, but for those of us who write our *first* drafts on a computer, it is essential that we see the mathematics, not TEX-code, on the screen as we type it. In this review I describe four programs for IBM PC compatibles that aspire to close the gap between the two ideals: WYSIWYG input; TEX output.

Three of the programs, *ChiWriter* (version 3.17), EXP (version 2.0), and T^3 (version 2.3) are popular scientific word processors that have added programs to convert their files to TEX files. The fourth, *Leo* (version 1.1), is a new program that works directly with TEX files. As does TEX, it comes in two flavors, $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX and LATEX, and I will describe the $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX version. At the time of writing (July 1990), the converters for *ChiWriter* and EXP were not in quite their final form—thus I could only test beta versions.

Of the four programs, only EXP was completely new to me as I came to write this review. I have been using T^3 and *Leo* almost from their introductions, six years and a few months ago respectively, and the principal author of *ChiWriter* was a graduate student at the University of Michigan when he wrote the first version.

TCI's T^3

T^3 works largely through menus, but these can be suppressed and replaced by [Ctrl]-key combinations for the most common actions. It has extensive context-sensitive help. For basic editing T^3 is very good.

It is supplied with italic, script, upper-case calligraphic ($\mathcal{ABC}\ldots$), fraktur (old German), Greek, and Cyrillic fonts, and a very large set of mathematical symbols. The only deficiency I have found is that it lacks a full alphabet in blackboard bold ($\mathbb{ABC}\ldots$), but it is possible to add your own characters and fonts to the system. Most

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characters are available in only one size. All characters can be enhanced with boldfacing or underlining.

The standard IBM keyboard has 47 character keys. By combining them with the [Shift] key you can enter 2×47 characters. In T^3 you can combine them with the [Shift] and [Alt] keys to enter $2^2 \times 47$ characters. This gives a very fast way of entering the 188 characters you use most often. For the remainder, T^3 offers a variety of strategies: you can pick a character off a keyboard displayed on the screen, you can switch between different keyboards (similar to a typist switching type-balls), you can enter the TEX-name of a symbol, or (as a last resort) you can enter the name of the font and the number of the character into a menu.

To construct complex mathematical expressions, you use the arrow keys to move the cursor around the screen (by whole spaces horizontally or half-lines vertically) and enter the characters. The space for a line opens up automatically to accommodate additional levels of superscripts and subscripts. Since everything is displayed on the screen as you type it, it is a simple matter to type even the most complex expressions. There was no difficulty entering the expressions in the table, but some, for example **2** and **6**, were a little tedious because structures such as root signs and large parentheses do not expand automatically to accommodate their contents.

The appearance of the material on the screen is very close to that printed out except that the screen does not display proportional spacing. It does however show line and page breaks correctly.

With version 2.21, T^3 added a program that converted between T^3 files and plain text files—this allowed two T^3 users to swap files by email. Finally with version 2.3, T^3 added a program to convert the plain text file to a TEX file. Writing such a converter was not easy because, whereas a TEX file is very structured (boxes within boxes within boxes), a T^3 file only remembers where each character is placed relative to the base line. Also, unlike TEX, T^3 has no special mode for mathematics. Nevertheless, the converter managed to correctly identify mathematics most of the time; for example, it recognized that a^b, b, G, and (A,λ,i) were mathematics, but it will fail to recognize a, I, or (A,i) as mathematics, and it will incorrectly identify (b), (c) as mathematics. It correctly converted most in-line mathematical expressions. Of the more complex structures in the table, it was completely successful with Examples **1**, **2**, and **9**, and partially successful with **3**, **4**, **11**, and **12**. As a rough rule-of-thumb, I expect it to save about 80–90% of the effort of turning a T^3 file into a TEX file.

ChiWriter

In its basic method of operation, *ChiWriter* is quite similar to T^3, and so I will describe it mainly in comparison with T^3. Whereas T^3 aspires to be a top-of-the-line program, *ChiWriter* emphasizes simplicity. It too works through menus, with shortcuts, but its menus are much better organized than those of T^3. In basic editing, it doesn't match T^3, mainly because it doesn't automatically reformat your paragraphs as you edit them. This feature is promised for version 4.0, but until *ChiWriter* acquires it, it is clumsy to reformat a document (for example, to change the line length). *ChiWriter* makes it easier than T^3 to copy between two documents because it allows you to display them both in windows.

ChiWriter comes with italic, script, fraktur, Greek, and blackboard bold fonts, and a very large collection of mathematical symbols. Again, you can add your own symbols and fonts. Only the standard Roman letters can be underlined or boldfaced.

The available characters are collected on 14 keyboards of (as many as) 94 characters each, corresponding to the function keys [F1]–[F10] and the shifted function keys [F1]–[F4]. To obtain a single character from one of the keyboards, hit the function key once and then a character key; to switch to the keyboard, hit the function key twice. Again, characters can be picked off a keyboard displayed on the screen.

Constructing complex mathematical expressions with *ChiWriter* is very similar to doing it with T^3, but because *ChiWriter* doesn't support over- and under-braces, Example **5** was not possible. Expanding root signs and large parentheses are promised for version 4. *ChiWriter*'s capabilities for editing formulas (deleting, or moving pieces of the formula around) are at least as good as those of T^3, and are easier to use. Unlike T^3, *ChiWriter* makes it simple to enclose formulas and tables in boxes.

While *ChiWriter* has all the basic page formatting features (footnotes, headers, and footers etc.), it doesn't match T^3 in this respect: T^3 allows you to divide the page into several different regions, for example, two or more columns; as you enter the coordinates of a region into a menu on the left of the screen, a picture of the page is displayed on the right. Also, while *ChiWriter* allows you to change margins and line-spacing anywhere in the document, T^3 allows you to build a library of line formats to choose from.

The appearance of a *ChiWriter* document, printed on a laser printer, is that of a perfectly typed document. Because it incorporates attractively designed proportional fonts, that of a T^3 document is somewhat better. In *ChiWriter*, the opening and closing of line-spacing to accommodate levels of superscripts and subscripts is less automatic than in T^3, but, in recompense, *ChiWriter* makes it easier to use one-and-a-half spacing, which is the recommended line-spacing for published lecture notes.

Since a *ChiWriter* file contains exactly the same information as a T^3 file, its converter should be as effective. In fact, version (0.9β) had a few more problems than T^3's current version. For example, it failed to recognize large parentheses, and it had difficulty determining when to switch out of math mode, especially when the mathematics was followed by a parenthesis. However, it succeeded completely with the Examples **1**, **2** and **9**, and partially with **4**, **11** and **12**. Version 1.0 of the converter should be closely comparable with T^3's. *ChiWriter* does offer one nice touch, namely, a "shadow" font that the converter passes through unchanged. This allows you to write your document in a mixture of *ChiWriter* and TEX code.

Both *ChiWriter* and T^3 convert to plain TEX and the standard (plain) fonts, but both include a text file which you can edit to enable the converter to translate additional fonts (for example, fraktur and blackboard bold) which are available in $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX.

The documentation for both *ChiWriter* and T^3 is very good. *ChiWriter* includes a brief tutorial; T^3 includes a comprehensive tutorial, which can also serve as an introduction to typing mathematics on a computer for nonmathematicians.

Leo

Unlike T^3 and *ChiWriter*, *Leo* works with straight *.tex files, which you can run directly through TEX.

Leo supports the fonts (italic, upper-case calligraphic, Greek, blackboard bold) and the characters supported by $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX 1.0 (those in Appendix E of *The Joy of TEX*, 1986 edition). It also supports many, but not all, of the control words. For example it does not recognize such control words as head, roster, proclaim, or demo. You can still enter them into your file, but *Leo* will display them verbatim in a box rather than translating them.

As far as entering mathematics is concerned, *Leo* works very well. The key-strokes you enter are close to those you normally use when typing TEX-code; for example ^ will move the cursor up for a superscript, and \ will prompt for the TEX name of a character. Each character is displayed on the screen as you type it, and such structures as square root signs and large parentheses expand automatically on screen to accommodate their contents. If you can't remember the name of the character, you can scroll through a table on the screen. To enter a fraction, type [Ctrl]-f, and a bar appears with the cursor positioned above it; type in the numerator, and hit enter; the cursor then moves under the bar, and you type in the denominator.

Entering the complex expressions in the table, many of which are "challenge exercises" in Knuth's *The TEXbook*, is as easy as with *ChiWriter* and T^3, except that, as I will explain below, *Leo* couldn't handle the vertical = sign in Example 7. (TEXperts will note that Examples **1** and **5** are not quite correct—the table illustrates what can be achieved working only from *Leo*'s manual.)

For reasons of speed and clarity, *Leo*'s screen display does not attempt the precise placement and sizing of TEX (it is not a previewer). It does show proportional spacing, but characters are shown in a single size. Line and page breaks will differ from those that TEX prints out.

Apart from its skills with mathematics, *Leo* has only the most basic word processing capabilities. It lacks an overwrite mode and automatic paragraph reformatting, and it will recognize a paragraph ending only if you leave a blank line. It does have block moves and deletes, and a rather primitive search and replace (plain text only). You can open several files in memory, and switch between them with a few key-strokes, and to speed your typing, it allows a limited number of macros and an unlimited number of abbreviations.

Don't expect *Leo* to be able to read TEX-files not produced by itself. Typically, a TEX-file begins with a list of new control sequences (effectively abbreviations) which *Leo* will not be able to recognize.

When given a file to read, *Leo* first checks it for syntax. If it detects an error, it refuses to accept the file, and lists the line number of the error, or it may simply crash. Unfortunately, it may do worse. When it finds something it doesn't understand, although correct TEX-code, it may attempt to "correct" it, and in doing so, corrupt it. For example, when the following lines are read by *Leo*

```
{\bf Axioms}\TeX
@.@\vert
```

it corrupts them to

```
{\bf Axioms\TeX}
@.\backslash$\vert
```

(The second line occurs in the code for Example 7.) This is disconcerting, but it happens only occasionally, and it is obvious when it does.*

If you don't happen to have the TEX system on your hard disk, *Leo* has its own "fast and dirty" print program.

Leo's manual is brief but clear. *Leo* is an easy program to learn and someone familiar with TEX will be able to use it after only a quick skim through the manual.

In comparison with *ChiWriter* or T^3, entering mathematics in *Leo* seems a little fussy—you have to worry about whether an item is text or math, or text in math, or math in text in math—and rigid, but for the first time, *Leo* allows you to work directly with TEX files with

*In response to a letter pointing out these problems, ABD Software sent me version 1.3 of *Leo*, which handles my code for Example 7 correctly, and said that it is correcting problems with font groupings.

an ease and speed approaching that of the best scientific word processors.

EXP

EXP can best be understood as having its own primitive form of TEX built in. For example, it has a quite precise proportional spacing with right justification, it automatically adjusts the sizes of square root signs and parentheses, and the heights of superscripts are automatically adjusted for the height of the preceding character. All this is displayed on the screen with considerable accuracy. Since its file structure is closer to that of TEX's than are those of *ChiWriter* and T^3, its TEX-converter is much more effective, and unlike *Leo*, it is a complete word processor, with such things as automatic reformatting and spell-checking. It allows you to incorporate graphics in a more sophisticated way than *ChiWriter* or T^3, and it allows you to display two files in windows on the screen and switch back and forth between them. Unfortunately, it is also much the most difficult program of the four to learn and to use, and it is the only one that expects you to type in large chunks of your mathematics in code.

EXP is completely command driven—there are no menus, and no help screens. It comes with two manuals: one is a reference work in the style of the DOS manual; the other is more readable, but has no complex examples. Since the EXP code for examples like those in the table is complicated, learning how to enter such examples is a much more difficult task than with any of the other programs.

EXP comes with italic, Cyrillic, Greek, script, fraktur, and blackboard bold fonts (the last three only in upper case). All are available in two sizes (10 point and 8 point). It has a good collection of mathematical characters, but you may miss a few. For example, it lacks $\coprod$. A font editor that will enable you to add fonts and characters should be available early in 1991.

Switching among text fonts is accomplished by [Alt]-[Fn] combinations. Mathematics is entered on a command line in a code which is similar, but in some respects more complicated, than that of TEX. For example, the EXP-code for

$$\left(\frac{1}{\sqrt{1-x^2}}\right)$$

is

```
\op num 1 den op 1 - x sp 2'8 cl sqr mid a(),
```

whereas the TEX-code is

```
$\left(\frac 1{\sqrt {1- x^2}}\right)$.
```

As in TEX, an EXP formula consists of nested boxes. In the above expression, the outermost box is started with op (for open) and closed with a() (adjusted parentheses); the innermost box is started with sp (superscript) and closed with cl (close). Note that EXP had to be instructed to put the superscript in 8 point— unlike TEX, EXP doesn't automatically size characters.

Entering EXP code offers some advantages over entering TEX code. After typing an expression on the command line, hitting [enter] will display it as mathematics. If the display is not correct, you can go back and edit the code. Also, you can enter a complex structure box by box. In the above example, you could first type $(\frac{1}{a})$, and then replace the a with $\sqrt{1-x^2}$. Of the formulas in the table, only Example 2 was easier to type with EXP than with the other programs: first type $\sqrt{1+x}$; a couple of keystrokes then replaces the x with $\sqrt{1+x}$, and so on. The EXP manuals do not mention commutative diagrams, and so I had to type Example 7 as a 3×9 matrix, and this was very clumsy. Unlike TEX, EXP doesn't adjust the size of the matrix to accommodate that of the entries, and the space reserved for each entry must be the same. Formulas had a disconcerting habit of collapsing like a pack of cards whenever I accidentally deleted a hidden control character.

To speed up the entry of mathematics, EXP offers what it calls a "tree" keyboard. Unlike a normal keyboard, which responds when a single key or shifted key is typed, the tree keyboard responds to a series of keystrokes. For example, you could set it up so that typing qa gives α, qb gives β, and so on, provided you make qq give q. Each sequence of keystrokes in the tree keyboard can have a macro assigned to it and macros can include pauses for characters or strings of characters.

Once you have mastered the program, entering mathematics works reasonably well provided you are typing from a (almost) finished manuscript, but having to enter the mathematics in code is a serious handicap if you are attempting to compose the mathematics at the computer. Since *Leo* is able to protect the user from TEX code, one has to wonder why EXP can't protect its users from EXP code.

On a laser printer, the output of EXP is of near-TEX quality—only a close inspection reveals that its type-setting abilities are significantly less complete than those of TEX. EXP prints in 10 point, which is ideal for book-size pages, but is generally regarded as too small for 8 1/2 x 11 inch paper. However, 12 point fonts are available from the publisher.

As expected, EXP's TEX-converter was much more successful than those of *ChiWriter* and T^3. It failed on Example 7 (at least, it failed to convert my entry of Example 7 in EXP), and its code for Example 5 was so inelegant that PC-TEX's print driver refused to touch it (it did show correctly in the previewer), but it succeeded on the remaining examples. If you follow EXP's extensive guidelines for typing an EXP document intended for conversion, the converted document will require only a little editing to improve spacing plus some minor proof reading.

Summary

Both *ChiWriter* and T^3 are easy to learn and easy to use, and they allow you to do everything you are likely to want to do. Their printed output is adequate for most purposes and their TEX converters take care of most of the effort of turning a file into TEX code. *ChiWriter* is the simpler program to learn, but it lacks a few of T^3's more sophisticated features.

For those wishing to work directly with TEX files, *Leo* makes this enormously easier. *Leo* will also be a boon to typing pools—only one person need learn TEX and the rest can work with *Leo*.

In many respects, EXP is a more powerful scientific word processor than *ChiWriter* or T^3, but its primitive user-interface makes it difficult to learn and to use.

Products Reviewed

ChiWriter: Horstmann Software Design, P.O. Box 1807, San Jose, CA 95109- 1807; (408) 298-0828. (Program $150; laser printer support $75; Cyrillic fonts $30; Word Perfect/WordStar converter $60; mail merge $30; TEX converter extra.)

Leo: ABK Software, 4495 Ottawa Place, Boulder, CO 80303; (303) 494-4872. (Program $150. To be used effectively, *Leo* requires the TEX system, which costs $250–$500.)

EXP: Brooks/Cole Publishing Co., 511 Forest Lodge Road, Pacific Grove, CA 93950; (408) 373-0728. (Program $295; 12 point fonts $60; font development kit and TEX converter extra.)

T^3: TCI Software Research, 1190 Foster Road, Las Cruces, NM 88001; (800) 874-2383. (Program $595; includes printer support, mail merge, and Word Perfect and TEX converters.)

(1,2)

$$a_0+\cfrac{1}{a_1+\cfrac{1}{a_2+\cfrac{1}{a_3+\cfrac{1}{a_4}}}} \qquad \sqrt{1+\sqrt{1+\sqrt{1+\sqrt{1+\sqrt{1+x}}}}}$$

(3)

$$\prod_{j\geq 0}\left(\sum_{k\geq 0} a_{jk}z^k\right)=\sum_{n\geq 0} z^n\left(\sum_{\substack{k_0,k_1,\cdots\geq 0\\ k_0+k_1+\cdots=n}} a_{0k_0}a_{1k_1}\cdots\right)$$

(4)

$$\Pi_R\begin{bmatrix}a_1,a_2,\cdots,a_N\\ b_1,b_2,\cdots,b_N\end{bmatrix}=\prod_{n=0}^{R}\frac{(1-q^{a_1+n})(1-q^{a_2+n})\cdots(1-q^{a_N+n})}{(1-q^{b_1+n})(1-q^{b_2+n})\cdots(1-q^{b_N+n})}$$

(5,6)

$$\underbrace{\overbrace{a,\cdots,a}^{k\ a\text{'s}},\overbrace{b,\cdots,b}^{l\ b\text{'s}}}_{k+l\ \text{elements}} \qquad \begin{pmatrix}\begin{pmatrix}a&b\\c&d\end{pmatrix}&\begin{pmatrix}e&f\\g&h\end{pmatrix}\\ 0&\begin{pmatrix}i&j\\k&l\end{pmatrix}\end{pmatrix}$$

(7)

$$\begin{array}{ccccccccc}0&\longrightarrow&\mathcal{O}_C&\xrightarrow{\ \iota\ }&\mathcal{E}&\xrightarrow{\ \rho\ }&\mathcal{L}&\longrightarrow&0\\ &&\|&&\downarrow\phi&&\downarrow\psi&&\\ 0&\longrightarrow&\mathcal{O}_C&\longrightarrow&\pi_*\mathcal{O}_D&\xrightarrow{\ \delta\ }&R^1f_*\mathcal{O}_V(-D)&\longrightarrow&0\end{array}$$

(8)

$$\sum_{n=0}^{\infty}a_nz^n \text{ converges if } |z|<\left(\limsup_{n\to\infty}\sqrt[n]{|a_n|}\right)^{-1}$$

(9)

$$\frac{f(x+\Delta x)-f(x)}{\Delta x}\to f'(x) \text{ as } \Delta x\to 0$$

(10)

$$\textit{The confluent image of}\left\{\begin{array}{c}\textit{an arc}\\ \textit{a circle}\\ \textit{a fan}\end{array}\right\}\textit{ is }\left\{\begin{array}{c}\textit{an arc}\\ \textit{an arc or a circle}\\ \textit{a fan or an arc}\end{array}\right\}$$

(11)

$$\prod_{k\geq 0}\frac{1}{(1-q^kz)}=\sum_{n\geq 0}z^n\Big/\prod_{1\leq k\leq n}(1-q^k)$$

(12)

$$\left(\int_{-\infty}^{\infty}e^{-x^2}\,dx\right)=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}e^{-(x^2+y^2)}\,dx\,dy$$
$$=\int_0^{2\pi}\int_0^{\infty}e^{-r^2}r\,dr\,d\theta=\int_0^{2\pi}\left(-\frac{e^{-r^2}}{2}\Bigg|_{r=0}^{r=\infty}\right)d\theta=\pi$$

Examples for the review of word processors (as entered by *Leo*).

Reviews of Mathematical Software

SPARSGEM

*Reviewed by Charles W. Champ**

There are many applied problems that require the solution of a system of linear equations. In some of these problems, the coefficient matrix is a sparse matrix, i.e., a matrix with a large percentage of zero elements. The applied problems that involve a sparse system of equations are found in such areas as computational circuit design, linear programming, and partial differential equations. Recently, in the area of statistical quality control, Champ and Woodall (1987) show how a Shewhart chart supplemented with runs rules can be modeled as a Markov chain. One of the keys to the Markov chain representation being tractable is that the transition matrix becomes more and more sparse as more rules are added to the chart. A desirable characteristic, the average run length of the chart, is a solution to a sparse system of equations whose coefficient matrix is a submatrix of the sparse transition matrix.

SPARSGEM is a library of *FORTRAN* subroutines for solving systems of equations with sparse coefficient matrices. The solution of a system is obtained using sparse Gaussian elimination and backward substitution. Hence, the name SPARSe Gaussian EliMination.

The software is available for the IBM compatible machines that use the DOS operating system with either 3 1/2 inch or 5 1/4 inch disk drive. A hard disk is strongly recommended. *SPARSGEM* is available for each of the following *FORTRAN* compilers:

IBM Professional *FORTRAN* Version 1.30
Lahey F77L *FORTRAN* Version 2.22
Microsoft *FORTRAN* Version 3.31
Microsoft *FORTRAN* Version 4.01
Ryan-McFarland *FORTRAN* Version 2.42

A coprocessor is not required to use *SPARSGEM* although one may be required by the compiler being used.

A tutorial and reference manual is provided with the *SPARSGEM* package plus a quick reference pamphlet. The manual consists of five chapters, three appendices, a glossary, a bibliography, and an index. Chapter 1 gives some introductory information and a general description of *SPARSGEM* which includes installation instructions. The second chapter begins with a simple example of a program that solves a single system of equations. This program is provided on one of the diskettes. The remainder of the chapter is devoted to explaining the program and the general solution process that *SPARSGEM* uses. It is recommended that the user compile and link this demonstration program. With some minor changes to this program, I was able to solve the sparse systems that were of interest to me. Appendix B gives instruction for compiling the user's program and linking it to the *SPARSGEM* library.

Three interactive test programs that are included with the *SPARSGEM* package are discussed in Chapter 3. Two of these demonstrate the capabilities of the three solution subroutines NDRV, TDRV, and CDRV for solving a system with a nonsymmetric coefficient matrix and the one subroutine, SDRV, for solving a system with a symmetric coefficient matrix. It should be pointed out that here a matrix is called symmetric if the $(i,j)^{th}$ and the $(j,i)^{th}$ elements are either both zero or both not zero. The third test program illustrates the capabilities of *SPARSGEM* data utilities, STOROW, STOMIJ, and GETMIJ. The data utilities are useful in simplifying the conversion of the coefficient matrix to sparse storage format before calling one of the solution driver subroutines. These programs are listed in Appendix C.

To aid in the development of a user's *FORTRAN* program that will make calls to the *SPARSGEM* library routines, various files are provided on diskette from which to construct a program. These can become valuable aids in program development. Each of these skeleton files is discussed in Chapter 4.

Chapter 5 is the subroutine reference chapter. It begins with a flow chart for choosing the *SPARSGEM* library routines that will best solve the user's sparse system of linear equations. Once I discovered this flow chart, it came in quite handy. The remainder of this chapter gives complete descriptions of each of the *SPARSGEM* library routines.

I used the *SPARSGEM* library of routines to find the average run lengths of various quality control charts that can be modeled as a finite state Markov chain. Control charts are often compared by comparing their average run lengths (ARL's). The ARL can be obtained by solving the system of equations, $(I - Q) \cdot \mu = 1$ for μ. The i^{th} component of the vector μ is the ARL of the chart that starts in state i and Q is the matrix obtained from the transition matrix of the Markov chain with the row and column associated with the absorbing state deleted. As already stated, this system is a sparse system of linear equations. Champ and Woodall (1987) used an approximation technique to determine the ARL's. Recently, others have obtained different results for some of the ARL's given by them. Ng and Case (1989) used simulation and Palm (1990) employed the technique

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given in Brook and Evans (1972). *SPARSGEM* was used to calculate some of the ARL's. In most cases, the different techniques gave results that were close. In some cases the results were noticeably different. For example, in one particular case, for the chart labeled C1234 by Champ and Woodall (1987), they obtained the same in-control ARL of 91.75 as was obtained using *SPARSGEM*. Ng and Case (1989) on the other hand gave a simulated ARL for this chart of 92.59 and Palm (1990) calculated an ARL of 94.57. Simulated results are generally only rough approximations and vary from simulation to simulation. The method used by Palm (1990) was based on an approximation method that is generally not as good as the one used by Champ and Woodall (1987).

I have been convinced that *SPARSGEM* is a very good set of library subroutines for solving sparse systems of linear equations. It is a bit cumbersome to get all the declarations straight in the main program, but no more so than in any *FORTRAN* program where successive subroutine calls are made which depend on the previous call. I would recommend the package for those who need to solve such a system. *SPARSGEM* can be obtained from

PC Scientific, Inc.
6 Pine Tree Drive, Suite 250
St. Paul, MN 55112
612-490-0615

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Champ, C.W., and Woodall, W.H. (1987), " Exact Results for Shewhart Control Charts with Supplementary Runs Rules," *Technometrics*, **29**, 393-399.

Ng, C.H., and Case, K.E. (1989), "Development and Evaluation of Control Charts Using Exponentially Weighted Moving Averages," *Journal of Quality Technology*, **21**, 242-250.

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Fields&Operators

*Reviewed by Marvin S. Margolis**

Introduction

Fields&Operators from Lascaux Graphics, 3220 Steuben Avenue, Bronx, N.Y. 10467, $59.95, is an interactive graphics program designed to help users visualize surfaces, vector fields, and integral flows; and to investigate the effects of differential operators applied to them. Lascaux Graphics also sells the complex variables graphics program $f(z)$ which I reviewed for this column in the July/August 1989, *Notices of the American Mathematical Society*.

The program uses a system of "layers" to display geometric figures rather than the windows that $f(z)$ uses. A layer is either a scalar field (represented as a surface), a vector field, or an integral flow. A single drawing may consist of up to 6 layers. The calculations that define any layer can depend on the results from previous layers. The user can define the relationship between the layers in terms of explicit functions (composition) or by a differential operator.

Fields&Operators supports the following differential operators: gradient, divergence curl, Laplacian, time derivative, and second derivative. Since most surfaces and fields a user wants to investigate are time dependent, *Fields&Operators* permits the inclusion of a time variable, t, in formulas. The user can save a sequence of "frames" to disk and later replay them to produce an animated picture.

I used the program to duplicate several computer-generated figures in the first edition of *Vector Calculus* by Jerrold E. Marsden and Anthony J. Tromba, San Francisco: W. H. Freeman and Company, 1976. In most cases *Fields&Operators* could reproduce the figures of real valued functions in three dimensions in chapter 2 of the Marsden and Tromba text. I set the program perspectives so that I could see the plots at the same elevation and deflection as Marsden and Tromba chose to show.

Similarly, when Marsden and Tromba discussed limits and continuity in chapter 2, I duplicated the computer-generated graphs that they used to illustrate those ideas. I also obtained closed form expressions for many derivatives given in the author's text although symbolic manipulation is limited in *Fields&Operators*.

Hardware Requirements

Fields&Operators runs on any PC compatible with 512 RAM and the following graphics adapters: CGA Low (4 color 320 x 200 resolution), CGA High (monochrome 640 x 200 resolution), EGA (16 color 640 x 350), VGA (16 color 640 x 480), and Hercules (monochrome 720 x 348). A Microsoft compatible mouse is optional and a Macintosh version is available. I tested the program on two computers: an IBM PS/2 with a mouse but without an 80287 coprocessor and an AT clone with an 80287 coprocessor but without a mouse. A higher level cpu, coprocessor, and mouse all improve program performance.

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Because it is a well-designed, small program, *Fields&Operators* installs simply and is easy to use. Part III of the manual and an included sample session file guides the beginner through the various program features. The manual includes a brief discussion of the program's mathematical structure but lacks references to the relevant literature or an index. A reference section provides more detailed description of the program controls.

Operation of the Program

The program displays the main menu on the right of the screen. The main menu shows the various options and commands that are available for creating graphs. The user presses up and down arrow keys, a capitalized letter, or a mouse to select an option. Users with a color system press a key to change the background color.

Initially the program centers the graph, graph title, and layer label on the screen. The user shifts their screen positions with a mouse or a numeric keyboard. To get a better viewing angle of the graph, the user selects the main menu's View option. Two panels then pop up on the screen; one displays the axes of the graph and the other shows rotation, zoom control, and reset options. Either a mouse or the numeric keyboard allows the user to rotate the axes in the display to show a change in elevation or deflection of a figure.

Animation

To better understand time dependent fields and surfaces, *Fields&Operators* allows the user to set and vary the time variable t. The user can fix the value of t (usually at $t = 0$) or vary it through a range of values. When the user varies t, the program generates a sequence of "frames"; one for each value of t. Each frame typically requires between several seconds to several minutes to display. To produce smooth animation, the user directs the program to store the sequence of frames in a disk file and then replays the frames. The speed and duration of the animation depend on the speed and capacity of the disk drive.

Mathematical Structure

The functions that *Fields&Operators* can analyze depend on four variables: three space variables, x, y, z, and a time variable, t. A domain, an array of points distributed in two or three dimensions, defines (directly or indirectly) the x, y, z variables. All layers share a common domain by default. Yet, the user can define a different domain for any layer. Calculations for each layer depend directly on values from the common domain, the domain of the current layer, or the domain of another layer.

The user specifies a vector field typically by giving three coordinate functions or using cross product, gradient, or curl operators. Time derivatives also yield vector fields. The user can distribute vector fields in two or three dimensions. In either case, the values of the field ("direction of the arrows") are three dimensional.

The user can draw normalized or scaled vectors. *Fields&Operators* makes the length of all normalized "arrows" equal. Otherwise it sketches the "arrows" proportional to their theoretical length. To draw a vector field, the program requires knowing where to base the vectors and the lengths and directions of the arrows. When a user defines a vector field, two layers are specified. One layer (which may be the domain) determines the base points of the field. The second layer values are inputs to the calculations that decide the directions.

The user specifies a scalar field typically by coordinate functions or as the result of a dot product, divergence or Laplacian operator. The program draws scalar fields as surfaces and connects points in a two dimensional lattice. If the domain is 3-dimensional (has more than one z-subdivision), then the program draws images as stacked two dimensional lattices.

Functions and Differential Operators

Fields&Operators supports the following functions: Numbers, +, -, *, /, ^ , sin, cos, tan, sinh, cosh, tanh, exp, and log. Exponents may only be constants, not functions. The program can apply various differential operators and computes them in closed form from given functions that are not numerical approximations. The dot and cross product operators operate on two vector fields and produce a new field.

Integral Flows

An integral flow results from following the path indicated by the arrows of a vector field. Technically, a flow line represents a solution to the differential equation represented by a vector field. *Fields&Operators* displays flows by simultaneously integrating numerically along paths beginning at several "initial" points distributed in space.

Singularities in Surfaces

Fields&Operators handles singularities in surfaces by omitting any line segments containing them. The program displays singularities in vector fields by a small circle instead of an arrow. A singularity occurs when the absolute value of a computation is larger than a cutoff value that the user specifies. A second cutoff control lets the user reject line segments when their actual screen dimensions, measured in pixels, are too large.

Comparison with a Competing Program

The strengths and weaknesses of the program mirror those of a higher priced ($200) and more featured com-

peting program, *Derive*, from SoftWarehouse. A recent *Derive* upgrade incorporated differential and integral vector calculus commands such as Grad, Curl, Div, and Laplacian that *Fields&Operators* also includes. Since Lascaux Graphics specifically designed *Fields&Operators* for vector calculus applications, the program is easier to use than *Derive* for those problems.

Like *Derive*, *Fields&Operators* features impressive two- and three-dimensional graphics with significant ability to manipulate the on-screen display. Also similar to *Derive*, the program lacks a programming language. The user cannot define new symbolic manipulation procedures as one can with a program like *Mathematica*. The user can define functions but they allow no branching in the definition and no recursive functions.

Also both programs lack direct support for output of their graphs to a printer. The user must either use DOS graphics if a supported monitor/graphics combination is available or a third-party program if a hard copy is needed.

Conclusions

Fields&Operators' hardware requirements are not demanding for mathematical software in its class. It is an excellent choice for students or anyone interested in exploring the world of vector calculus. The program includes basic vector calculus commands and supports both two- and three-dimensional graphs.

The user interface is better than most other programs. The user can easily issue commands especially with a mouse. It also has a first-letter-driven menu mode for those without a mouse. If its limitations aren't serious to users, they will find the program a joy to use.

Inside the AMS

From Manuscript to Published Paper: How does it happen? Part 2

The AMS Composition Services Department

Many AMS members don't realize that the Society is one of the largest publishers of mathematical literature in the world. Of the 170 or so employees at AMS headquarters in Providence, Rhode Island, about sixty work in publications-related jobs. The AMS publishes about eighty books per year (most of them as part of twenty ongoing book series) and twenty journals, in addition to nine other journals published by the Society on contract from other scientific societies. The AMS headquarters houses a full editorial staff, a translations department, and a print shop and bindery. In addition, because it does all of its typesetting in-house, the AMS has a Composition Services staff that works on the computer typesetting of books and journals.

Most *Notices* readers are familiar with the mathematical typesetting language TEX. TEX is basically a computer language whose commands describe to the computer exactly where text and mathematical symbols and displays should appear on a page, and how multiple pages should be laid out. The computer then transmits this information to an output device (a computer screen, a laser printer, or phototypesetter), which produces the pages of text. The AMS developed a software package called AMS-TEX, which simplifies the typesetting of complex mathematical displays and the formatting of documents. Today, AMS-TEX is used to produce all of the Society's mathematical publications.

The AMS Composition staff consists of around thirty employees, approximately twelve of whom work from their homes, using computer modems to connect them to the AMS computers. Most of the Composition staff (and all of those who work at home) are TEX typists, or "keyboarders," as they are known in the office. It takes about six months to train a new keyboarder, because, in addition to learning TEX, they need to learn various aspects of mathematical typesetting and the production procedures at the AMS. For example, they must learn to identify mathematical symbols, letters from other alphabets (such as Greek and Cyrillic), and proofreading marks. And they must be well versed in the use of the AMS computer system (which consists of a VAX/VMS 6320 cluster).

Suppose you have submitted an article to an AMS journal, or a manuscript to an AMS book series, and it has been refereed and accepted. Once your manuscript reaches the Providence office, it is in the hands of a production editor, who oversees all aspects of the production of the publication. (For more information about the Society's Editorial department, see "From Manuscript to Published Paper: How does it happen?", *Notices*, September 1990, page 870.) After marking the manuscript for any changes, the production editor passes it along to Composition, where the article is keyboarded. Proof copy is then printed on a laser printer, the production editor marks the proof copy for corrections, and returns it to Composition. After these corrections are made, the proof copy is sent to the author for review, and sent back to Composition. The production editor is responsible for re-checking the paper to verify that the author's corrections were made. This process of review and correcting insures that the final product will be as free of errors as possible. The at-home keyboarders are generally responsible for initial keyboarding and the first two sets of corrections, while keyboarders who work in the office deal with the latter stages, such as finalizing page layouts and producing camera copy.

Authors can also submit papers (once they have been refereed and accepted) to the AMS in electronic form. The number of TEX manuscripts submitted electronically has steadily increased in the last few years. During the first six months of 1990, the AMS received more than 200 electronic submissions for publication, two-thirds through electronic mail and the remainder on diskettes. The production process for electronic submissions is basically the same as for paper submissions, but the keyboarding step is eliminated. The Composition department uses the author's file to produce a proof copy, which is then treated as the manuscript, which the production

editor proofreads and copy edits.

When they submit manuscripts electronically, authors sometimes wonder why the final published version is not exactly like what they printed out on their own printers; often spacing, line breaks, and page breaks are different. Part of the reason is that the AMS uses the Times Roman font (which is the font of choice for technical publications), while most people who use TEX on personal computers have the Computer Modern font. Because of differences between the fonts, the line breaks, page breaks, and other format features change when the AMS converts the file to Times Roman. In addition, authors sometimes include TEX coding that causes their manuscripts to have different style characteristics from that of the journal or book series in which the manuscript will appear. In that case, the format of the manuscript is changed to conform to the style of the journal or book series.

In addition to text, symbols, and equations, Composition also has to handle figures and displays. Sometimes, figures supplied by an author are not suitable for reproduction, or TEX is not capable of producing a certain kind of diagram. In such cases, the Composition department will reproduce the figure, either by hand or using a graphics program on a Macintosh computer. When a figure is supplied by the author, Composition can use an image scanner, which digitizes the figure and stores it in the Macintosh. The figure can then be enhanced (darkened, enlarged, sharpened, etc.) using the Adobe Illustrator program on the Macintosh and printed out on a typesetter that produces high-resolution copy suitable for reproduction. In addition, a Macintosh is also used for layout for the *UME Trends* newsletter.

Figures, pictures, and diagrams need to be pasted on separately when the camera copy is prepared for printing. This is done by the Publications Makeup section of the Composition department. Before the AMS used TEX, camera copy was generated in scrolls, which Pub Makeup staff would cut apart and paste up to make pages. But because TEX does pagination automatically, the need for pasteup has diminished in recent years; currently, Pub Makeup consists of only two staff members. However, pasteup is still an important function for last-minute corrections to the camera copy, or for taking care of certain kinds of layouts that TEX cannot do. In addition, the AMS books and journals which are published from author-prepared camera copy require pasteup.

Composition's technical support staff, which consists of five programmers, have a variety of responsibilities in keeping the entire typesetting production system running smoothly. They maintain various programs needed by the keyboarders, they write TEX macros (which can be thought of as subroutines in the TEX language) used to produce a particular journal or book style, they work with fonts and the output devices (laser printers and the phototypesetters), and they handle archiving for AMS publications. In addition, this group helped to develop the AMS stylefiles for use with the LATEX software package and has worked on facilitating submission of electronic manuscripts. This group will also answer queries from users of AMS software (AMS-TEX, AMS fonts, AMS-LATEX, and MathSci-TEX).

In addition to its role as a production department, Composition also provides services to AMS staff when typesetting is needed for manuals, brochures, posters, signs, and the like. Outside organizations (other societies and publishers) also contract various typesetting services from Composition, from keyboarding to formatting to camera-ready output. For example, the National Research Council contracted the AMS to typeset its recent report, "On the Shoulders of Giants," and the AMS donated typesetting for the NRC report "Everbody Counts," which appeared in 1989.

Recently, the AMS won two typesetting awards for its publication designs. As a leader in mathematical publishing and in the use of TEX as a production tool, the AMS will continue to make improvements in its publications program to insure that the mathematical community will have excellent, timely publications in the years to come.

Prepared by AMS Staff.

Registration Fees

The alert member in attendance at the San Francisco meeting will observe a larger than normal increase in the registration fee. The question is why.

The level of registration fees at a joint meeting of the American Mathematical Society and the Mathematical Association of America was set by agreement many years ago. There was also an understanding that the fees could be raised if necessary but that the annual increases should not exceed the increase in the cost of living. Costs related to a meeting are of several kinds. There are the joint costs attributable to the meeting itself, including both the preparatory operations and the work on site. Then there are additional costs to MAA or AMS alone of events or activities that are concurrent with meetings. The issue here concerns the true joint costs.

It was initially intended and arranged that the registration fees cover the joint costs. When they did not, the deficit was made up by equal contributions from the two organizations, that is indirectly from the entire membership. So long as the deficit was small, this was an equitable arrangement. With the passage of time and changing circumstances the deficits grew larger. A contributing factor is that the package of goods and services related to a meeting is a different mixture from that in the cost of living index. In the last few years the general membership of MAA and AMS has been bearing

a substantial part of the cost of meetings even though less than ten percent of the membership attended.

To what degree is this fair? The general membership benefits from meetings, even those persons who do not attend. Meetings are concerned with the spread of knowledge and the health of the profession. Persons become members in part to promote these two purposes. On the other hand, the immediate returns and the more substantial rewards of a meeting come to the participants.

It was the conclusion of the governing bodies of the AMS and MAA that the burden of cost of joint meetings had shifted too far from the registrants to the membership. They are in agreement that the current level of services provided is the correct one and should not be reduced. Thus the remedy, which one sees at the San Francisco meeting, is to raise the registration fees.

The new level of registration fees is still below the average of those for comparable scientific meetings. Among 7 similar organizations, the average fee for a four-day meeting is approximately $208.

Robert M. Fossum
AMS Secretary
Kenneth A. Ross
MAA Associate Secretary

e-MATH Services On-line

The American Mathematical Society announces the availability of e-MATH, its new electronic service for the mathematical profession. e-MATH is a node on the INTERNET that provides mathematicians with the ability to electronically communicate with a central information source, the AMS offices, and with each other. Partially funded with a National Science Foundation grant, e-MATH consists of a dedicated computer facility and associated software maintained and supported by AMS staff members.

The scope of services will eventually be quite extensive, but implementation will occur in stages. Beginning October 15, the following services will be available:

- Directory Information
  The Combined Membership List (of MAA, SIAM, and AMS) online
- Professional Opportunities
  Events
    General meetings
    Regional activities
  Employment opportunities
  Post-Doctoral opportunities
  Special study opportunities
- Software Library
  $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX software
  Author Information: Style Files
- Document Delivery
  Mathematical Reviews document delivery service

New services and changes in existing services will be announced in the Notices.

e-MATH is designed to be compatible with VT100 terminals or terminal emulators, in order to serve the largest possible audience. Contact the network manager on your site if you have questions about how to connect to the INTERNET in VT100 mode.

If your organization is not yet connected to the INTERNET, investigate possibilities for arranging guest accounts on computer systems local to your site that are connected to the INTERNET. At this time, e-MATH connection by direct dial-up is not planned.

To access e-MATH, type

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telnet e-math.ams.com
```

and press RETURN. At the login prompt, type

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e-math
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and press RETURN. At the password prompt, type

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e-math
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and press RETURN. You will get the e-MATH welcome screen. Press RETURN to continue.

Each of the services supported on the e-MATH system is associated with help information. Select help to get an overview of how the service works and how to use it. Some of the services (those retrievals from the software library requiring the transmission of large files or of binary files; for an example see "TEX-related Software", below) require users to utilize anonymous FTP. e-MATH will provide detailed instructions to users by e-mail in response to requests to the e-MATH menu. Users will, presumably, print a copy of the e-mailed instructions, login again to the e-MATH machine via anonymous FTP, and follow the instructions.

Send e-mail to:

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support@e-math.ams.com
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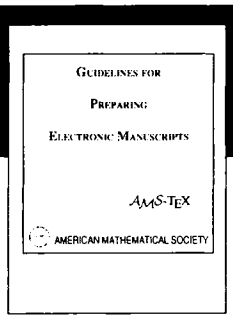
with any suggestions for new services or ways to improve existing services.

TEX-related Software Available

Among the first services available from e-MATH is access to a software library of TEX-related macro packages and fonts, consisting at this time of $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX 2.0, AMSFonts 2.0, $\mathcal{A}\mathcal{M}\mathcal{S}$-LATEX 1.0, and Author Information/Documentstyle Files. To obtain detailed instructions about the utilization of anonymous FTP to access this library, signon to e-MATH and follow the menu instructions under the Software Library option.



Now Available

The *Guidelines for Preparing Electronic Manuscripts* explains the details of electronic manuscript preparation, submission of the electronic file, and handling of the paper once it reaches the AMS. Both the *Guidelines* and the example files that are included were created to help avoid problems before they occur and minimize extra work for everyone involved in the production of a paper. There are two versions of the *Guidelines* : one for AMS-TEX version 2.0 users and one for AMS-LATEX users. The AMS-TEX version is available now; the AMS-LATEX version will be available in late October.

Free copies of the *Guidelines* can be obtained in the following ways:

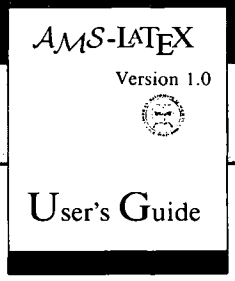
Through anonymous FTP from the Society's public domain archive on the Internet node e-MATH.ams.com. (See "Inside the AMS" in this issue for detailed instructions on how to do this.)

By sending an e-mail message to GUIDE-ELEC@MATH.AMS.COM. Please specify AMS-TEX or AMS-LATEX and include a complete mailing address.

By sending a request to the Society's Publications Department.

By adding order code "GUIDELECA" or "GUIDELECL" to any order you are sending to the Society.

AMS-LATEX



To make AMS-TEX and LATEX more compatible, the Society has sponsored the development of several document style files for LATEX. The first is an AMS-TEX style option that allows LATEX users to use many of the AMS-TEX mathematical macros within existing LATEX document styles. The other two (AMSBOOK amd AMSART) are style options that provide AMS formats for books and articles. The distribution includes the AMS-LATEX version 1.0 User's Guide and sample files.

The complete distribution can be obtained, at no charge, in the following ways:

Through anonymous FTP from the Society's public domain archive on the Internet node e-MATH.ams.com. (See "Inside the AMS" in this issue for detailed instructions on how to do this.)

By sending an e-mail message to AMS-LATEX@MATH.AMS.COM. Please specify the AMS-LATEX distribution and include a complete mailing address.

By sending a request to the Society's Publications Department.

Washington Outlook

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

The new staff of the Joint Policy Board for Mathematics' Office of Governmental and Public Affairs (OGPA) is recommitting the organization to an effective strategy to support its role as advocate for mathematics in federal policy debates. A successful public policy program will require the help of people dedicated to the notion that a robust mathematics enterprise is crucial to the progress of society, industry, and technology. On behalf of Edward Connors, the new and determined Director of OGPA, I invite all mathematicians to work with us to raise our political leaders' awareness of the contributions of mathematics.

September is the month when official Washington, returning from August vacations, scrambles to piece together a budget before the fiscal year begins on October 1, a feat it has had trouble accomplishing in recent years. On the surface, this year's budget squabble looks no different than those of past years: members of both political parties blame the members of the other party for avoiding real deficit reduction as budget summiteers negotiate overall levels of federal spending and revenue.

Meanwhile, the appropriations subcommittees race to enact spending bills without regard for such fiscal realities as the costs of the savings and loan bailout. Working with the President's seven-month-old proposal based on now-obsolete estimates of interest rates and economic growth, the House voted several spending measures that substantially exceed the President's requests and include the usual parochial projects and home-district pork.

In the House, the $170 billion appropriation for education, labor, health, and human services exceeds the President's figure by $4.2 billion, and the House plan for transportation spending, at $31 billion, tops the White House request by nearly 14 percent. The veterans affairs, housing and urban development, and independent agencies appropriations package, passed by the House in late June, totals $83.6 billion after surviving a proposed 14.5 percent cut on the floor by a vote of 355 to 48. Incidentally, the only item eliminated on the floor was the Search for Extra-Terrestrial Intelligence, a $6.2 million NASA program. (At press time, the Senate had not yet begun marking up its spending bills.)

Members of Congress say they can still meet overall budget targets by cutting defense spending more than the President would like. But defense budgets are just as difficult to pare: the President and Congressional Republicans are opposed to such a formula, and individual defense programs engender formidable support from the districts in which funds are spent. The crisis on the Arabian Peninsula has generated rigid expenditures and will serve to bolster the arguments of those favoring healthy military appropriations.

Ultimately, all spending packages face cuts mandated by a budget agreement and/or a Gramm-Rudman-Hollings sequestration. Such cuts will likely be made across-the-board. That is, no prioritization will take place before the axe falls, and the large increases approved by the House will be negated.

Amid the budget turmoil, however, signs that a compromise budget deal could yet be realized do exist. Although every year economists make dire predictions for the consequences of inaction on deficit reduction, some Washington policymakers appear to be less willing to risk these worst-case scenarios. President Bush did, after all, backtrack on the long-standing Republican tenet of "no new taxes." And several Members of Congress have submitted thoughtful proposals for controlling the deficit despite the political consequences of going out on a limb.

In this political and fiscal climate, public interest organizations struggle to maintain the programs they deem vital to the Nation's welfare. Much time and effort must be devoted to convincing policymakers that certain activities deserve a high priority in the allocation of scarce federal funds. Newspaper columns, Congressional testimony, press conferences, letter-writing campaigns, and personal visits are arranged to maintain the visibility that leads to funding.

Mathematics research and education is most certainly an interest that should not be allowed to get overlooked. The concerns of mathematicians for the future vitality of the mathematical sciences need to be thoroughly and repeatedly conveyed to federal policymakers. The recommendations embodied in David II will go unheeded if not reinforced by mathematicians acting as constituents.

Despite the vigorous efforts of the scientific community and the high-priority given by the Administration, support for scientific research, and especially for basic research, has not been sufficient to bring about the proposed doubling of the National Science Foundation budget. The President's Assistant for Science and Technology, Allan Bromley, has urged scientists to redouble their efforts to persuade Congress that funding for science and mathematics must be strengthened. He has said that Senator Barbara Mikulski (D-MD), chair of the panel responsible for NSF appropriations, told him that she never hears from scientists. She undoubtedly receives mail from scientific societies and academic research organizations. But one suspects she does not hear often enough from scientists and mathematicians working in Maryland.

JPBM's Office of Governmental and Public Affairs, mathematics' Washington presence, would like to correct this situation by facilitating communications between the mathematics community and public policy officials. OGPA encourages mathematicians to engage their Members of Congress in a dialogue on the importance of mathematics. We invite all members of the mathematical organizations to visit us here in Washington, D.C., to discuss ways we can work together to ensure an adequate federal commitment to mathematics. If you are going to be in Washington, let us know in advance and we will attempt to arrange a meeting with you and your Member of Congress or his or her staff. We will also provide any materials or other information you might find useful in getting the message across. Ideally, a long-term relationship based on mutual trust and understanding with your representatives is the most effective way to maintain their support for mathematics, which might otherwise be suspended amid competing priorities and issues that command more attention.

Finally, if you are interested in familiarizing yourself with the hot issues in science and mathematics policy, we invite you to subscribe to TIDBITS, a weekly electronic newsletter sent over INTERNET, by sending an e-mail message to me at jpbm@athena.umd.edu. I believe, as Allan Bromley believes, that with some thought, mathematicians can make a difference in the way politicians perceive mathematics. I look forward to working with you.

News and Announcements

Marshall Hall, Jr.
1910–1990

Marshall Hall, Jr., Professor Emeritus of Mathematics of the California Institute of Technology and distinguished Professor of Emory University, passed away on July 4, 1990. He was born in St. Louis, Missouri on September 17, 1910. After receiving his Ph.D. at Yale University in 1936, he became a member of the Institute for Advanced Study (1936-1937) and returned to his Alma Mater as Instructor and Assistant Professor (1937–1946). From 1946 to 1959, he served as associate and full professor at the Ohio State University and as professor at the California Institute of Technology from 1959 to 1981. In 1975, he became a member of the American Academy of Sciences.

Professor Hall was a mathematician in the broadest sense of the word, but with a predilection for group theory and its application to algebra, geometry and combinatorics, which was given full expression in his book on the theory of groups (Macmillan, New York 1959). The group theoretic collection process of Philip Hall (no relation) inspired Marshall Hall to the construction of a basis for free Lie rings and higher commutators in free groups (*Proceedings of the AMS*, 1 (1950) 575-589) with great potential for further research. His 1969 project, entitled A Search for Simple Groups of Orders Less Than One Million, produced a new simple group of order 604,800 named after him and David Wales. The book on Combinatorial Theory (1967 and 1986) summarizes his research achievements in combinatorics, in particular his deep results on combinatorial designs, and provides a new chart for an ancient branch of mathematics.

Marshall Hall organized many international symposia, conferences, etc., including the AMS Summer Institute in Finite Groups, held at the California Institute of Technology in 1960. He was Editor of various journals over many years. At the time of his death he was Editor-in-Chief of the *Journal of Combinatorial Theory*, and Editor of the *Journal of Algebra*. His Ph.D. students include a number of well know mathematicians. He gave many major invited addresses at national and international conferences, including the American Mathematical Society National Meeting in Houston in 1967.

Hans Zassenhaus
The Ohio State University

F. Jessie MacWilliams
1917–1990

Florence Jessie Collinson MacWilliams was born in 1917 in Stoke-on-Trent in England. She received her B.A. in 1938 and her M.A. the following year, both from Cambridge University. In 1939, she received a traveling scholarship from Cambridge and went to Johns Hopkins University, where she studied with Oscar Zariski. In 1940, she followed Zariski to Harvard to study there for a year. She married in 1941 and had three children.

In 1958, MacWilliams was employed as a computer programmer by Bell Telephone Laboratories in Murray Hill, New Jersey. She became interested in coding theory when R. C. Bose came to Bell Labs and gave a talk on the subject. In 1961-1962, she returned to Harvard for a year and obtained a Ph.D., studying coding theory with Andrew Gleason. She published many papers and presented many lectures on this subject. Her 1972 book, *The Theory of Error-correcting Codes*, was written in collaboration with Neil J. A. Sloane. In 1980, she presented the first Emmy Noether Lecture, sponsored by the Association for Women in Mathematics. She retired from Bell Laboratories in January 1983 and devoted herself to her four grandchildren and her home and garden. MacWilliams died in May 1990.

Fields Medalists and Nevanlinna Prize Winner Announced

On August 21, during the International Congress of Mathematicians in Kyoto, four Fields Medals and the Nevanlinna Prize were awarded.

The Fields Medalists were VLADIMIR GERSHONOVICH DRINFELD of the Institute for Low Temperature Physics and Engineering in Kharkov, USSR; VAUGHAN F. R. JONES of the University of California at Berkeley; SHIGEFUMI MORI of the Research Institute of Mathematical Sciences of Kyoto University in Japan; and EDWARD WITTEN of the Institute for Advanced Study in Princeton.

The Nevanlinna Prize Winner was ALEXANDEROVICH A. RAZBOROV of the Steklov Institute, USSR.

An article describing the work of the awardees is now being prepared. It is hoped that the article will be ready in time to appear in the November issue.

MAA Presents Awards

The Mathematical Association of America (MAA) presented a number of awards during the Joint Mathematics Meetings in Columbus in August. The Association celebrated its 75th anniversary at the Meetings with a host of special lectures and activities. The awards, of $500 each, were given for articles of expository excellence appearing in MAA journals.

The Carl B. Allendoerfer Awards were awarded for articles appearing during 1989 in the *Mathematics Magazine*. One award went to W. THOMAS ARCHIBALD of Acadia University in Canada, for his article "Connectivity and smoke-rings: Green's second identity in its first fifty years." The second award went to the three co-authors of "Steiner trees on a checkerboard": MARTIN GARDNER, former editor of the Mathematical Games column in *Scientific American*, and RONALD L. GRAHAM and FAN CHUNG, both of AT&T Bell Laboratories.

The Lester R. Ford Awards were presented for articles appearing during 1989 in the *American Mathematical Monthly*. The awards went to: DORON ZEILBERGER of Temple University for "Kathy O'Hara's constructive proof of the unimodality of the Gaussian polynomials"; JACOB GOODMAN of City College, CUNY, JANOS PACH of the Hungarian Academy of Sciences and the Courant Institute, and CHEE K. YAP of the Courant Institute for co-authoring "Mountain climbing, ladder moving, and the ring-width of a polygon."

The George Pólya Awards were presented for articles appearing during 1989 in the *College Mathematics Journal*. The awards went to: ISRAEL KLEINER of York University in Canada for "Evolution of the function concept: A brief survey"; and RICHARD D. NEIDINGER of Davidson College for "Automatic differentiation and APL."

New Members of the Parisian Academy

The Académie des Sciences, Paris has elected a number of mathematical scientists to its ranks. The Foreign Members elected in 1989 are: SHIING-SHEN CHERN, Mathematical Sciences Research Institute, Berkeley; MIKAEL GROMOV, Institute des Hautes Etudes Scientifiques, Bûres-sur-Yvette; FRIEDRICH HIRZEBRUCH, Max Planck Institute; KIYOSI ITÔ, Kyoto University; LOUIS NIRENBERG, Courant Institute of Mathematical Sciences, New York University.

A number of others were elected as Corresponding Members in 1990. Those in mathematics are: THIERRY AUBIN, Université de Paris, VI; JEAN MICHEL BISMUT, Université de Paris, XI, Orsay; JEAN MICHEL BONY, Ecole Polytechnique; FRANÇOIS BRUHAT, Université de Paris, VII; and MICHEL HERMAN, Centre National des Recherches Scientifiques. Those mathematicians elected in mechanics are: PHILIPPE CIARLET, Université de Paris, VI; and Gérard Iooss, Université de Nice.

The Academy also made a number of awards. These included the Grand Prix Ampère of 200,000FF, which went to JEAN-MICHEL BISMUT of Université de Paris, XI, Orsay.

NSF Awards Visiting Professorships for Women

The National Science Foundation has awarded grants totalling $2.51 million to twenty-three women scientists, engineers, and mathematicians in its Visiting Professorships for Women (VPW) program. In addition, the host institutions have contributed over $360,000 to these awards.

The VPW program enables women scientists and engineers from industry, government, and academic institutions to serve as visiting professors. In this capacity, the visiting professors conduct research and are involved in lecturing, counseling, and other activities to encourage students, particularly other women, to pursue careers in science, engineering, and mathematics.

Among the awardees were three mathematical scientists. Their names, affiliations, host institutions, and research topics are: JUDITH A. GOLDSMITH, Dartmouth College, Boston University, *An investigation of the isomorphism conjecture, self-reducibility, and reverse mathematics and theoretical computer science*; WEN-CHING W. LI, Pennsylvania State University, University of Pennsylvania, *Number theory, combinatorics, and representation theory*; and LINN I. SENNOTT, Illinois State University, University of Illinois, Urbana-Champaign, *Optimal policies in infinite state Markov decision processes.*

For information about applying for Visiting Professorships for Women, see the Stipends for Study and Travel section in this issue of *Notices.*

Ford Foundation Awards Minority Fellowships

Two Ford Foundation programs have awarded fellowships to minority scholars in a range of academic disciplines in its Predoctoral and Dissertation Fellowships Programs. The programs aim to increase the presence of underrepresented minorities on the nation's college and university faculties. Both programs are administered by the National Research Council.

Out of 118 awards in the two programs, only one was in mathematics: DAVID J. TORRES of the University of Arizona received a predoctoral fellowship.

Plans for the 1991 competitions are now under way. For more information, see the Stipends for Study

and Travel section in this issue of *Notices*.

Society Receives Bequest

Before his death in February of this year, Carroll V. Newsom informed the Society of his plans to donate funds to be used to memorialize the life and accomplishments of one of the greatest mathematicians of this century, John von Neumann. After Newsom's death in February 1990, the Society received a thoughtful and generous bequest from Newsom's estate in the amount of $100,000.

In 1988, upon learning of Newsom's plans, the AMS Board of Trustees adopted the following resolution of thanks: "The Trustees of the American Mathematical Society welcome the proposed endowment to memorialize the accomplishments of its distinguished past president John von Neumann, to be established by his friend Dr. Carroll V. Newsom. They look forward to the impetus to research in mathematics engendered by such a bequest. They are gratified that the name and memory of von Neumann will be kept alive in yet another way through this gift."

The gift has been used to establish a fund, the income from which will support a quadrennial symposium, the John von Neumann Symposium, which will focus on fundamental concepts at the forefront of mathematics. The subjects of the Symposia are to be topics of emerging significance that are expected to underlie future mathematical development. The Society hopes that the ideas expressed and shared at the Symposia will reflect exceptional mathematical leadership. In addition, the Society will publish the proceedings of the Symposia, in order to broaden the dissemination of the ideas they foster.

Two years prior to each von Neumann Symposium, the President of the Society will appoint a committee of distinguished mathematicians who will select a topic and organizers for the Symposium. The organizers will then select speakers and propose a site.

Born in 1904 in Buckley, Illinois, Carroll Newsom received his Ph.D. in mathematics from the University of Michigan in 1931. He was a professor at the University of New Mexico until 1944, during which time he founded the Southwestern Section of the Mathematical Association of America. After a period at Oberlin College, he moved on to a series of academic administrative positions that culminated in his serving as Executive Vice President (1955-1956) and President (1956-1962) of New York University. After that, Newsom served as President of Prentice-Hall, Inc., Chairman of the Executive Committee and Director of Random House, and Vice President for Education of RCA. (Newsom's obituary, prepared by G. Baley Price, appeared in *Notices*, September 1990, page 877.)

While at New York University, Newsom became acquainted with John von Neumann through Richard Courant. That was the beginning of a friendship between Newsom and von Neumann that lasted until von Neumann's death in 1957. In sharing many conversations with von Neumann about mathematics, science, and philosophy, Newsom was struck by the many aspects of von Neumann's intellect. For example, Newsom later wrote: "As our discussions progressed over a long period of time, it became clear to me that associated with [von Neumann's] remarkable understanding of the behavior of nature was an amazing comprehension on his part of how his own mind was able to carry out its functions." It was during this time that Newsom developed a deep personal respect for von Neumann's profound contributions to science and mathematics.

Call for Nominations for AWM Award

The Executive Committee of the Association for Women in Mathematics (AWM) has established the Louise Hay Award for Contributions to Mathematics Education, to be given annually at the January AWM Business Meeting, beginning in 1991. The purpose of the award is to recognize outstanding achievements by a woman in any area of mathematics education, to be interpreted in the broadest possible sense. The awardee will be selected by a committee appointed by the President and will receive a citation at the Business Meeting.

While Louise Hay was widely recognized for her contributions to mathematical logic and for her strong leadership as Head of the Department of Mathematics, Statistics, and Computer Science at the University of Illinois at Chicago, her devotion to students and her lifelong commitment to nurturing the talent of young women and men secure her reputation as a consummate educator. The annual presentation of this award is intended to highlight the importance of mathematics education and to evoke the memory of all that Hay exemplified as a teacher, scholar, administrator, and human being. Hay died in October, 1989.

Nominations for the award should be sent by **December 15, 1990** to: The Hay Award Committee, c/o Patricia N. Cross, Association for Women in Mathematics, Box 178, Wellesley College, Wellesley, MA 02181.

Call for Nominations for Waterman Award

The National Science Foundation (NSF) has called for nominations for the 16th annual Alan T. Waterman Award. The award is intended to give recognition to an outstanding young researcher in any field of science, mathematics, or engineering and to encourage further high-quality research.

The awardee receives up to $500,000 for up to three years of research or advanced study in the mathematical, physical, medical, biological, engineering, social, or other

sciences at the institution of the recipient's choice.

Candidates must be U.S. citizens or permanent residents and must be 35 years of age or younger, or not more than five years beyond the Ph.D. by December 31 of the year in which the nomination is made. Candidates should have sufficient personal accomplishments, outstanding capability, and exceptional promise for significant future achievement. In addition, candidates' research should exhibit quality, innovation, and potential for discovery.

The mathematical scientists who have received previous Waterman Awards are Charles Fefferman (1976) and William P. Thurston (1979), both of Princeton University; Harvey Friedman of Ohio State University (1984); and Edward Witten of the Institute for Advanced Study (1986).

The deadline for nominations is **December 31, 1991**. Nominations for the award may be submitted by individuals, professional societies, industrial companies, and other appropriate organizations within the scientific and educational communities. A special form is necessary for submitting nominations. The forms and further information may be obtained from Susan Fannoney, Alan T. Waterman Award Committee, National Science Board, National Science Foundation, 1800 G Street, NW, Room 545, Washington, DC 20550; telephone 202-357-7512.

The award will be announced in May, 1991. The Waterman Award was established by Congress in 1975 to mark the 25th anniversary of the NSF and to honor Alan T. Waterman, the first director of the Foundation.

MAA Appoints Hawkins as SUMMA Director

William A. Hawkins has been appointed director of Project SUMMA (Strengthening Underrepresented Minority Mathematics Achievement) of the Mathematical Association of America (MAA). Hawkins went on leave from the University of the District of Columbia to take the SUMMA position.

A graduate of Howard University, Hawkins received his Ph.D. from the University of Michigan in 1982. He has been involved in the education of minority students for more than twenty years, including a short stint as a high school mathematics teacher.

SUMMA was developed by the MAA's Committee on Minority Participation in Mathematics, co-chaired by Hawkins and Manuel Berriozabal of the University of Texas at San Antonio. Following Hawkins' appointment as director of SUMMA, Sylvia Bozeman of Spelman College was appointed to take his place as co-chair of the Committee.

SUMMA encompasses five national projects: pre-college intervention, collegiate mainstreaming, faculty mentorship, development assistance, and minority teacher recruitment. Now in the planning stage, SUMMA is supported by the Exxon Education Foundation, the Carnegie Corporation of New York, and the MAA. Long-term funding is being sought from government agencies and private foundations.

If you are interested in any of the projects listed above, or if you have information that might be useful to SUMMA as the staff and steering committee proceeding with planning, please contact: Dr. William A. Hawkins, Director, Project SUMMA, 1529 Eighteenth Street, NW, Washington, DC 20036; telephone 202-387-5200; electronic mail: maa@athena.umd.edu.

News from the Institute for Mathematics and Its Applications

University of Minnesota

On October 12-13, 1990 the Institute for Mathematics and Its Applications (IMA) will hold its first tutorial workshop "Connecting to Industry" which will address the question of how mathematicians can begin interactions with their local industries. Based on the experience gained in the last three years, the workshop will feature several round table discussions which will focus on practical suggestions and "tips." There will also be presentations of a spectrum of problems encountered in industry, by Peter Castro from Eastman Kodak, Gary McDonald from General Motors Research and Gunter Stein from Honeywell. Avner Friedman will talk about his own experience in visiting industry and will present "research vignettes" of problems which have originated with industry. The workshop will begin with a talk in the "Industrial Problems Seminar" by R. Olmstead of 3M, presenting a problem in magnetically switchable particles. More information can be obtained at the IMA office, 612-624-6066.

IMA has organized a summer program on semiconductors to be held July 15-August 9, 1991. The coordinators of this program are: Farouk Odeh (chair), IBM, Yorktown Heights; Julian Cole, Rensselaer Polytechnic Institute; William M. Coughran, Jr., AT&T Bell Laboratories, Murray Hill, NJ; Peter Lloyd, AT&T Bell Laboratories, Allentown, PA; Jacob White, Massachusetts Institute of Technology.

IMA will be hosting a special year in Applied Linear Algebra from September 1991 to June 1992. Workshops, tutorials, and a conference will be the highlights of this activity. The year will be divided into three periods, roughly corresponding to fall, winter, and spring quarters.

Period I, September-December, 1991: Discrete matrix analysis with emphasis on the mathematical analysis of sparse matrices and combinatorial structure. Long-term confirmed visitors: Ake Bjorck, Richard Brualdi, Shmuel Friedland, J. Alan George, John Gilbert, Victor Klee, Joseph Liu, Mitchell Luskin. A tutorial will be held September 4-10, and a SIAM Conference on Applied linear Algebra will be held September 16-19. Workshops: Sparse ma-

trix computations: Graph theory issues and algorithms (October 14-18), Combinatorial and graph-theoretic problems in linear algebra (October 11-15).

Period II, January-March, 1992: Matrix computations with special emphasis on iterative methods for solving systems of linear equations and computing the eigenvalues of sparse, possibly structured matrices. Long-term confirmed visitors: Adam Bojanczyk, Richard Brualdi, James Demmel, Gene Golub, Anne Greenbaum, N. J. Higham, Mitchell Luskin, Robert J. Plemmons, G. W. Stewart. Workshops: Linear algebra, Markov chains, and queuing models (January 13-17), Iterative methods for sparse and structured problems (February 24-March 1). The last two days of the latter workshop will be a celebration dedicated to Gene Golub on the occasion of his sixtieth birthday.

Period III, April-June, 1992: Signal processing, systems and control, with emphasis on the matrix analysis and computations that arise in this area of application. Long-term visitors: Adam Bojanczyk, Jim Bunch, George Cybenko, James Demmel, Gene Golub, Mitchell Luskin, Robert J. Plemmons, G. W. Stewart, Paul Van Dooren. Workshops: Linear algebra for signal processing (April 6-10), Linear algebra for control theory (June 1-5).

News from the Center for Discrete Mathematics and Theoretical Computer Science

Rutgers University

As part of its program, the Center for Discrete Mathematics and Theoretical Computer Science (DIMACS) will sponsor a variety of activities each year which revolve around a special theme. The special theme for the academic year 1990-1991 is Complexity Theory of Interactive Computation. A year-long series of research programs devoted to this theme has been organized. These programs are concerned with such topics as cryptography, communication complexity, computational learning, computational number theory, and circuit complexity.

The organizing committee for the special year consists of: Endre Szemeredi (Rutgers University), Andrew Yao (Princeton University), Manuel Blum (University of California, Berkeley), Hendrik Lenstra (University of California, Berkeley), Laszlo Lovasz (Princeton University), and Andrew Odlyzko (AT&T Bell Labs).

A major direction of research for computational complexity in recent years has been the formulation and development of complexity theories for various environments in which there is more than one participant involved in the computation. By now, significant results have been obtained in these theories and the initial goals for considering these theories have been realized to various degrees. This special year aims at making a concerted effort to pursue further the unfinished tasks and to determine the most fruitful future directions in light of the accomplishments so far.

As part of the special year, the following workshops have been scheduled. More information about these workshops can be obtained from the organizer whose name appears or from the DIMACS office.

Special Year Workshops:

October 1990: Cryptography, Organizer: Andrew Yao, 609-258-5030, email: yao@princeton.edu

December 1990: Structural Complexity and Cryptography, Organizer: Eric Allender, 201-932-3629, email: allender@aramis.rutgers.edu

January 1991: Circuit and Communications Complexity, Organizer: Andrew Yao, 609-258-5050, email: yao@princeton.edu

March 1991: Computational Number Theory, Organizer: Andrew Odlyzko, 201-582-7286, email: amo@research.att.com

In addition to the workshops, several weekly seminars on Complexity Theory of Interactive Computation are being run.

During the special year, DIMACS will host several long term visitors and postdoctoral fellows at DIMACS who have research interests in this area. Furthermore, there will be a very large number of visitors, from periods of a week to several months, who will be participating in the activities of the special year.

Further information about the events of the special year in Complexity Theory of Interactive Computation can be obtained from the organizer, Andrew Yao, 609-258-5030, email: yao@princeton.edu or from the DIMACS office 201-932-4449.

New MSEB Report Now Available

What mathematics should be learned by today's young people and tomorrow's workforce? This question is explored in *On the Shoulders of Giants*, the latest in a series of reports designed to lay foundations for reform in mathematics education. The report was published by the Mathematical Sciences Education Board (MSEB) of the National Research Council.

The report is organized around five mathematical themes or "strands" that could form the basis for a new school mathematics curriculum. "Traditional school mathematics picks very few strands (e.g., arithmetic, geometry, algebra) and arranges them horizontally to form the curriculum," the report says. "This layer-cake approach to mathematics education effectively prevents informal development of intuition along the multiple roots of mathematics."

The report offers an alternative to this approach by focusing on basic mathematical themes which are discussed in five essays: "Dimension," by Thomas F. Banchoff of Brown University; "Quantity," by James T. Fey of the University of Maryland; "Uncertainty," by David S. Moore of Purdue University; "Shape," by Marjorie Senechal of Smith College; and "Change," by Ian Stewart of the University of Warwick in England.

"Each chapter explores a rich variey of patterns that can be introduced to children at various stages of school," the report says. "Those who develop curricula will find in these essays many valuable new options for school mathematics. Those who help determine education policy will see in these essays examples of new standards for excellence. And everyone who is a parent will find in these essays numerous examples of important and effective mathematics that could excite the imagination of their children."

Copies of the report can be purchased for $17.95 (plus $2 for shipping and handling) from the National Academy Press, 2101 Constitution Avenue, NW, Washington, DC 20418; telephone 800-624-6242.

Report on Tutors and Mentors

The U.S. Department of Education has released a three-volume study entitled "Review of Programs Involving College Students as Tutors or Mentors in Grades K-12." Congress requested the study to report on the extent and effectiveness of tutoring programs for disadvantaged students.

The study found that, during the 1987-1988 academic year, more than 63,000 college students, primarily volunteers, worked with about 200,000 younger students. Colleges were the primary supporters of the 1700 programs in operation at over 900 campuses.

Many of the students surveyed said that the tutoring and mentoring they received made them more motivated, self-confident, and enthusiastic about learning. There were also benefits for the college student tutors and mentors, including increased commitment to community service, exposure to new cultural environments, and improved academic records. Highly structured programs were found to be the most effective.

Copies of the report are available from the Office of Planning, Budget, and Evaluation, U.S. Department of Education, 400 Maryland Avenue, SW, Room 4049, Washington, DC 20202-4110.

Education and Energy Secretaries Sign Agreement

Secretary of Education Lauro F. Cavazos and Secretary of Energy James D. Watkins have signed a memorandum of understanding to develop joint programs to improve mathematics, science, and technical education and to strengthen ties among existing programs.

The aim of this agreement is to increase the number of American students pursuing careers in scientific and technical fields, improve teaching in these fields, and strengthen the basic scientific and technical literacy of American citizens. Particular attention will be given to students traditionally underrepresented in these fields: minorities, women, and students from non-English-speaking backgrounds.

The memorandum describes a cooperative effort between the Department of Education and the Department of Energy (DOE) to develop joint programs encompassing such activities as teacher and student participation in research experiences at DOE laboratories, career counseling for students by DOE staff and scientists, and school-laboratory linkages.

In addition, the DOE has announced that it will support ther Academy for Mathematics and Science Teachers, dedicated to improving the teaching and learning of mathematics and science in the Chicago public schools. The Academy's goal is to involve 15,000 public school teachers in an integrated program of mathematics and science, emphasizing hands-on participation and providing teachers with first-hand experience in state-of-the-art science at DOE laboratories and other science and technology centers. The DOE intends to provide an initial planning grant of $215,000 for the Academy. Major DOE funding of $2 million should come this fall, with the passage of the fiscal yera 1991 budget.

Database for Logic in Computer Science

The Institute of Electrical and Electronic Engineers (IEEE) has announced that as of Fall 1990 only people on a new LICS database will receive directly announcements about their Logic in Computer Science conferences, and about other topics of interest to the Logic in Computer Science community.

If you are interested in receiving such information, please send name, postal address, and email address by physical mail, to Logic in Computer Science, School of Computer Science, Carnegie-Mellon University, Pittsburgh, PA 15213, U.S.A., or email the requested information to lics@cs.cmu.edu.

Mathematics Staff in NSF's Education Directorate

The directorate for Education and Human Resources (EHR) at the National Science Foundation (NSF) sponsors a range of programs that support educational projects in mathematics, science, and engineering. Listed below are the names and telephone numbers of those EHR program officers whose background is in the mathematical sciences. These individuals can provide information about their own programs, as well as information about other programs within EHR.

Materials Development
Joseph Adney
202-357-7066

Calculus Curriculum Development
John S. ("Spud") Bradley
202-357-7051

Teacher Enhancement
Joan Ferrini-Mundy
202-357-7074

Faculty Enhancement
William Haver
202-357-7051

Materials Development
Christian Hirsch
202-357-9635

Teacher Preparation
Glenda Lappan
202-357-7069

Among the administrative staff are:
Materials Development, Research, and Informal Science Education
Joan Leitzel, Division Director
202-357-7073

Program Evaluation
Thomas Berger, Section Head
202-357-9540

Berger, a continuing rotator from the University of Minnesota, has moved from the Materials Development program to take a newly-created position of Section Head for Program Evaluation. The new rotators are Joseph Adney from Michigan State University, Christian Hirsch from Western Michigan University, and William Haver from Virginia Commonwealth University. In addition to running the Faculty Enhancement program, Haver will assist with the Undergraduate Curriculum Development program, which has been expanded beyond its original focus on calculus and engineering.

The community expresses its thanks for a job well done to outgoing mathematics rotator Carroll Wilde, who will be returning to the Naval Postgraduate School in Monterey, California.

Program officers in EHR can be reached via electronic mail. To form an individual's address, take the first initial and last name, and append @nsf.gov for Internet, or @nsf for Bitnet. For example, to contact Christian Hirsch on Internet, use the address chirsch@note.nsf.gov.

The mailing address is Directorate for Education and Human Resources, National Science Foundation, 1800 G Street, NW, Washington, DC 20550.

Guidelines for Electronic Submissions

The AMS has published "Guidelines for Preparing Electronic Manuscripts," a handbook for authors wishing to submit book or journal manuscripts to the AMS in electronic form. The Society will accept manuscripts prepared with the macro package $\mathcal{AMS}$-TEX, Version 2.0, or with LaTeX using the $\mathcal{AMS}$-LaTeX style files. The guidelines for $\mathcal{AMS}$-TEX Version 2.0 users is available now, while the guidelines for $\mathcal{AMS}$-LaTeX users will be available in late October.

The purpose of the handbook is to explain to authors the details of electronic manuscript preparation and submission to the AMS, as well as the handling of these papers once they reach the AMS office. Instructions for using specific macros are given, and there are several examples of the input and output for these macros.

The Guidelines contain instructions for preparing both monographs and articles. Articles may be submitted electronically for journals or for collections (such as conference proceedings), and differences between these two types of submissions are covered. There is a separate section devoted to monographs, which differ substantially from articles in their requirements. (Submission to *Abstract of Papers Presented to the AMS* or to *Mathematical Reviews* are not covered in the handbook. Instructions for *Abstracts* can be requested from the AMS Publications Division, and instructions for *MR* can be found in any *MR* issue.)

Free copies of the Guidelines can be obtained in a number of ways.

- Use anonymous FTP from the Society's public domain archive on the Internet node e-MATH.ams.com. (See "Inside the AMS" in this issue of *Notices* for detailed instructions on how to do this.)

- Send an email message to guideelec@math.ams.com or a written request to Publications Division, American Mathematical Society, P.O. Box 6248, Providence, RI 02040. Please specify whether you would like the $\mathcal{AMS}$-TEX or $\mathcal{AMS}$-LaTeX version of the Guidelines and include a complete mailing address.

- If you are sending a book order to the Society, you may request the Guidelines by including the order code GUIDELECA (for the $\mathcal{AMS}$-TEX version) or GUIDELECL (for the $\mathcal{AMS}$-LaTeX version).

Funding Information for the Mathematical Sciences

AMS Centennial Fellowships Invitation for Applications, 1991-1992 Deadline December 1, 1990

These fellowships are intended to provide enhanced research opportunities to mathematicians who are several years past the Ph.D., who have a strong research record, but who have not had extensive postdoctoral research support in the past. Applicants should have received the Ph.D. degree between January 1, 1979, and December 31, 1984, and should not have had the equivalent of more than two years of full-time postdoctoral support.

The stipend for fellowships awarded in 1991-1992 has been set by the Trustees of the Society at $38,000 for nine months. In addition, there will be an expense allowance of $1,200. Applicants must be citizens or permanent residents of a country in North America. The fellowship may be combined with other stipends and/or part-time teaching; this option can be used to extend the award to cover a period of up to two years. For further information about the acceptability of such arrangements, individuals should contact the Secretary of the Society.

The number of fellowships to be awarded is small and depends on the amount of money contributed to the program. The Trustees have arranged a matching program from general funds in such fashion that funds for at least one fellowship are guaranteed. Because of the generosity of the AMS membership it was possible to award three fellowships a year for the past three years (1988-1989, 1989-1990, and 1990-1991).

The deadline for receipt of applications is **December 1, 1990**. Awards will be announced in February 1991, or earlier if possible.

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

Mathematical Sciences Postdoctoral Research Fellowships

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

The fellowships will be offered only to persons who 1. are U.S. citizens or nationals as of January 1, 1991; 2. will have earned, by the beginning of their fellowship tenure, a doctoral degree in one of the mathematical sciences; 3. will have held the doctorate for no more than five years as of January 1, 1991; and 4. will not previously have held any other NSF postdoctoral fellowship. The evaluation of applicants will be based, in part, on ability as evidenced by past research work and letters of recommendation, likely impact on the future scientific development of the applicant, and scientific quality of the research likely to emerge. Applicants' qualifications will be evaluated by a panel of mathematical scientists.

For copies of the application brochure or further information, contact the Special Projects Program, Division of Mathematical Sciences, National Science Foundation, 1800 G Street, NW, Washington, DC 20550; telephone 202-357-3453; or the American Mathematical Society at telephone 401-455-4000.

The deadline for applications is **November 15, 1990.**

University Fellowships for Women

Since 1888, the American Association of University Women (AAUW) Educational Foundation has awarded more than 5000 fellowships. In 1990, the Foundation awarded 253 fellowships totaling more than $2 million. Providing graduate support to women who have demonstrated scholarly excellence, AAUW offers three different kinds of fellowships that may be of interest to women in the mathematical sciences.

The first category is the *American Fellowships*, consisting of postdoctoral and dissertation fellowships for women who are citizens or permanent residents of the U.S. Applicants for the postdoctoral fellowships must hold a doctoral degree by the appli-

cation deadline, **November 15, 1990.** Nine postdoctoral fellowships will be awarded, ranging from $20,000 to $25,000. Scholars in any field may apply. The dissertation fellowships provide stipends of $12,500, for the final year of writing the dissertation. An applicant must have completed all coursework, passed all examinations, and have had the dissertation proposal or plan approved by the application deadline, **November 15, 1990.** The dissertation fellowships are open to all fields except engineering.

The *Selected Professions Fellowships* are awarded to women who are citizens or permanent residents of the U.S. and are in certain fields. For 1991-1992, this category includes Science/Technology Fellowships, which are available in a number of areas, including computer/information science and mathematics/statistics. These fellowships, which range from $5000 to $9500, support full-time study in the final year of master's degree programs (including one-year programs). The deadline is **December 15, 1990.**

International Fellowships are awarded to women of outstanding academic ability who are not citizens or permanent residents of the U.S. for full-time graduate or postgraduate study in the U.S. Applicants must hold the equivalent of a U.S. bachelor's degree before December 1, 1990. Upon completion of studies, fellowship recipients must return to their home countries to pursue professional careers. Previous and current recipients of AAUW fellowships are not eligible. The fellowships provide $13,000 each. The deadline is **December 1, 1990.**

For more information, contact: AAUW Educational Foundation, 1111 16th Street, NW, Washington, DC 20036; telephone 202-872-1430. You may request only one application and may apply for only one fellowship. Requests for applications must be received by AAUW two weeks before the application deadline.

Computing Research Equipment Program Deadline

SCREMS (Scientific Computing Research Equipment in the Mathematical Sciences) is a program of the Division of Mathematical Sciences of the National Science Foundation. The program will make a limited number of awards for the purchase of scientific computing equipment for mathematical sciences research. SCREMS is designed to provide for the kind of equipment that is difficult to justify for a single research project, but could be used by several (two to five) projects.

SCREMS will support the purchase of, and limited personnel support for, special-purpose computing environments dedicated to research in the mathematical sciences. The awards are intended to support specific research projects rather than to provide general computing capacity.

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

The deadline for receipt of proposals for SCREMS is **December 3, 1990.** For further information, contact the Division of Mathematical Sciences, Room 339, National Science Foundation, 1800 G Street, N.W., Washington, DC 20550; telephone 202-357-3691. Or send electronic inquiries to: screms@nsf.gov (Internet), or screms@nsf (Bitnet).

Econometrics and Statistics Workshops

The Economics program and the Statistics and Probability program of the National Science Foundation invite proposals for a special review of workshops and institute-like activities to build and support the interaction of econometrics and statistics.

The purpose of the competition is to develop programs that will improve communication between academic statisticians and econometricians to expand the frontiers of econometrics and statistics that are most relevant to economists. The funding level for the workshops is likely to total approximately $75,000 per year for a two to three year period.

The deadline for proposals is **October 15, 1990.** There will be another competition in the fall of 1991. For further information, contact Nell Sedransk or Peter Arzberger in the Division of Mathematical Sciences, Room 339, National Science Foundation, 1800 G Street, NW, Washington, DC 20550; telephone 202-357-3693. Electronic mail may be sent to parzberg@nsf.gov or nsedrans@nsf.gov (Internet) or parzberg@nsf or nsedrans@nsf (Bitnet).

Pilot Projects for Graduate Education

The AMS-MAA-SIAM Committee on Preparation for College Teaching has been awarded a three-year grant from the Fund for Improvement of Post-Secondary Education of the U.S. Department of Education. The grant, to be administered through the MAA, will provide limited funding for the planning of six or seven pilot projects that encourage mathematical breadth and attention to pedagogy for graduate students in Ph.D.-granting departments.

The general model of the projects includes development of a seminar to provide graduate students with information and experiences that will be useful in their future teaching responsibilities in colleges and universities.

A report of the Committee, "How Should Mathematicians Prepare for College Teaching?" appeared in *Notices*, December 1989, pages 1344–1346. In addition, Bettye Anne Case has organized a dialogue entitled "Paradigm Meets Reality: What Do Future College Teachers Need? What is Feasible in Ph.D. Programs?", to be held at the Joint Mathematics

Meetings in San Francisco, Wednesday, January 16, 1991, at 9:30 a.m. The speakers include Richard Millman and Stephen Rodi (who will speak on needs), and William Jaco and Ivar Stakgold (who will speak on feasibility). The discussion period should provide new ideas and information to strengthen the Committee's recommendations.

Proposals for summer 1991 pilot projects should be submitted by **November 15, 1990**. The Committee will be happy to work with planners of potential projects. In addition, before the Committee meets during the Joint Mathematics Meetings in January, it would like to see plans for projects to begin in the academic year 1992-1993 or later.

Guidelines are available from (and plans should be sent to) Bettye Anne Case, Chair, AMS-MAA-SIAM Committee on Preparation for College Teaching, Mathematics B-154, Tallahassee, FL 32306; electronic mail case@gauss.math.fsu.edu; telephone 904-644-1586.

For Your Information

Publication Rates Among Mathematicians at Liberal Arts Colleges

D. A. Robbins
Trinity College

Recently, spurred by the necessity of educating a tenure and promotion committee about the rate of publication in mathematics, especially at liberal arts colleges without graduate programs, I did some looking around to see if there was any information available.

There was essentially none that I came across of any recent vintage. The only previous widely-based information on this topic that I found was a 1969 publication of the Conference Board of the Mathematical Sciences [*Aspects of Graduate Training in the Mathematical Sciences*, 1969, pp. 115-122], which was itself based on a 1962-1963 survey by the U.S. Office of Education. It gave, for example, the average number of professional articles by mathematicians as seven; this contrasts to the biological sciences, where it was twenty-seven; and the social sciences, where it was ten. There was no indication of time span, or of the type of academic homes of the mathematicians. And, of course, the figures were quite old, verging on the antediluvian. In a similar vein, but more narrowly, a study by the University of Michigan of its graduates over a twenty-year period showed that only 37% had published more than five papers and that 26% had published no papers [P.L. Duren, *Notices*, American Mathematical Society, Volume 20, number 3, (1973), pp. 125-126]. Since the years surveyed were 1948-1967, these figures are also ancient and perhaps bear no relation to what is going on now.

Thus, such published sources as I was able to find supported the argument that mathematicians publish less as a rule than their colleagues in other disciplines, but the figures were so old as perhaps to be meaningless now. There does, however, seem to be folklore that the median publication rate of mathematicians is in the neighborhood of two to five professional papers. Perhaps more pertinently, the AMS, when it is doing a literature search to prepare the list of U.S. entries to the *World Directory of Mathematicians*, uses a standard of publishing three papers in five years [*Renewing U.S. Mathematics*, National Research Council, 1984, p. 63f.]–the implication being, I suppose, that to put out twenty or so papers in a thirty-year career is to be fairly productive.

While this was all interesting, I did not see how it could be sufficient to persuade anyone either of the rate of publication in mathematics, overall, or of what I anticipated would be the slower publication rate by mathematicians at the liberal arts colleges.

To satisfy my curiosity and to provide guidance for future tenure and promotion committees at Trinity, I therefore sent out a survey to the chairs of the mathematics departments at the 135 (or so) colleges with a Carnegie classification of Liberal Arts I–these are colleges which give a majority of their degrees in the non-professional liberal arts; the vast majority of them have no graduate program in mathematics.

Specifically, I asked for information on holders of the Ph.D., either tenured or on tenure-track: length of time since doctorate, length of time at the institution, tenure status, rank, number of professional articles published or accepted, estimated number of pages, and number of books published or close to being published. As to what constituted a professional article, I indicated that both research and expository (say *Monthly* or *Mathematics Magazine* type) articles would count, but that a problem solution in the *Monthly* probably would not. In addition, I asked that co-authored papers be counted as one, for each author as appropriate, and that each edition of a book (not printing) be counted as one. And, I left aside any questions of quality, looking instead at mere quantity.

I received responses from 51 schools, with information on 278 mathematicians, whose time since doctorate ranged from 1 to 38 years. Some of the data are listed in Tables 1 and 2.

With the benefit of hindsight, after entering all the data, I could see that I should perhaps have tried to slice a little more finely with respect to the information requested—for instance, I did not ask whether a given department was jointly mathematics and computer science, nor whether there were any Ph.D. computer

scientists in the data, nor whether the publications listed could be classified as mathematics or mathematics education. In retrospect, it might also have been interesting to know what the teaching loads were at the various colleges; surely that at least could have a direct effect on publication productivity. I also pretty much sloughed the questions of exactly what is a professional article and where the borderline is between books and articles; and I totally ignored software packages and manuals. Finally, it could have been useful to know the distribution of women and minorities among this group and the reason for, what seems to me, at least, to be the tiny number of really new (one or two years out) people on tenure-track.

It should be clear at this point that the survey was by no means scientific, so one should be wary of drawing firm conclusions from it. But, overall, I am struck by the way in which the distributions are skewed toward the low end—if I absolutely had to make one hard judgment, it would be that, whatever the *desirable* rate of publication should be for mathematicians at liberal arts colleges, the *normal* rate is not very high. I'm reasonably certain that the numbers of papers listed form upperbounds for publications in refereed mathematics research journals, but not of anything beyond that. As a result, I have some sympathy, but I do not totally agree with, the person who said in the letter which he enclosed with his information that "... it is all but impossible for a mathematician at a liberal arts college to do serious research, and it is folly to expect it. However, exposition and scholarship are not impossible, and even though they too are not to be expected, they should be encouraged and rewarded." It might be useful for there to be a "birds of a feather" meeting of the liberal arts colleges at some AMS/MAA annual meeting in order to discuss the kinds of productivity we in the liberal arts colleges should expect from ourselves.

TABLES 1 AND 2

Years since Ph.D.	# in this range	Distribution of papers by years since degree						Distribution of estimated pages of articles, by years since degree					
		Low	Q1	Med	Q3	High	Mean	Low	Q1	Med	Q3	High	Mean
1 - 2	9	0	0	1	1.5	4	1.0	0	0	12	20	50	12.7
3 - 4	18	0	1	1	2.5	13	2.3	0	8.5	14.5	39	75	23.2
5 - 6	23	1	3	3	4.5	13	4.1	4	20	30	40	130	37.5
7 - 8	24	0	2.5	4	8.5	20	5.4	0	21	45	95.5	154	55.8
9 - 12	39	0	0	2.5	6.5	15	6.9	0	0	26.5	66	180	78.5
13 - 16	33	0	1	5	10.5	42	7.4	0	5	47.5	112.5	300	73.2
17 - 20	47	0	1	3.5	11.5	42	7.3	0	9	47.5	140	1000	90.4
21 - 24	35	0	1	3	8.5	32	5.5	0	9.5	22.5	61.5	350	42.6
25 - 28	28	0	2	3	5.5	22	5.5	0	8.5	25	50	150	39.6
29 or more	22	0	1	4	12	60	10.3	0	11	32	107	720	87.3

Rank	Number in rank	Distribution of papers in rank						Years since Ph.D. (range)	Distribution of estimated pages of articles, in rank						No Info
		Low	Q1	Med	Q3	High	Mean		Low	Q1	Med	Q3	High	Mean	
Professor	116	0	1	4	10.5	60	7.8	11-38	0	7.5	30	98.5	1000	72.9	2
Assoc. P.	82	0	1	3	7	42	4.9	6-33	0	10	29	75.5	342	52.8	1
Asst. P.	80	0	1	2	4	20	3.4	1-33	0	7.5	25	45	154	34.4	1

Colleges Responding to Survey:

Agnes Scott C., Antioch C., Augustana C. (IL), Bard C., Beloit C., Birmingham-Southern C., Bowdoin C., Bucknell U., C. Holy Cross., C. Wooster, Carleton C., Carroll C. (WI), Centre C., Colby C., Connecticut C., Davidson C., Denison U., DePauw U., Drew U., Earlham C., Franklin & Marshall C., Gettysburg C., Goucher C., Guilford C., Hampden-Sydney C., Juniata C., King C., Knox C., Lewis & Clark C., Luther C., Macalester C., Manhattan C., Muhlenberg C., Pomona C., Randolph-Macon C., Reed C., Skidmore C., Smith C., Thomas More C., Trinity C. (CT), U. Dallas, Ursinus C., Vassar C., Wartburg C., Washington & Jefferson C., Washington & Lee U., Western Maryland C., Westmont C., Wheaton C. (IL), Whitman C., Willamette U.

1990 AMS Elections

Candidates

OFFICERS

Vice President (one to be elected)

Chandler Davis	Hans F. Weinberger

Secretary*

Robert M. Fossum

Associate Secretaries*

Joseph A. Cima (Southeast)	W. Wistar Comfort (Central)

Treasurer*

Franklin P. Peterson

Associate Treasurer*

Steve Armentrout

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

David A. Cox	Edward B. Saff
John M. Franks	Lesley M. Sibner
Frank Gilfeather	Steven H. Weintraub
Kunio Murasugi	Ruth J. Williams
Donald St. P. Richards	Lai-Sang Young

Board of Trustees (one to be elected)

Jane P. Gilman	M. Susan Montgomery

NOMINATING COMMITTEE FOR 1991

(Preferential Ballot, three to be elected)

Michael Aschbacher	Jerry Lawrence Kazdan
Eric D. Bedford	Walter David Neumann
Henri Gillet	Stephen Wainger

EDITORIAL BOARDS COMMITTEE FOR 1991

(Preferential Ballot, two to be elected)

Jon F. Carlson	Stephen S. Shatz
Richard James Milgram	Nolan R. Wallach

*Uncontested offices

Election Information

The ballots for election of members of the Council and Board of Trustees of the Society for 1991 will be mailed on or shortly after September 10, in order for members to receive their ballots well in advance of the November 10 deadline. Prior to casting their ballots members are urged to consult the following articles and sections of the Bylaws of the Society: article I, section 1; article II, sections 1, 2; article III, sections 1, 2, 3; article IV, sections 1, 2, 4; article VII, sections 1, 2, 5. The complete text of the Bylaws appears on pages 1261–1266 of the November 1989 issue of *Notices*. A list of the members of the Council and Board of Trustees serving terms during 1990 appears in the **AMS Reports and Communications** section of this issue.

REPLACEMENT BALLOTS

This year ballots for the AMS election will be mailed September 10, 1990, or within a day or two thereafter. The deadline for receipt of ballots in Providence is November 10, 1990.

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

To help alleviate this problem, the following replacement procedure has been devised: A member who has not received a ballot by October 10, 1990, or who has received a ballot but has accidentally spoiled it, may write after that date to the Secretary of the AMS, Post Office Box 6248, Providence, RI 02940, asking for a second ballot. The request should include the individual's member code and the address to which the replacement ballot should be sent. Immediately upon receipt of the request in the Providence office, a second ballot, which will be indistinguishable from the original, will be sent by first class or air mail. It must be returned in an inner envelope, which will be supplied, on the outside of which is the following statement to be signed by the member:

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

_____

signature

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

SUGGESTIONS FOR 1991 NOMINATIONS

Each year the members of the Society are given the opportunity to propose for nomination the names of those individuals they deem both qualified and responsive to their views and needs as part of the mathematical community. Candidates will be nominated by the Council to fill positions on the Council and Board of Trustees to replace those whose terms expire December 31, 1991. See the **AMS Reports and Communications** section of this issue for the list of current members of the Council and Board of Trustees. Members are requested to write their suggestions for such candidates in the appropriate spaces below.

SUGGESTIONS FOR 1991 NOMINATIONS

Council and Board of Trustees

President-Elect (1)

_____

Associate Secretaries (2) (Western and Central Sections)

_____

_____

Members-at-large of the Council (5)

_____

_____

_____

_____

_____

Member of the Board of Trustees (1)

_____

The completed form should be addressed to AMS Nominating Committee, Post Office Box 6248, Providence, RI 02940, to arrive no later than **November 10, 1990**.

Amherst, Massachusetts
University of Massachusetts, Amherst
October 20 – 21

Program

The eight-hundred-and-sixtieth meeting of the American Mathematical Society will be held at the University of Massachusetts, Amherst, on Saturday, October 20, and Sunday, October 21, 1990. Scientific sessions will be held in the Lederle Graduate Research Tower and several nearby buildings.

Invited Addresses

By invitation of the Eastern Sectional Program Committee, there will be four invited one-hour addresses. The speakers, their affiliations, the titles of their talks, and the scheduled times of presentation are:

CHRISTOPHER B. CROKE, University of Pennsylvania, *On the rigidity induced by the length of geodesics: Problems and recent progress*, 11:00 a.m. Saturday.

WILLIAM M. GOLDMAN, University of Maryland, College Park, *Complex hyberbolic Kleinian groups*, 11:00 a.m. Sunday.

JOHN J. MALLET-PARET, Brown University, *Global dynamics of delay differential equations*, 1:30 p.m. Saturday.

HENRY P. MCKEAN JR., Courant Institute of Mathematical Sciences, New York University, *Two compatible symplectic structures*, 1:30 p.m. Sunday.

Special Sessions

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

Hyperbolic manifolds, COLIN C. ADAMS, Williams College.

Lattices, geometry, and combinatorics, M. K. BENNETT and GARRETT BIRKHOFF, Harvard University.

Nonlinear dynamics in mathematics and science, MELVYN BERGER and ROBERT GARDNER, University of Massachusetts, Amherst.

Semigroups, HASKELL COHEN, University of Massachusetts, Amherst.

Discrete groups and geometric structures in 2, 3, and 4 dimensions, WILLIAM M. GOLDMAN, and BERNARD MASKIT, SUNY at Stony Brook.

Lie groups and algebraic groups, JAMES E. HUMPHREYS, and IVAN MIRKOVIĆ, University of Massachusetts, Amherst.

Algebraic graph theory, CHJAN LIM, Rensselaer Polytechnic Institute.

Ergodic theory, V. S. PRASAD, University of Lowell.

Aperiodicity and order, CHARLES RADIN, University of Texas, Austin, and MARJORIE SENECHAL, Smith College.

Abstracts for consideration for these sessions should have been submitted by the **July 16, 1990** deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited Speakers and Special Sessions section of *Notices*.

Contributed Papers

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

Registration

The registration desk will be located in the 16th floor lobby of the Lederle Graduate Research Tower and will be open from 8:00 a.m. to 5:00 p.m. on Saturday, October 20, and from 8:00 a.m. to noon on Sunday, October 21. The registration fees are $30 for members of the AMS, $45 for nonmembers, and $10 for students or unemployed mathematicians.

Activities of Other Organizations

On Friday, October 19, there will be an international symposium on *Nonlinear Dynamics in Mathematics and Science*, hosted by the Center for Applied Mathematics of the University of Massachusetts, Amherst, and the five college applied mathematics committees, and sponsored by the Office of Naval Research. This conference will take place from 10:00 a.m. until the late evening in the Mathematics Colloquium Room (1634 Graduate Research Tower). Many mathematicians and scientists

from this country and abroad (Soviet Union, England, and Japan) have been invited to participate in this event. Here is a chance to learn of many of the major research developments in this field and to meet many of the major contributors all in one day. The invited participants include R. Coifman, R. Devaney, R. Dobrushin, C. Foias, L. E. Fraenkel, C. Jones, V. Judovich, G. Knightly, N. Kopell, H. Matano, H. McKean, A. Polyakov, J. Spruck, J. T. Stuart, and J. Toland. There will be a two-day Special Session of invited talks on nonlinear dynamics. This session is organized by M. S. Berger and R. Gardner.

Social Event

The Department of Mathematics and Statistics will host a social event late Saturday afternoon.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the announcement of the Columbus meetings in the April 1990 issue of *Notices*.

Accommodations

Rooms have been blocked for participants at the following hotels or motels in the area. Because of the popularity of the New England fall foliage, hotel/motel reservations should be made as soon as possible. Participants should make their own reservations directly and mention the AMS meeting. The deadline for reservations at the Lincoln Campus Center was September 29; Lord Jeffery Inn, October 5; Motel 6, September 30; Country Belle Motel, September 9; Howard Johnson Motel, September 19; and University Motor Lodge, was August 19. The AMS is not responsible for rate changes or the quality of the accommodations offered by these hotels/motels.

Country Belle Motel (two miles from campus)
392 Russell Street, Hadley, MA 01035 (Rte.9)
Telephone: 413-586-0715

Single $54 Double $54

Howard Johnson Motel (two miles from campus)
401 Russell Street, Hadley, MA 01035 (Rte.9)
Telephone: 413-586-0114

Single $85 Double $85

Lincoln Campus Center Hotel (on campus)
University of Massachusetts, Amherst, MA 01003
Telephone: 413-549-6000

Single $54 Double $64

Lord Jeffery Inn (one mile from campus)
30 Boltwood Avenue, Amherst, MA 01002
Telephone: 413-253-2576

Single $80 Double $80

Motel 6 (ten miles from campus)
State Road, (I-91 Exit 24, North rte. 5 and 10), South Deerfield, MA 01373
Telephone: 413-665-7161

Single $29.56 Double $36.15

University Motor Lodge (1/4 mile from campus)
345 North Pleasant Street, Amherst, MA 01002
Telephone: 413-527-8468

Single $67 Double $67

Food Service

Meals will be available at the following campus locations. Saturday only: Top of the Campus Restaurant (located in Lincoln Campus Center on the 11th floor). Hours are from 5:00 p.m. to 9:00 p.m.

Saturday and Sunday:	
Hatch Cafeteria	8:00 a.m. – 10:30 p.m.
Saturday:	
Newman Center	8:30 a.m. – 4:00 p.m.
Sunday:	
Newman Center	8:30 a.m. – 10:00 p.m.

Parking

Parking will be permitted in any of the parking lots on campus from 6:00 p.m. Friday until 7:00 a.m. Monday at no charge. The only restrictions apply to spaces indicated as reserved for handicapped or towing zone areas. Parking at other hours is available for a fee at the parking garage adjacent to the Lincoln Campus Center.

Travel and Local Information

The University of Massachusetts, Amherst, is accessible by air, bus, or car. In the town of Amherst there is no taxi service but it is expected that the Pioneer Valley Transit Authority (PVTA) bus service will be available to and from the campus. Amherst is approximately a one-hour drive from Bradley International Airport in Windsor Locks, Connecticut, which is served by such major airlines as American, Delta, Eastern, TWA, United, and USAir.

Participants are advised to fly in and out of Bradley since it is closer and more convenient than Logan International Airport in Boston. Peter Pan Bus Line is available at Bradley and runs directly to the campus. Peter Pan presently operates daily between the hours of 7:00 a.m. and 8:15 p.m. (10:15 p.m. on Friday). Return

buses to Bradley from the campus presently operate daily from 5:05 a.m. until 6:20 p.m. (8:20 p.m on Sunday).

Most major car rental companies have agencies at Bradley International Airport. Directions for participants driving to the meeting are as follow:

FROM THE NORTH: Route 91 South to Exit 25 (South Deerfield) onto Route 116 South to UMass Exit onto Massachusetts Avenue.

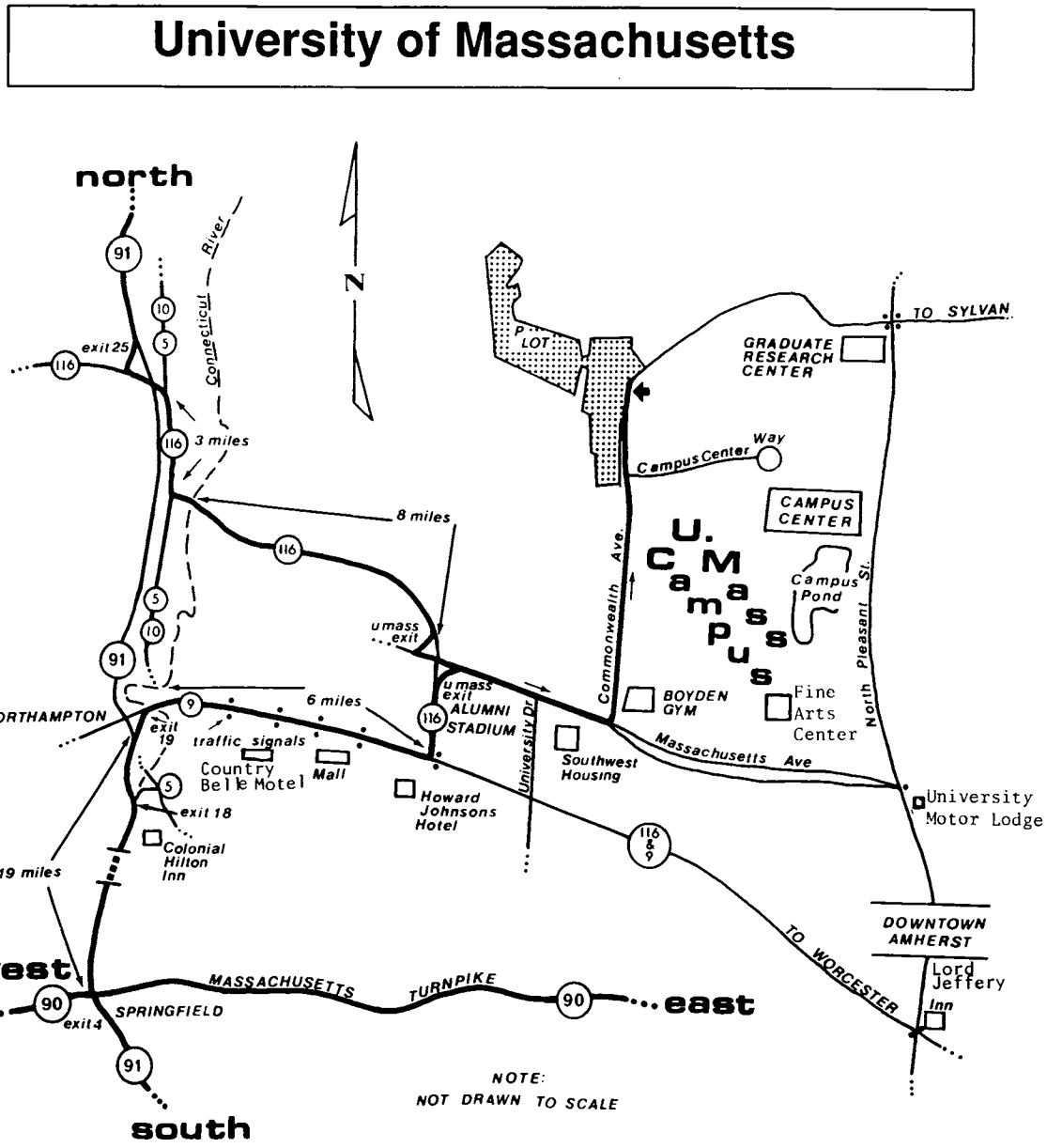
FROM THE SOUTH: Route 91 North to Exit 19 (Amherst) onto Route 9 to Route 116 North (left turn at lights) to UMass Exit onto Massachusetts Avenue (turn right).

FROM THE EAST: Massachusetts Turnpike (Route 90) West to Exit 4 (West Springfield), onto Route 91 North (Holyoke Exit) to Exit 19 (Amherst), onto Route 9 to Route 116 North (left turn at lights), to UMass Exit onto Massachusetts Avenue (turn right).

FROM THE WEST: Massachusetts Turnpike (Route 90) to Exit 4 (West Springfield), onto Route 91 North (Holyoke Exit) to Exit 19 (Amherst), onto Route 9 to Route 116 North (left turn at lights) to UMass Exit onto Massachusetts Avenue (turn right).

Weather and Local Attractions

Weather conditions in October can vary greatly. Balmy Indian Summer weather is expected, but rapid changes in conditions have brought on snow storms in the past. Participants should be prepared for both warm and cold conditions.



Program of the Sessions

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

Abstracts of papers presented in the sessions at this meeting will be found in the October 1990 issue of *Abstracts of papers presented to the American Mathematical Society*, ordered according to the numbers in parentheses following the listings below.

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

Saturday, October 20

Session on Applied Mathematics

8:50 a.m.–10:45 a.m. Room 51, Goessmann Laboratory

8:50 a.m. *Remarks on Volterra functional-differential equations.* Preliminary report.
(1) **C. Corduneanu**, University of Texas, Arlington (860-34-126)

9:05 a.m. *Closure of the semi-group of convolutions.*
(2) **C. Konstantopoulos**, **W. Ma** and **G. Sandri***, Boston University (860-46-130)

9:20 a.m. *Electron electrodynamics.*
(3) **Domina Eberle Spencer***, University of Connecticut, Storrs, and **Shama Y. Uma**, Bridgewater State College (860-78-89)

9:35 a.m. *Comparison of electric and magnetic field vectors in classical and Gaussian electrodynamics.*
(4) **Domina Eberle Spencer**, University of Connecticut, Storrs, and **Shama Y. Uma***, Bridgewater State College (860-78-90)

9:50 a.m. *The differential equations of magneto-hydrodynamics.*
(5) **Gerard Coutu***, Hartford Graduate Center, and **Domina Eberle Spencer**, University of Connecticut, Storrs (860-76-91)

10:05 a.m. *The complete Maxwell equations.*
(6) **Arjan S. Mirchandaney**, Defiance College, **Domina Eberle Spencer**, University of Connecticut, Storrs, **Shama Y. Uma**, Bridgewater State College, and **Philip J. Mann***, University of Connecticut, Storrs (860-78-92)

10:20 a.m. *Linear programming and toral actions.*
(7) **Leonid Faybusovich**, Harvard University (860-90-104)

10:35 a.m. *Characterization of an f-distance property for 1-dimensional d-symbol quasicrystals.*
(8) **Ramin Vakilian**, University of California, Davis (860-82-124)

Special Session on Hyperbolic Manifolds, I

9:00 a.m.–10:50 a.m. Room 20, Goessmann Laboratory

9:00 a.m. *The orthogonal spectrum of a hyperbolic manifold.*
(9) **Ara Basmajian**, University of Oklahoma (860-53-110)

9:30 a.m. *Geometrically tame hyperbolic 3-manifolds.*
(10) **Dick Canary**, Stanford University (860-57-123)

10:00 a.m. *The smallest hyperbolic 3-manifolds with totally geodesic boundary.*
(11) **Sadayoshi Kojima*** and **Yosuke Miyamoto**, Tokyo Institute of Technology, Japan (860-20-49)

10:30 a.m. *Amalgamation and the invariant trace field of a Kleinian group.*
(12) **Walter D. Neumann***, Ohio State University, Columbus, and **Alan W. Reid**, Ohio State University, Columbus and University of Aberdeen, Scotland (860-57-50)

Special Session on Lattices, Geometry, and Combinatorics, I

9:00 a.m.–10:50 a.m. Room 103, Lederle Graduate Research Center

9:00 a.m. *The adjunction argument.* Preliminary report.
(13) **Frank Grosshans**, West Chester University of Pennsylvania (860-51-60)

9:30 a.m. *Lattice geometries.* Preliminary report.
(14) **M. K. Bennett**, University of Massachusetts, Amherst, and **Robert Piziak***, Baylor University (860-06-74)

10:00 a.m. *Formally real $*$-fields.* Preliminary report.
(15) **Samuel S. Holland, Jr.**, University of Massachusetts, Amherst (860-06-55)

10:30 a.m. *A Boolean formalization of the predicate calculus.*
(16) **Isidore Fleischer**, University of Windsor (860-03-57)

Saturday, October 20 (cont'd)

Special Session on Non-linear Dynamics in Mathematics and Science, I

9:00 a.m.–10:50 a.m. Room 126, Hasbrouck Laboratory

9:00 a.m. *Meromorphic nonlinear integrable systems.*
(17) **Solomon J. Alber**, University of Pennsylvania (860-35-117)

9:30 a.m. *Transient solutions of the Navier-Stokes equations.*
(18) Preliminary report.
D. Sather, University of Colorado, Boulder (860-76-11) (Sponsored by Melvyn S. Berger)

10:00 a.m. *Calculus of variations and Besicovitch dynamics.*
(19) Preliminary report.
M. S. Berger, University of Massachusetts, Amherst, and **Y. Y. Chen***, Princeton University (860-34-113)

10:30 a.m. *Properties of travelling waves in a suspension bridge.*
(20) Preliminary report.
A. C. Lazer, University of Miami, and **P. J. McKenna***, University of Connecticut, Storrs (860-35-111)

Special Session on Semigroups, I

9:00 a.m.–10:50 a.m. Room 111, Lederle Graduate Research Center

9:00 a.m. *The congruence extension property, I.*
(21) **John A. Hildebrant***, Louisiana State University, Baton Rouge, and **Josefa I. Garcia**, University of Puerto Rico, Arecibo (860-20-66)

9:30 a.m. *The congruence extension property, II.*
(22) **Josefa I. Garcia***, University of Puerto Rico, Arecibo, and **John A. Hildebrant**, Louisiana State University, Baton Rouge (860-20-65)

10:00 a.m. *Difference semigroups.*
(23) **Boris M. Schein**, University of Arkansas, Fayetteville (860-20-62)

10:30 a.m. Discussion

Special Session on Discrete Groups and Geometric Structures in 2, 3 and 4 Dimensions, I

9:00 a.m.–10:50 a.m. Room 64, Goessmann Laboratory

9:00 a.m. *Mixing elements into Kleinian groups.*
(24) **James Anderson**, State University of New York, Stony Brook (860-30-100)

9:30 a.m. *Spectral geometry of arithmetic hyperbolic manifolds.*
(25) **Robert Brooks**, University of Southern California (860-58-27)

10:00 a.m. Discussion

10:30 a.m. *Hausdorff dimensions of limit sets.*
(26) **Kevin Corlette**, University of Chicago (860-53-122)

Special Session on Lie Groups and Algebraic Groups, I

9:00 a.m.–10:50 a.m. Room 201, Lederle Graduate Research Center

9:00 a.m. *Special unipotent representations.* Preliminary report.
(27) **Jeffrey Adams**, University of Maryland, College Park, **Dan Barbasch**, Cornell University, and **David A. Vogan, Jr.***, Massachusetts Institute of Technology (860-22-20)

9:30 a.m. *Lefschetz numbers and cyclic base change for purely imaginary extensions.* Preliminary report.
(28) **Birgit Speh**, Cornell University (860-11-76)

10:00 a.m. *On Dixmier algebras.* Preliminary report.
(29) **Iwan Pranata**, Cornell University (860-17-16)

10:30 a.m. *Szegö mappings into representations in cohomology.*
(30) Preliminary report.
Leticia Barchini and **A. W. Knapp***, State University of New York, Stony Brook (860-22-06)

Special Session on Algebraic Graph Theory, I

9:00 a.m.–10:50 a.m. Room 101, Lederle Graduate Research Center

9:00 a.m. *Chordal graphs and matrix structure: A survey.*
(31) **Charles R. Johnson**, College of William and Mary (860-15-94) (Sponsored by Chjan Lim)

9:40 a.m. *Graphs with given group, order, and size.* Preliminary report.
(32) **Louis V. Quintas**, Pace University, New York (860-05-03)

10:20 a.m. *On binary trees and S-pairs.*
(33) **Chjan Lim**, Rensselaer Polytechnic Institute (860-05-119)

Special Session on Ergodic Theory, I

9:00 a.m.–10:50 a.m. Room 203, Lederle Graduate Research Center

9:00 a.m. *Some rigorous results for the Greenberg-Hastings model.*
(34) **Richard Durrett** and **Jeffrey Steif***, Cornell University (860-60-79)

9:30 a.m. *Invariants for shift equivalence of matrices of polynomials.*
(35) **David Handelman**, University of Ottawa (860-28-71) (Sponsored by Vidhu S. Prasad)

10:00 a.m. *A characterization of ergodic dissipative flow.*
(36) **Yuji Ito**, Keio University, Japan (860-28-47)

10:30 a.m. Discussion

Special Session on Aperiodicity and Order, I

9:30 a.m.–10:50 a.m. Room 124, Hasbrouck Laboratory

9:30 a.m. (37) *A spectral dictionary.* Preliminary report.
Marjorie Senechal, Smith College (860-42-32)

10:00 a.m. (38) *On certain properties of deterministic disorder generated by substitutions of finite automata.*
Françoise Axel, Solid State Physics Laboratory, France (860-82-137) (Sponsored by Charles Radin)

10:30 a.m. (39) *Fault-tolerant and self-organizing cellular automata.* Preliminary report.
Peter Gács, Boston University (860-68-34)

Invited Address

11:00 a.m.–noon Room 131, Marcus Hall

(40) *On the rigidity induced by the length of geodesics: Problems and recent progress.*
Christopher B. Croke, University of Pennsylvania (860-99-148)

Invited Address

1:30 p.m.–2:30 p.m. Room 131, Marcus Hall

(41) *Global dynamics of delay differential equations.*
John J. Mallet-Paret, Brown University (860-39-73)

Special Session on Hyperbolic Manifolds, II

2:45 p.m.–5:05 p.m. Room 20, Goessmann Laboratory

2:45 p.m. (42) *The geometry of hyperbolic manifolds.* Preliminary report.
John G. Ratcliffe, Vanderbilt University (860-22-114)

3:15 p.m. (43) *Totally geodesic surfaces in hyperbolic 3-manifolds.*
William Menasco, State University of New York, College at Buffalo, and **Alan W. Reid***, Ohio State University, Columbus and University of Aberdeen, Scotland (860-57-52)

3:45 p.m. (44) *Configurations of curves on surfaces.* Preliminary report.
Joel Hass, University of California, Davis, and **Peter Scott***, University of Michigan, Ann Arbor (860-57-01)

4:15 p.m. (45) *Geometric triangulations of hyperbolic 3-orbifolds.*
William D. Dunbar, Pennsylvania State University, Erie (860-57-48)

4:45 p.m. (46) *Dehn surgery and spherical space forms.* Preliminary report.
Steven A. Bleiler*, Portland State University, and **Craig Hodgson**, Columbia University (860-57-51)

Special Session on Lattices, Geometry, and Combinatorics, II

2:45 p.m.–5:05 p.m. Room 103, Lederle Graduate Research Center

2:45 p.m. (47) *Lattices of quasivarieties of 3-element algebras.*
M. E. Adams*, State University of New York, College at New Paltz, and **W. Dziobiak**, N. Copernicus University, Poland (860-06-56)

3:15 p.m. (48) *Equational theory of if-then-else.*
Ernest G. Manes, University of Massachusetts, Amherst (860-06-53) (Sponsored by James E. Humphreys)

3:45 p.m. (49) *Halting sets of programs over universal algebras.*
H. Peter Gumm, State University of New York, College at New Paltz (860-68-103)

4:15 p.m. (50) *Varieties of demi-pseudocomplemented lattices.*
Hanamantagouda P. Sankappanavar, State University of New York, College at New Paltz (860-06-132)

4:45 p.m. (51) *A characterization of finite subdirectly irreducible lattices.* Preliminary report.
J. B. Nation, University of Hawaii, Honolulu (860-06-54)

Special Session on Non-linear Dynamics in Mathematics and Science, II

2:45 p.m.–5:05 p.m. Room 126, Hasbrouck Laboratory

2:45 p.m. (52) *Chaotic spikes arising from a model of bursting in excitable membranes.*
David Terman, Ohio State University, Columbus (860-92-116)

3:15 p.m. (53) *Existence and stability of travelling wave solutions.* Preliminary report.
Roger Lui, Worcester Polytechnic Institute (860-35-70)

3:45 p.m. (54) *Nonlinear development of detonation instabilities.*
Victor Roytburd, Rensselaer Polytechnic Institute (860-76-106) (Sponsored by Melvyn S. Berger)

4:15 p.m. (55) *Weak shocks for a $\lambda - \omega$ system are stable.* Preliminary report.
Todd Kapitula, Brown University (860-35-78)

4:45 p.m. (56) *Nonphysical limits of solutions of the Navier-Stokes equations for compressible flow.*
David Hoff*, Indiana University, Bloomington, and **Denis Serre**, Ecole Normale Superieure de Lyon, France (860-35-36)

Saturday, October 20 (cont'd)

Special Session on Semigroups, II

2:45 p.m.–5:05 p.m. Room 111, Lederle Graduate Research Center

2:45 p.m. (57) *The structure sheaf of a Baer-semigroup.* Preliminary report.
Gary D. Crown*, Wichita State University, and **Melvin F. Janowitz**, University of Massachusetts, Amherst (860-06-63)

3:15 p.m. (58) *Embeddability of functions in one-way flows.*
Abe Sklar, Illinois Institute of Technology (860-39-61) (Sponsored by Haskell Cohen)

3:45 p.m. (59) *Semigroups, ruled continua, and fixed points.*
Louis F. McAuley, State University of New York, Binghamton (860-57-64)

4:15 p.m. Discussion

Special Session on Discrete Groups and Geometric Structures in 2, 3 and 4 Dimensions, IIA

2:45 p.m.–5:35 p.m. Room 64, Goessmann Laboratory

2:45 p.m. (60) *Parabolic elements and Margulis space-times.* Preliminary report.
Todd A. Drumm, University of Maryland, College Park (860-53-23)

3:15 p.m. (61) *A Seifert geometry for $SO(p, q+1)$.*
Kyung Bai Lee, University of Oklahoma, and **Frank Raymond***, University of Michigan, Ann Arbor (860-57-146)

3:45 p.m. (62) *The biholomorphic automorphisms of Schottky space.*
Clifford J. Earle, Cornell University (860-30-22)

4:15 p.m. (63) *Projective structures with Schottky holonomy.*
Daniel Gallo, Saint John's University (860-30-77)

4:45 p.m. (64) *Two-generator discrete subgroups of $PSL(2, \mathbb{R})$: The geometry of intersecting axes.* Preliminary report.
Jane Gilman, Rutgers University, Newark (860-30-83)

5:15 p.m. (65) *Upper bounds for the Hausdorff dimension of nonergodic sets of measured foliations.*
Howard Masur, University of Illinois, Chicago (860-32-84)

Special Session on Discrete Groups and Geometric Structures in 2, 3 and 4 Dimensions, IIB

2:45 p.m.–5:35 p.m. Room 51, Goessmann Laboratory

2:45 p.m. (66) *Kähler manifolds and 1/4-pinching.*
Luis Hernández, University of Chicago (860-53-108)

3:15 p.m. (67) *Schottky groups with automorphisms.* Preliminary report.
Ruben A. Hidalgo, State University of New York, Stony Brook (860-99-149)

3:45 p.m. (68) *On geometrically finite Kleinian groups.* Preliminary report.
Irwin Kra, State University of New York, Stony Brook (860-30-105)

4:15 p.m. (69) *On holomorphic motions.*
Zbigniew Slodkowski, University of Illinois at Chicago (860-32-134) (Sponsored by Stephen D. Smith)

4:45 p.m. (70) *The hyperbolic characteristic submanifold theorem.*
Bernard Maskit, State University of New York, Stony Brook (860-30-87)

5:15 p.m. (71) *Pellian reflections and continued fractions on the $\sqrt{p}$ surface.* Preliminary report.
Mark Sheingorn, Bernard M. Baruch College, City University of New York (860-11-02)

Special Session on Lie Groups and Algebraic Groups, II

2:45 p.m.–5:05 p.m. Room 201, Lederle Graduate Research Center

2:45 p.m. (72) *Infinitesimal structure of representations: Some examples.* Preliminary report.
Roger E. Howe, Yale University (860-22-14)

3:15 p.m. (73) *Invariant theory and symplectic structure of nilpotent orbits.*
R. K. Brylinski*, Pennsylvania State University, University Park, and **B. Kostant**, Massachusetts Institute of Technology (860-22-120)

3:45 p.m. (74) *Prolongation of $\mathfrak{g}$-modules.* Preliminary report.
Gregg J. Zuckerman, Yale University (860-17-15)

4:15 p.m. (75) *Lagrangian construction of the enveloping algebra of sl_n.* Preliminary report.
Victor Ginsburg, Moscow State University, USSR (860-17-18) (Sponsored by James E. Humphreys)

4:45 p.m. (76) *Irreducible representations of Lie superalgebras.* Preliminary report.
Vera Serganova, Yale University (860-17-147) (Sponsored by Ivan Mirkovic)

Special Session on Algebraic Graph Theory, II

2:45 p.m.–4:35 p.m. Room 101, Lederle Graduate Research Center

2:45 p.m. (77) *Enumeration of highly irregular trees by automorphism group order.*
Kathleen A. McKeon, Connecticut College (860-05-101)

3:15 p.m. (78) *On self-complementary graphs.*
M. S. Krishnamoorthy* and **M. McMenamin**, Rensselaer Polytechnic Institute (860-05-85) (Sponsored by Chjan Lim)

3:45 p.m. (79) *Stable sets, max-cuts and quadratic 0-1 optimization.*
Jean-Marie Bourjolly, Concordia University (860-49-118) (Sponsored by Chjan Lim)

Special Session on Ergodic Theory, II

2:45 p.m.–5:05 p.m. Room 203, Lederle Graduate Research Center

2:45 p.m. (80) *An ergodic transformation with no non-trivial self-even equivalences.*
Adam Fieldsteel*, Wesleyan University, and **Daniel J. Rudolph**, University of Maryland, College Park (860-28-43)

3:15 p.m. (81) *Kronecker Gaussian processes and some counterexamples.* Preliminary report.
Andrés del Junco, University of Toronto (860-28-45)

3:45 p.m. (82) *Uniformly sweeping out does not imply mixing.*
T. M. Adams and **N. A. Friedman***, State University of New York, Albany (860-28-38)

4:15 p.m. (83) *A classification of the isometric extensions of a multidimensional Bernoulli shift.* Preliminary report.
Janet Whalen Kammeyer, United States Naval Academy (860-28-42)

4:45 p.m. (84) *On the classification of Z^d-actions up to Kakutani equivalence.* Preliminary report.
J. Roberto Hasfura, Trinity University (860-28-131)

Special Session on Aperiodicity and Order, II

2:45 p.m.–5:05 p.m. Room 124, Hasbrouck Laboratory

2:45 p.m. (85) *Long range order from local rules.*
Charles Radin, University of Texas, Austin (860-60-31)

3:15 p.m. (86) *Icosahedral solids: Perfect quasicrystals or random tilings?*
David P. Divincenzo, IBM T. J. Watson Research Center, Yorktown Heights, New York (860-82-33) (Sponsored by Charles Radin)

3:45 p.m. (87) *High order mixing.* Preliminary report.
Shahar Mozes, Hebrew University, Israel (860-28-12)

4:15 p.m. (88) *On the work of Godrèche and Luck.* Preliminary report.
Jean E. Taylor, Rutgers University, New Brunswick (860-82-07)

4:45 p.m. (89) *Why do real atoms form quasicrystals?*
Veit Elser, LASSP, Cornell University (860-82-141) (Sponsored by Charles Radin)

Sunday, October 21

Special Session on Hyperbolic Manifolds, III

8:30 a.m.–10:50 a.m. Room 20, Goessmann Laboratory

8:30 a.m. (90) *Kleinian groups with two parabolic generators.* Preliminary report.
John R. Parker, University of Maryland, College Park (860-30-98) (Sponsored by William M. Goldman)

9:00 a.m. (91) *Commutators, collars and the geometry of Möbius groups.* Preliminary report.
F. W. Gehring*, University of Michigan, Ann Arbor, and **G. J. Martin**, University of Auckland, New Zealand (860-30-95)

9:30 a.m. (92) *Volume estimates for hyperbolic orbifolds and manifolds.* Preliminary report.
F. W. Gehring, University of Michigan, Ann Arbor, and **G. J. Martin***, University of Auckland, New Zealand (860-30-96)

10:00 a.m. (93) *Computing the Chern-Simons invariant and the η invariant for hyperbolic 3-manifolds.* Preliminary report.
Robert Meyerhoff, Boston University (860-57-97)

10:30 a.m. (94) *Growth functions for negatively curved and automatic groups.*
David Epstein, University of Warwick, England (860-57-80)

Special Session on Lattices, Geometry, and Combinatorics, III

8:30 a.m.–10:50 a.m. Room 103, Lederle Graduate Research Center

8:30 a.m. (95) *Threshold orders.*
Kenneth P. Bogart, Dartmouth College (860-06-58)

9:00 a.m. (96) *Computer-assisted combinatorial exploration of finite posets and lattices.*
Curtis Greene, Haverford College (860-05-109)

9:30 a.m. (97) *Computers and ordered structures.*
George Markowsky, University of Maine, Orono (860-06-93)

10:00 a.m. (98) *Newman commutativity lattices.* Preliminary report.
M. K. Bennett*, University of Massachusetts, Amherst, and **Garrett Birkhoff**, Harvard University (860-06-10)

Sunday, October 21 (cont'd)

10:30 a.m. (99) *Newman associativity lattices.* Preliminary report. **Garrett Birkhoff***, Harvard University, and **M. K. Bennett**, University of Massachusetts, Amherst (860-06-102)

Special Session on Discrete Groups and Geometric Structures in 2, 3 and 4 Dimensions, III

8:30 a.m.–10:50 a.m. Room 64, Goessmann Laboratory

8:30 a.m. (100) *Pleatings and depleatings of Möbius manifolds, R-trees, and measured geodesic laminations.* **Ravi S. Kulkarni***, Queens College, City University of New York, and **Ulrich Pinkall**, University of Berlin, Germany (860-53-26)

9:00 a.m. (101) *Dirichlet and Ford domains for Kleinian groups.* Preliminary report. **Peter Waterman**, Northern Illinois University (860-30-25)

9:30 a.m. (102) *Cross-sections of the space of Schottky groups of genus two.* **David J. Wright**, Oklahoma State University, Stillwater (860-30-136)

10:00 a.m. (103) *Concentration points for Fuchsian groups.* **Darryl McCullough**, University of Oklahoma (860-57-28)

10:30 a.m. Discussion

Special Session on Lie Groups and Algebraic Groups, III

8:30 a.m.–10:50 a.m. Room 201, Lederle Graduate Research Center

8:30 a.m. (104) *Tensor products of modules with restricted highest weights.* Preliminary report. **Cornelius Pillen**, University of Massachusetts, Amherst (860-20-133)

9:00 a.m. (105) *Differential operators and quotient spaces.* **Gerald W. Schwarz**, Brandeis University (860-22-21)

9:30 a.m. (106) *Overgroups of unipotent elements in groups of Lie type.* **Donna M. Testerman**, Wesleyan University (860-20-142)

10:00 a.m. (107) *Some results on symmetric varieties.* **Aloysius G. Helminck**, North Carolina State University (860-22-17)

10:30 a.m. (108) *Quantum deformations of Schubert schemes.* **V. Lakshmibai***, Northeastern University, and **N. Reshetikhin**, Harvard University (860-14-135)

Special Session on Ergodic Theory, III

8:30 a.m.–10:50 a.m. Room 203, Lederle Graduate Research Center

8:30 a.m. (109) *On the topological entropy of transitive maps of the interval.* **Melissa C. Hidalgo**, University of Hartford (860-58-46)

9:00 a.m. (110) *A weak type inequality for some nonsingular transformations.* Preliminary report. **Idris Assani**, University of North Carolina, Chapel Hill (860-28-41)

9:30 a.m. (111) *Entropy of a skew product with a Z^2-action.* **Kyewon Park**, Bryn Mawr College (860-28-37)

10:00 a.m. (112) *Product structure and joinings for endomorphisms, I.* **Karma Dajani** and **Jane Hawkins***, University of North Carolina, Chapel Hill (860-28-39)

10:30 a.m. (113) *Product structure and joinings for endomorphisms, II.* **Karma Dajani*** and **Jane Hawkins**, University of North Carolina, Chapel Hill (860-28-40)

Special Session on Aperiodicity and Order, III

8:30 a.m.–10:50 a.m. Room 124, Hasbrouck Laboratory

8:30 a.m. (114) *Old theorems about the Penrose pieces.* **John Horton Conway**, Princeton University (860-05-139)

9:00 a.m. (115) *Self-similarity and randomness.* **Murad S. Taqqu**, Boston University (860-60-09)

9:30 a.m. (116) *Aperiodicity and constraints.* **Hao Wang**, The Rockefeller University (860-05-35) (Sponsored by Charles Radin)

10:00 a.m. (117) *Stabilization of quasicrystals: Energy vs. entropy.* **Sergei Burkov**, Landau Institute for Theoretical Physics, USSR and LASSP, Cornell University (860-82-138) (Sponsored by Charles Radin)

10:30 a.m. (118) *A non-Pisot five fold symmetric tiling with complex Fourier spectrum.* **Claude Godrèche**, Service de Physique du Solide et de Résonance Magnétique, France (860-82-140) (Sponsored by Charles Radin)

Special Session on Non-linear Dynamics in Mathematics and Science, III

9:00 a.m.–10:50 a.m. Room 126, Hasbrouck Laboratory

9:00 a.m. (119) *A geometrical study of an equation for a floating beam.* Preliminary report. **Alan C. Lazer***, University of Miami, and **P. Joseph McKenna**, University of Connecticut, Storrs (860-35-115)

9:30 a.m. (120) *Elliptic KP flows.* Preliminary report.
Emma Previato, Boston University (860-58-69)

10:00 a.m. (121) *Functional and numerical analyses of nonlinear dynamical systems.*
Peter J. Costa* and **Ruth Hampton Westlake**, Raytheon Company, Wayland, Massachusetts (860-46-68)

10:30 a.m. Discussion

Special Session on Algebraic Graph Theory, III

9:00 a.m.–10:50 a.m. Room 101, Lederle Graduate Research Center

9:00 a.m. (122) *Planar posets are lexicographically shellable.*
Karen L. Collins, Wesleyan University (860-05-29)

9:40 a.m. Discussion

10:20 a.m. (123) *A degree condition for Hamiltonian cycles in t-tough graphs with $t > 1$.*
Douglas Bauer*, **Lewis L. Lasser**, Stevens Institute of Technology, and **Guantao Chen**, Memphis State University (860-05-30)

Session on Pure Mathematics

9:35 a.m.–10:45 a.m. Room 51, Goessmann Laboratory

9:35 a.m. (124) *Joint embedding for normal models of open induction.* Preliminary report.
M. Otero, Mathematical Institute, University of Oxford, England (860-03-127)

9:50 a.m. (125) *Geodesics and bounded harmonic functions on infinite planar graphs.*
Sam Northshield, State University of New York, College at Plattsburgh (860-05-128)

10:05 a.m. (126) *Algorithmic trigonometry: Verification of numerical identities.*
Stanley Rabinowitz, Westford, MA (860-12-81)

10:20 a.m. (127) *Lattices over number fields.*
Richard Margolin, Princeton University (860-20-125)

10:35 a.m. (128) *$\mathbb{Z}_p$-points of the Chevalley group scheme in a given Bruhat cell.* Preliminary report.
Romuald Dabrowski, Indiana University, Bloomington (860-20-143)

Invited Address

11:00 a.m.–noon Room 131, Marcus Hall

(129) *Complex hyperbolic Kleinian groups.*
William M. Goldman, University of Maryland, College Park (860-57-72)

Invited Address

1:30 p.m.–2:30 p.m. Room 131, Marcus Hall

(130) *Two compatible symplectic structures.*
Henry P. McKean, Jr., Courant Institute of Mathematical Sciences, New York University (860-70-145)

Special Session on Hyperbolic Manifolds, IV

2:45 p.m.–4:05 p.m. Room 20, Goessmann Laboratory

2:45 p.m. (131) *Leafwise negative curvature of laminated 3-manifolds.* Preliminary report.
Lee Mosher* and **Ulrich Oertel**, Rutgers University, Newark (860-57-82)

3:15 p.m. (132) *Dirichlet domains for hyperbolic 3-manifolds.* Preliminary report.
Jeff Weeks, Middlebury, Vermont (860-57-99)
(Sponsored by Colin C. Adams)

3:45 p.m. (133) *An undetected slope in a knot manifold.* Preliminary report.
D. Cooper and **D. D. Long***, University of California, Santa Barbara (860-57-129)

Special Session on Lattices, Geometry, and Combinatorics, IV

2:45 p.m.–4:35 p.m. Room 103, Lederle Graduate Research Center

2:45 p.m. (134) *Jauch-Piron attributes.*
D. J. Foulis, University of Massachusetts, Amherst, **R. J. Greechie***, Kansas State University, and **G. T. Rüttiman**, University of Bern, Switzerland (860-06-107)

3:15 p.m. (135) *Normal functionals, predual Banach spaces, and complemented subspaces arising from quasi manuals.* Preliminary report.
Yewande Olubummo, Smith College, and **Thurlow Cook***, University of Massachusetts, Amherst (860-06-112)

3:45 p.m. (136) *Classification of attributes.* Preliminary report.
D. Foulis*, University of Massachusetts, Amherst, **R. Greechie**, Kansas State University, and **G. Rüttimann**, University of Bern, Switzerland (860-81-59)

4:15 p.m. (137) *A lattice product.* Preliminary report.
Steve Seif, University of Louisville (860-06-121)

Sunday, October 21 (cont'd)

Special Session on Discrete Groups and Geometric Structures in 2, 3 and 4 Dimensions, IV

2:45 p.m.–4:35 p.m. Room 64, Goessmann Laboratory

2:45 p.m. (138) *Spherical CR manifolds with amenable holonomy.* **Robert R. Miner**, University of Maryland, College Park (860-57-05)

3:15 p.m. (139) *The role of quasiconformality in CR geometry.* Preliminary report. **Adam Koranyi**, Herbert H. Lehman College, City University of New York (860-32-24)

3:45 p.m. (140) *Dirichlet polyhedra for cyclic groups in complex hyperbolic space.* **Mark B. Phillips**, University of Richmond (860-57-75)

4:15 p.m. (141) *Complex reflection groups acting on complex hyperbolic space.* **Kurt Sauter**, University of Michigan, Ann Arbor (860-57-86)

Special Session on Lie Groups and Algebraic Groups, IV

2:45 p.m.–4:35 p.m. Room 201, Lederle Graduate Research Center

2:45 p.m. (142) *Kazhdan-Lusztig conjecture for Kac-Moody algebras.* **Luis Casian**, Ohio State University, Columbus (860-22-88)

3:15 p.m. (143) *On the geometric Langlands conjecture.* **Kari Vilonen**, Brandeis University (860-22-144) (Sponsored by James E. Humphreys)

3:45 p.m. (144) *Representations of Chevalley groups arising from admissible lattices.* Preliminary report. **Zongzhu Lin**, University of Washington (860-20-19)

4:15 p.m. Discussion

Special Session on Ergodic Theory, IV

2:45 p.m.–4:05 p.m. Room 203, Lederle Graduate Research Center

2:45 p.m. (145) *Commuting endomorphisms of the circle.* **Aimee Johnson***, Tufts University, and **Daniel J. Rudolph**, University of Maryland, College Park (860-28-44)

3:15 p.m. (146) *Ergodic theory on infinite measure spaces.* **S. J. Eigen**, Northeastern University (860-28-67)

3:45 p.m. (147) *Fixed points for measure preserving homeomorphisms.* **V. S. Prasad**, University of Lowell (860-28-08)

Special Session on Aperiodicity and Order, IV

2:45 p.m.–4:05 p.m. Room 124, Hasbrouck Laboratory

2:45 p.m. Discussion

W. Wistar Comfort
Associate Secretary
Middletown, Connecticut

Presenters of Papers

Numbers following the names indicate the speakers' positions on the program.
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Denton, Texas
University of North Texas
November 2 – 3

Program

The eight-hundred-and-sixty-first meeting of the American Mathematical Society will be held at the University of North Texas, Denton, on Friday, November 2, and Saturday, November 3, 1990. All scientific sessions will be held in the Union Building on the campus.

Invited Addresses

By invitation of the Central Section Program Committee, there will be four invited one-hour addresses. The speakers, their affiliations, and the titles of their talks are:

AVNER D. ASH, Ohio State University, *Galois representations attached to GL(n,Z)*, Saturday, 11:00 a.m.

PETER S. CONSTANTIN, University of Chicago, *Navier-Stokes equations: Some new results and directions*, Friday, 11:00 a.m.

JOHN E. LUECKE, University of Texas, Austin, *Combinatorics of intersecting surfaces in 3-manifolds*, Saturday, 1:30 p.m.

CLARENCE W. WILKERSON, JR., Purdue University, *Classifying spaces and finite loop spaces*, Friday, 1:15 p.m.

Special Sessions

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

Arithmetic groups, AVNER D. ASH and MARK S. REEDER, University of Oklahoma.

Geometric inequalities and convex bodies, ILYA BAKELMAN, Texas A&M University.

Banach spaces-functional analysis, ELIZABETH M. BATOR, RUSSELL G. BILYEU, and PAUL W. LEWIS, University of North Texas, Denton.

Commutative algebra, SCOTT T. CHAPMAN, Trinity University, and NICK H. VAUGHN, University of North Texas, Denton.

Texas topology and geometry, DANIEL S. FREED, ROBERT F. WILLIAMS, and MICHAEL WOLF, University of Texas, Austin.

The probability theory of patterns and runs, ANANT P. GODBOLE, Michigan Technological University.

Low dimensional topology, JOHN LUECKE and ROBERT MYERS, Oklahoma State University.

Representation theory of Lie groups, LISA MANTINI and ROGER C. ZIERAU, Oklahoma State University

Differential equations, JOHN W. NEUBERGER and HENRY A. WARCHALL, University of North Texas, Denton.

Algebraic geometry, PETER F. STILLER, Texas A&M University.

Several complex variables, EMIL J. STRAUBE, Texas A&M University.

Abstracts for consideration for these sessions should have been submitted by the **July 16, 1990** deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited Speakers and Special Sessions section of *Notices*.

Contributed Papers

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

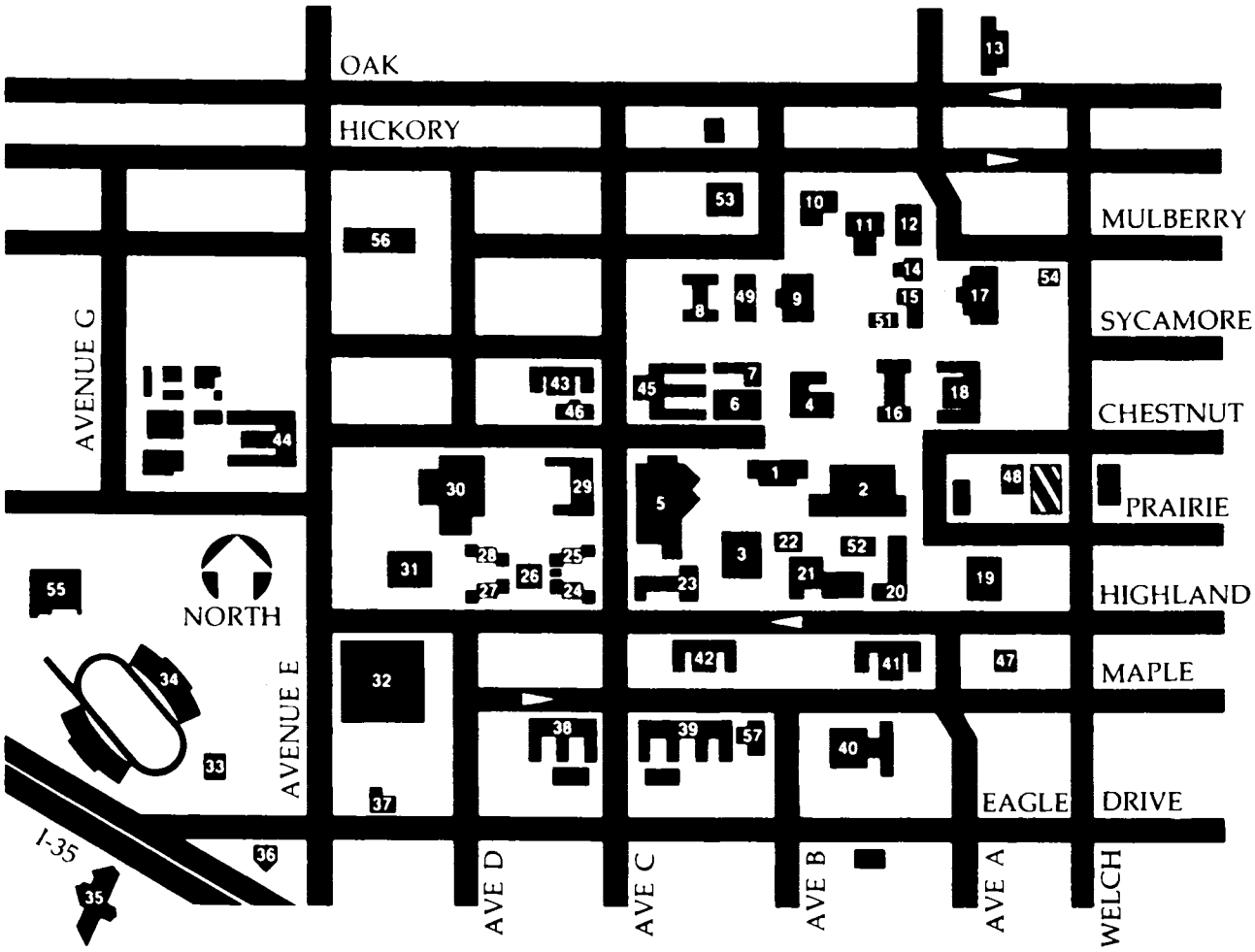
Registration

The meeting registration desk will be located in the Gallery Reception Area in the Union Building and will be open from 7:00 p.m. to 9:00 p.m. on Thursday, from 8:00 a.m. to 2:00 p.m. on Friday, and from 8:00 a.m. to noon on Saturday. The registration fees are $30 for members of the AMS, $45 for nonmembers, and $10 for students or unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the announcement for the Columbus meetings in the April 1990 issue of *Notices*.

University of North Texas



Parking Garage

2 University Union
4 Science Library
9 Math Department Offices
35 Sheraton Hotel

Accommodations

Special rates have been negotiated at selected local hotels, all of which are located on the I-35 corridor. Both the Royal Hotel Suites and the Sheraton are within easy walking distance of the campus. Participants should make their own arrangements directly with the hotel of their choice and ask for the special AMS meeting rate. The rates listed are subject to change and do not include applicable taxes. The deadline for reservation at all locations is **October 1, 1990 to obtain the published rates.** The AMS is not responsible for rate changes or the quality of the accommodations offered by these hotels/motels.

Holiday Inn (2.5 miles from campus)
1500 Dallas Drive, Denton, TX 76205
Telephone: 817-387-3511

Single $40 Double $40

LaQuinta Motor Inn (1.5 miles from campus)
700 Fort Worth Drive, Denton, TX 76205
Telephone: 817-387-5840

Single $31 Double $36

Motel 6 (3 miles from campus)
I-35 North of University Drive, Denton, TX 76205
Telephone: 817-566-4798

Single $21.95 Double $27.95

Auburn Inn (2 miles from campus)
820 S I-35E at Teasley Lane, Denton, TX 76205
Telephone: 817-387-0591

Single $35 Double $35

Royal Hotel Suites (.5 miles from campus)
1210 I-35E, Denton, TX 76205
Telephone: 817-383-2007

Single $24 Double $34

Sheraton Hotel (.5 miles from campus)
2211 I-35E, Denton, TX 76205
Telephone: 817-565-8499

Single $53 Double $58

Food Service

Many fast food restaurants are located within two blocks of the campus, and more formal dining is available at the Sheraton Hotel and several local restaurants. Food service in the Union will be available according to the following schedule only: Breakfast, lunch, and sandwiches until 5:00 p.m. on Thursday; breakfast and lunch on Friday; and lunch only on Saturday.

Travel

Denton is located approximately 35 miles north of Dallas and Fort Worth and 25 miles north of DFW International Airport, which is served by most major airlines. Airport shuttle service is available from the DFW International Airport to Denton (Telephone 817-565-9936 two to five days in advance for reservations). However, since one-way fare is $16 and only the Royal Hotel Suites and the Sheraton Hotel are within easy walking distance from campus, those flying to DFW should consider renting a car and driving to Denton.

Weather

Autumn in North Texas is a pleasant season with mild, sunny weather punctuated by short periods of rainfall. The average temperature for November is 61.5°F with relative humidity around 55 percent. The average date of the first freeze is November 8.

Program of the Sessions

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

Abstracts of papers presented in the sessions at this meeting will be found in the October 1990 issue of *Abstracts of papers presented to the American Mathematical Society*, ordered according to the numbers in parentheses following the listings below.

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

Friday, November 2

Special Session on Geometric Inequalities and Convex Bodies, I

8:30 a.m.–10:50 a.m. Room 412, University Union Building

8:30 a.m. (1) *Geometric inequalities governing multiplicative estimates and integral maximum principles in nonlinear elliptic boundary value problems.* Preliminary report.
Ilya J. Bakelman, Texas A & M University, College Station (861-35-13)

9:00 a.m. (2) *Qualitative behavior of solutions to a system of partial differential equations from nonlinear elasticity.* Preliminary report.
Patricia Bauman*, Purdue University, West Lafayette, **Nicholas Owen**, The University of Sheffield, England, and **Daniel Phillips**, Purdue University, West Lafayette (861-35-25)

9:30 a.m. (3) *The Weyl problem for surfaces of nonnegative curvature.* Preliminary report.
Joseph Iaia, University of Pennsylvania (861-35-14)

10:00 a.m. (4) *On a family of torsional creep problems.*
Bernhard Kawohl, University of Heidelberg, Federal Republic of Germany (861-35-04)

10:30 a.m. (5) *Singularities and the conformal scalar curvature equation.* Preliminary report.
Robert C. McOwen, Northeastern University (861-35-15)

Special Session on The Probability Theory of Patterns and Runs, I

8:30 a.m.–10:50 a.m. Room 415, University Union Building

8:30 a.m. (6) *Moving average representations in prediction theory.*
Jay Rothman, University of Colorado, Denver (861-60-184)

9:00 a.m. (7) *Distribution of periods and frequencies of runs in binary sequences.*
Solomon W. Golomb, University of Southern California (861-60-185)

9:30 a.m. (8) *Probabilistic analysis of some problems in molecular genetics.*
Betty Tang, Arizona State University (861-60-108)

10:00 a.m. (9) *Exchangeability in the conditional distribution theory of runs.*
Eugene F. Schuster, University of Texas, El Paso (861-60-115) (Sponsored by Anant P. Godbole)

10:30 a.m. (10) *Some limit theorems on distributional patterns of balls in urns.*
Ming-Ying Leung, University of Texas, San Antonio (861-60-103)

Special Session on Algebraic Geometry, I

8:30 a.m.–10:50 a.m. Room 418, University Union Building

8:30 a.m. (11) *Homotopy limits in general (co)fibration categories.*
Jerome William Hoffman, Louisiana State University, Baton Rouge (861-55-147)

9:00 a.m. (12) *Goppa codes and Weierstrass gaps.*
Robert F. Lax, Louisiana State University, Baton Rouge (861-14-39)

9:30 a.m. (13) *Periods of mixed cusp forms.*
Min Ho Lee, University of Northern Iowa (861-11-38)

10:00 a.m. (14) *A beginner's guide to Persson diagrams.* Preliminary report.
Charles F. Schwartz*, Rider College, and **William L. Hoyt**, Rutgers University, New Brunswick (861-14-182)

10:30 a.m. (15) *Nef cotangent bundles of branched coverings.*
Michael J. Spurr, East Carolina University (861-14-142)

Friday, November 2 (cont'd)

Special Session on Banach Spaces-Functional Analysis, I

9:00 a.m.–10:50 a.m. Gold Eagle Suite B, University Union Building

9:00 a.m. (16) *On the complemented subspaces of X_p.* **Dale E. Alspach**, Oklahoma State University, Stillwater (861-46-70)

9:30 a.m. (17) *Regular and Dunford-Pettis operators on L_1.* Preliminary report. **Kevin T. Andrews**, Oakland University (861-47-84)

10:00 a.m. (18) *The Vitali integral convergence theorem and uniform absolute continuity.* **Elizabeth M. Bator***, **Russell G. Bilyeu** and **Paul Lewis**, University of North Texas (861-46-74)

10:30 a.m. (19) *An arbitrarily distortable space.* **Thomas Schlumprecht**, University of Texas, Austin (861-46-83) (Sponsored by Edward Odell)

Special Session on Commutative Algebra, I

9:00 a.m.–10:50 a.m. Gold Eagle Suite C, University Union Building

9:00 a.m. (20) *The Noetherian property in rings of integer-valued polynomials.* Preliminary report. **Robert Gilmer**, Florida State University, **William Heinzer**, Purdue University, West Lafayette, and **David Lantz***, Colgate University (861-13-151)

9:30 a.m. (21) *Comaximizable primes.* **Raymond C. Heitmann** and **Stephen McAdam***, University of Texas, Austin (861-13-93)

10:00 a.m. (22) *Torsion-free divisible groups as unit groups of fields.* Preliminary report. **Maria Contessa**, University Degli Studi, Italy, **Joe L. Mott*** and **Warren Nichols**, Florida State University (861-13-192)

10:30 a.m. (23) *Factorization in Dedekind domains.* Preliminary report. **Scott Chapman***, Trinity University, and **William W. Smith**, University of North Carolina, Chapel Hill (861-13-191)

Special Session on Texas Topology and Geometry, I

9:00 a.m.–10:50 a.m. Room 410, University Union Building

9:00 a.m. (24) *The total Chern class is an infinite loop map.* **Benjamin M. Mann**, University of New Mexico (861-55-170)

9:30 a.m. (25) *Counting periodic tilings of the plane.* **Reinhard O. W. Franz**, University of Bielefeld, Federal Republic of Germany (861-05-160)

10:00 a.m. (26) *On the geometry of the moduli space of flat tori.* **Daniel B. Swearingen**, Rice University (861-51-178)

10:30 a.m. (27) *The Hyperkähler geometry of instanton moduli.* **Charles P. Boyer**, University of New Mexico (861-53-140)

Special Session on Low Dimensional Topology, I

9:00 a.m.–10:50 a.m. Room 411, University Union Building

9:00 a.m. (28) *Geodesic separation points for Fuchsian groups and laminations in surfaces.* **Darryl McCullough**, University of Oklahoma (861-57-67)

9:30 a.m. (29) *Geometric structures on branched covers over universal links.* Preliminary report. **Kerry Jones**, University of Texas, Austin (861-57-63)

10:00 a.m. (30) *Links as critical sets.* Preliminary report. **Masahico Saito**, University of Texas, Austin (861-57-64)

10:30 a.m. (31) *Dehn functions of groups, extensions of two-complexes, and quasi-isometries.* **Stephen G. Brick**, University of Oklahoma (861-20-163)

Special Session on Representation Theory of Lie Groups, I

9:00 a.m.–10:50 a.m. Gold Eagle Suite A, University Union Building

9:00 a.m. (32) *Categories of Whittaker modules.* **Dragan Miličić**, University of Utah (861-22-130)

9:30 a.m. (33) *Analytic version of Kempf's geometric resolution.* **Mario Candia**, University of Utah (861-22-128)

10:00 a.m. (34) *A singular representation of E_6.* **B. T. Binegar*** and **R. Zierau**, Oklahoma State University, Stillwater (861-22-162)

10:30 a.m. (35) *Lusztig's conjecture for negative level modules.* **Luis Casian**, Ohio State University, Columbus (861-17-137)

Special Session on Differential Equations, I

9:00 a.m.–10:50 a.m. Silver Eagle Suite C, University Union Building

9:00 a.m. (36) *On a model equation for the spectrum of 3D turbulence.*
Ciprian Foias*, Indiana University, Bloomington, **John W. Neuberger**, University of North Texas, and **Roger Temam**, University of Paris XI, France and Indiana University, Bloomington (861-35-118)

9:30 a.m. (37) *Discrete eigenfunction approximations for continuous spectrum operators.*
Robert M. Kauffman, University of Alabama, Birmingham (861-34-30)

10:00 a.m. (38) *A pole-free strip for potential scattering.*
Brian J. Loe, Iowa State University (861-35-117)

10:30 a.m. (39) *Symbolic manipulation software and the study of differential equations.*
Man Kam Kwong, Argonne National Laboratory (861-34-157)

Invited Address

11:00 a.m.–11:50 a.m. Silver Eagle Suite A, University Union Building

(40) *Navier-Stokes equations: Some new results and directions.*
Peter S. Constantin, University of Chicago (861-35-127)

Invited Address

1:15 p.m.–2:05 p.m. Silver Eagle Suite A, University Union Building

(41) *Classifying spaces and finite loop spaces.*
Clarence W. Wilkerson, Jr., Purdue University, West Lafayette (861-55-215)

Special Session on Arithmetic Groups, I

2:30 p.m.–4:50 p.m. Room 417, University Union Building

2:30 p.m. (42) *An algebraic realization of the cohomology of a Hilbert modular variety.*
B. Brent Gordon, University of Oklahoma (861-11-204)

3:00 p.m. Informal Discussion

3:30 p.m. (43) *Modular symbols and the Steinberg representation.*
Mark S. Reeder, University of Oklahoma (861-57-138)

4:00 p.m. (44) *Basic sharblies, ideal skeleta of $SL(n,\mathbb{R})/SO(n,\mathbb{R})$, and a generalization of "reduction to unimodular symbols."* Preliminary report.
Lee Rudolph, Clark University (861-57-155)

4:30 p.m. Informal Discussion

Special Session on Banach Spaces-Functional Analysis, II

2:30 p.m.–5:20 p.m. Gold Eagle Suite B, University Union Building

2:30 p.m. (45) *A fixed point property for the Lorentz space $Lp,1(\mu)$.* Preliminary report.
N. L. Carothers, Bowling Green State University, **S. J. Dilworth***, University of South Carolina, Columbia, **C. J. Lennard**, University of Pittsburgh, Pittsburgh, and **D. A. Trautman**, The Citadel (861-46-81)

3:00 p.m. (46) *Rosenthal sets and the radon-nikodym property.* Preliminary report.
Patrick N. Dowling, Miami University, Oxford (861-46-77)

3:30 p.m. (47) *Near-isometries and centralizers.* Preliminary report.
Ehrhard Behrends, Freie University of Berlin, Federal Republic of Germany, **Peter Greim*** and **David A. Trautman**, The Citadel (861-46-139)

4:00 p.m. (48) *Sequential domination in Banach spaces and some new classes of Baire-1 functions.*
C. S. Schumacher, Kenyon College (861-46-89)

4:30 p.m. (49) *Complemented subspaces of Banach lattices.*
Nigel Kalton, University of Missouri, Columbia (861-46-88)

5:00 p.m. (50) *On the strongly extreme points of convex bodies in separable Banach space.*
B. V. Godun, Kharkov Institute, USSR, **Bor-Luh Lin***, University of Iowa, and **S. L. Troyanski**, Sofia University, Bulgaria (861-46-80)

Special Session on Geometric Inequalities and Convex Bodies, II

2:30 p.m.–5:50 p.m. Room 412, University Union Building

2:30 p.m. (51) *Pseudoconvexity for semi-Riemannian spaces.* Preliminary report.
John K. Beem, University of Missouri, Columbia (861-52-05)

3:00 p.m. (52) *Asymptotic approximations to fundamental solutions of differential equations on manifolds.*
S. A. Fulling, Texas A & M University, College Station (861-41-16) (Sponsored by Ilya Bakelman)

3:30 p.m. (53) *Crofton-type formulas and radon transforms.* Preliminary report.
Paul R. Goodey, University of Oklahoma (861-52-26)

4:00 p.m. (54) *Stability properties of geometric inequalities.* Preliminary report.
H. Groemer, University of Arizona (861-52-22)

Friday, November 2 (cont'd)

4:30 p.m. (55) *Inequalities for mixed projection bodies.* Preliminary report.
Erwin Lutwak, Polytechnic Institute of New York (861-52-23)

5:00 p.m. (56) *Elliptic systems for a medium with micro-structure.*
R. E. Showalter, University of Texas, Austin (861-35-03)

5:30 p.m. (57) *Non-Euclidean bodies of constant width.*
Boris V. Dekster, Mount Allison University, Canada (861-52-01)

Special Session on Commutative Algebra, II

2:30 p.m.–5:20 p.m. Gold Eagle Suite C, University Union Building

2:30 p.m. (58) *Integral domains with finitely generated groups of divisibility.*
D. D. Anderson, University of Iowa (861-13-94)

3:00 p.m. (59) *Length functions on integral domains.*
David F. Anderson*, University of Tennessee, Knoxville, and **Paula Pruis**, Purdue University, West Lafayette (861-13-91)

3:30 p.m. (60) *On n-flat modules over a commutative ring.*
David E. Dobbs, University of Tennessee, Knoxville (861-13-92)

4:00 p.m. (61) *Artinian subrings of a commutative ring.*
Robert Gilmer, Florida State University, and **William Heinzer***, Purdue University, West Lafayette (861-13-190)

4:30 p.m. (62) *On t-linked overrings.* Preliminary report.
David E. Dobbs, University of Tennessee, Knoxville, **Evan G. Houston***, **Thomas G. Lucas**, University of North Carolina, Charlotte, **Moshe Roitman**, University of Haifa, Israel, and **Muhammad Zafrullah**, Winthrop College (861-13-211)

5:00 p.m. (63) *Endomorphism overrings of Prüfer domains.*
M. Fontana, University of Rome-La Sapienza, Italy, **J. Huckaba***, **I. Papick**, University of Missouri, Columbia, and **M. Roitman**, University of Haifa, Israel (861-13-193)

Special Session on Texas Topology and Geometry, II

2:30 p.m.–5:30 p.m. Room 410, University Union Building

2:30 p.m. (64) *Convergent perturbation theories for volume preserving flows and maps.*
A. Delshams, University of Barcelona, Spain, and **R. de la Llave***, University of Texas, Austin (861-58-99)

3:00 p.m. (65) *Schwarz' P-surface is stable.*
Marty Ross, Rice University (861-49-205)

3:30 p.m. Problem Session

Special Session on The Probability Theory of Patterns and Runs, II

2:30 p.m.–5:00 p.m. Room 415, University Union Building

2:30 p.m. (66) *Runs of superimposed Poisson processes.*
Hao Zhang, University of Pennsylvania (861-60-101)

3:00 p.m. (67) *New exact runs tests for randomness.*
Marilyn A. Agin, Michigan Technological University (861-62-104)

3:30 p.m. (68) *Approximate hypercube reliabilities.*
Sanjay Khunger, Michigan Technological University (861-60-105) (Sponsored by Anant P. Godbole)

4:00 p.m. (69) *Exact and limiting runs distributions.*
Michelle C. Gornowicz, Michigan Technological University (861-60-107) (Sponsored by Anant P. Godbole)

4:30 p.m. Informal Discussion

Special Session on Low Dimensional Topology, II

2:30 p.m.–3:30 p.m. Room 411, University Union Building

2:30 p.m. (70) *Automorphisms of free products.*
Darryl McCullough and **Andy Miller***, University of Oklahoma (861-20-68)

3:00 p.m. (71) *Skein modules of open contractible 3-manifolds.* Preliminary report.
Jim Hoste*, Pitzer College, and **Józef H. Przytycki**, Institute for Advanced Study (861-57-202)

Special Session on Representation Theory of Lie Groups, II

2:30 p.m.–5:50 p.m. Gold Eagle Suite A, University Union Building

2:30 p.m. (72) *Representations of Lie algebras.*
Thomas Enright, University of California at San Diego, La Jolla (861-22-214) (Sponsored by Lisa Mantini)

3:00 p.m. (73) *On the unitary representations of $SO(p, q)$: the regular integral case.* Preliminary report.
Susana Alicia Salamanca-Riba, New Mexico State University, Las Cruces (861-22-164)

3:30 p.m. (74) *Dual pairs and holonomic systems.* Preliminary report.
Tomasz Przebinda, Louisiana State University, Baton Rouge (861-22-56)

4:00 p.m. *The Capelli identity and unitary representations.*
(75) **Siddhartha Sahi**, Princeton University (861-22-53)
(Sponsored by Lisa Mantini)

4:30 p.m. *Covariant differential operators.*
(76) **Mark G. Davidson***, Louisiana State University, Baton Rouge, **Thomas J. Enright**, University of California at San Diego, La Jolla, and **Ronald J. Stanke**, Baylor University (861-43-57)

5:00 p.m. *Szegö maps and unitary highest weight*
(77) *representations.*
Mark G. Davidson, Louisiana State University, Baton Rouge, and **Ronald J. Stanke***, Baylor University (861-22-58)

5:30 p.m. Informal Discussion

Special Session on Algebraic Geometry, II

2:30 p.m.–5:50 p.m. Room 418, University Union Building

2:30 p.m. *Exponential sums and Newton polyhedra.*
(78) **Alan Adolphson**, Oklahoma State University, Stillwater (861-14-213)

3:00 p.m. *Characteristic numbers for singular cubics.*
(79) **Paolo Aluffi**, Oklahoma State University, Stillwater (861-14-124)

3:30 p.m. *Birational mappings between hypersurfaces of degree*
(80) $\mathbb{M}+1$ *in* $\mathbf{P}^{M+1}$.
Bruce Crauder, Oklahoma State University, Stillwater (861-14-153)

4:00 p.m. *Families of Abelian varieties over modular curves, the*
(81) *generalized Tate conjecture, and ordinary primes for modular forms.* Preliminary report.
B. Brent Gordon, University of Oklahoma (861-14-219)

4:30 p.m. *Hilbert modular threefolds.*
(82) **H. G. Grundman**, Massachusetts Institute of Technology (861-14-135)

5:00 p.m. *Homogeneous and scheme-theoretic generation of*
(83) *varieties by quadrics.*
Sheldon Katz, Oklahoma State University, Stillwater (861-14-134)

5:30 p.m. *On the existence of components of the Hilbert scheme*
(84) *with the expected number of moduli.* Preliminary report.
Angelo Lopez, University of California, Riverside (861-14-181)

Special Session on Several Complex Variables, I

2:30 p.m.–4:50 p.m. Room 413, University Union Building

2:30 p.m. *Topology of Levi-flat hypersurfaces.*
(85) **David E. Barrett**, University of Michigan, Ann Arbor (861-32-165)

3:00 p.m. *On Levi-flat hypersurfaces.*
(86) **Zbigniew Slodkowski***, University of Illinois, Chicago, and **Giuseppe Tomassini**, Scuola Normale Superiore, Italy (861-32-166) (Sponsored by Emil J. Straube)

3:30 p.m. *Real surfaces in complex varieties.* Preliminary report.
(87) **Gary A. Harris**, Texas Technical University (861-32-06)

4:00 p.m. *Finite type conditions for a single complex vector field.*
(88) Preliminary report.
John P. D'Angelo, University of Illinois, Urbana-Champaign (861-32-34)

4:30 p.m. *Behavior of holomorphic functions near weakly*
(89) *pseudoconvex boundary points.*
Frank Beatrous, University of Pittsburgh, Pittsburgh (861-32-150)

Session on Algebra, Geometry, and Analysis

2:30 p.m.–4:00 p.m. Ponder Room, University Union Building

2:30 p.m. *Algebra structures on resolutions of rings defined by*
(90) *grade four almost complete intersections.*
Susan M. Palmer, Southwest Missouri State University (861-13-95) (Sponsored by Andy R. Magid)

2:50 p.m. *Some new cohomological formulas for the Chow*
(91) *groups.*
Yevsey Nisnevich, Johns Hopkins University, Baltimore (861-14-141)

3:10 p.m. *Monotone operators on* R^n. Preliminary report.
(92) **David Gurney**, Southern Louisiana University (861-26-176)

3:30 p.m. *A Levinson-type lemma for differential equations*
(93) *without absolute convergence.*
Dale T. Smith, University of North Texas (861-34-114)

3:50 p.m. *Complemented subspaces of spaces obtained by*
(94) *interpolation.*
Stephen J. Montgomery-Smith*, University of Missouri, Columbia, and **D. J. H. Garling**, University of Cambridge, England (861-46-149)

Special Session on Differential Equations, II

3:00 p.m.–5:50 p.m. Room 406, General Academic Building

3:00 p.m. *Differential equations on open sets with fractal*
(95) *boundary.*
Michel L. Lapidus, Yale University and University of Georgia (861-35-156)

3:30 p.m. *Recent developments in semi-positone problems.*
(96) **Ratnasingham Shivaji**, Mississippi State University (861-35-125)

4:00 p.m. *Positivity properties and stability of solitary-wave*
(97) *solutions of model equations for long waves.*
John P. Albert, University of Oklahoma (861-35-169)

Friday, November 2 (cont'd)

4:30 p.m. (98) *Existence and non-existence results for ground states of quasilinear elliptic equations.*
James Serrin and **Henghui Zou***, University of Minnesota, Minneapolis (861-35-49)

5:00 p.m. (99) *Reconstruction techniques for classical inverse Sturm-Liouville problems.*
William Rundell*, Texas A & M University, College Station, and **Paul E. Sacks**, Iowa State University (861-34-46)

5:30 p.m. (100) *Symplectic continued fractions arising in the discrete regulator problem.*
Calvin D. Ahlbrandt, University of Missouri, Columbia (861-34-152)

Saturday, November 3

Special Session on Geometric Inequalities and Convex Bodies, III

8:00 a.m.–10:50 a.m. Room 412, University Union Building

8:00 a.m. (101) *Null foliations and gravitational plane wave metrics.*
P. Ehrlich* and **G. Emch**, University of Florida (861-53-02)

8:30 a.m. (102) *Deforming curves on convex surfaces to simple closed geodesics.*
Michael E. Gage, University of Rochester (861-53-111)

9:00 a.m. (103) *Geometry and uncertainty.*
Francis J. Narcowich, Texas A & M University, College Station (861-51-24)

9:30 a.m. (104) *Applications of geometric methods to elliptic and parabolic problems.* Preliminary report.
Andrejs E. Treibergs, University of Utah (861-53-27)

10:00 a.m. (105) *Inequalities and random convex bodies.* Preliminary report.
Richard A. Vitale, University of Connecticut, Storrs (861-52-21)

10:30 a.m. (106) *Evolution problem for plastic anti-planar shear.*
Xiaodong Zhou, Rice University (861-49-28)

Special Session on Texas Topology and Geometry, III

8:00 a.m.–10:50 a.m. Room 410, University Union Building

8:00 a.m. (107) *Some quasilinear systems with a lack of ellipticity.*
S. Walter Wei, University of Oklahoma (861-58-179)

8:30 a.m. (108) *Determinants on CR manifolds.* Preliminary report.
Terry Lohrenz, Wiess School of Natural Sciences, Rice University (861-58-196)

9:00 a.m. (109) *The orthogonal spectrum of a hyperbolic manifold.*
Ara Basmajian, University of Oklahoma (861-53-177)

9:30 a.m. (110) *Examples of symplectic structures on fiber bundles.* Preliminary report.
Brian Kasper, University of Texas, Austin (861-53-96)

10:00 a.m. (111) *The gradient flow for the Yang-Mills functional in two and three dimensions.*
Johan Råde, University of Texas, Austin (861-35-207)

10:30 a.m. (112) *Bifurcation analysis of the Eckhaus instability.*
Laurette S. Tuckerman, University of Texas, Austin (861-76-180) (Sponsored by Daniel S. Freed)

Special Session on Low Dimensional Topology, III

8:00 a.m.–10:50 a.m. Room 411, University Union Building

8:00 a.m. (113) *Links with trivial Alexander-Gassner matrices.* Preliminary report.
Tim D. Cochran, Rice University (861-57-59)

8:30 a.m. (114) *Torsion and the Casson-Gordon invariant.* Preliminary report.
Patrick M. Gilmer*, Louisiana State University, Baton Rouge, and **Charles Livingston**, Indiana University, Bloomington (861-57-60)

9:00 a.m. (115) *Homotopically ribbon concordance of fibered knots.*
Katura Miyazaki, University of California at San Diego, La Jolla (861-57-66)

9:30 a.m. (116) *Branched coverings of 3-manifolds and patterned surfaces.*
John Hempel, Rice University (861-57-69)

10:00 a.m. (117) *Contractible open manifolds which are not covering spaces.*
David G. Wright, Brigham Young University (861-57-71)

10:30 a.m. (118) *Examples of eventually end-irreducible 3-manifolds of nonfinite genus at infinity.*
Bobby Neal Winters, Pittsburg State University (861-57-11)

Special Session on Representation Theory of Lie Groups, III

8:00 a.m.–10:50 a.m. Gold Eagle Suite A, University Union Building

8:00 a.m. (119) *A comparison theorem for π-homology.*
Henryk Hecht* and **Joseph Taylor**, University of Utah (861-22-129)

8:30 a.m. (120) *Characteristic cycles of holomorphic discrete series.*
Jen-Tseh Chang, Oklahoma State University, Stillwater (861-22-52)

9:00 a.m. (121) *Local representations, analytic continuation, and integrability of Lie algebras of operators.*
Humberto E. Prado, Oklahoma State University, Stillwater (861-22-122)

9:30 a.m. (122) *Primary summand functions on 3-dimensional, compact solvmanifolds.*
Carolyn B. Pfeffer, Rutgers University, New Brunswick (861-22-123)

10:00 a.m. (123) *An explicit plancherel formula for exponential solvable Lie groups.*
Bradley N. Currey, Saint Louis University (861-22-55)

10:30 a.m. (124) *Global regularity on 3-dimensional solvmanifolds.*
Jacek M. Cygan* and **Leonard F. Richardson**, Louisiana State University, Baton Rouge (861-22-08)

Special Session on Differential Equations, III

8:00 a.m.–10:50 a.m. Silver Eagle Suite C, University Union Building

8:00 a.m. (125) *Existence theorems for second-order boundary value problems.*
Hans G. Kaper*, **Mariette Knapp** and **Man Kam Kwong**, Argonne National Laboratory (861-34-206)

8:30 a.m. (126) *Degenerate parabolic systems for a medium with micro-structure.*
R. E. Showalter*, University of Texas, Austin, and **N. J. Walkington**, Carnegie Mellon University (861-35-32)

9:00 a.m. (127) *Strain softening in viscoelasticity of the rate type.*
Athanassios E. Tzavaras, University of Wisconsin, Madison (861-35-119)

9:30 a.m. (128) *Bifurcation phenomena in a singular DAE detonation problem.*
W. Zhang and **I. Gladwell***, Southern Methodist University (861-34-47)

10:00 a.m. (129) *Reaction-diffusion systems from climate modeling.*
Georg Hetzer, Auburn University, Auburn (861-35-50)

10:30 a.m. (130) *Asymptotic solutions of Lotka-Volterra competition equations.*
Shair Ahmad, University of Texas, San Antonio (861-34-45)

Special Session on Algebraic Geometry, III

8:00 a.m.–10:50 a.m. Room 418, University Union Building

8:00 a.m. (131) *On desingularized Horrocks-Mumford quintics.*
Ciprian Borcea, Institute for Advanced Study (861-14-120)

8:30 a.m. (132) *Period relations for twisted Legendre equations.*
W. L. Hoyt, Rutgers University, New Brunswick (861-14-154)

9:00 a.m. (133) *Field of definition of the group of sections of elliptic surfaces.*
Masato Kuwata, University of British Columbia, (861-11-198)

9:30 a.m. (134) *The singularities of the parameter surface of a minimal elliptic threefolds.*
Antonella Grassi, Tufts University (861-14-197)

10:00 a.m. (135) *On a conjecture of Tyurin.*
Yun-Gang Ye, Duke University (861-14-212)

10:30 a.m. (136) *Adjunction for vector bundles.*
Qi Zhang, Johns Hopkins University, Baltimore (861-14-183)

Special Session on Arithmetic Groups, II

8:30 a.m.–10:50 a.m. Room 417, University Union Building

8:30 a.m. (137) *Cohomology of the symplectic group $SP_4(\mathbb{Z})$.*
Alan B. Brownstein, Rutgers University, Newark (861-11-43)

9:00 a.m. (138) *The "coadjoint" representation of $PSp_4(2)$.*
Ronnie Lee, Yale University, and **Steven H. Weintraub***, Louisiana State University, Baton Rouge (861-20-07)

9:30 a.m. (139) *A central series of Torelli groups and its relation to invariants of 3-manifolds.* Preliminary report.
Ronnie Lee, Yale University (861-55-218)

10:00 a.m. (140) *Commensurability of isospectral arithmetic hyperbolic 2 and 3 manifolds.* Preliminary report.
Alan W. Reid, Ohio State University, Columbus and University of Aberdeen, Scotland (861-11-116)

10:30 a.m. (141) *Short geodesics in arithmetic hyperbolic 3-manifolds.*
Alan W. Reid, Ohio State University, Columbus and University of Aberdeen, Scotland, and **Walter D. Neumann***, Ohio State University, Columbus (861-57-42)

Special Session on Banach Spaces-Functional Analysis, III

8:30 a.m.–10:50 a.m. Gold Eagle Suite B, University Union Building

8:30 a.m. (142) *A problem on spreading models.*
E. Odell, University of Texas, Austin (861-46-90)

9:00 a.m. (143) *A new approximation scheme for monotone operators on Banach spaces.* Preliminary report.
Simon Fitzpatrick, University of Auckland, New Zealand, and **R. R. Phelps***, University of Washington (861-46-78)

9:30 a.m. (144) *The Auerbach volume-ratio for finite-dimensional Banach spaces.* Preliminary report.
Haskell Rosenthal, University of Texas, Austin (861-46-82)

10:00 a.m. (145) *On unconditionally converging and weakly precompact operators.*
Elias Saab* and **Paulette Saab**, University of Missouri, Columbia (861-46-87)

10:30 a.m. (146) *On integral and strictly integral operators.*
Paulette Saab, University of Missouri, Columbia (861-46-86)

Saturday, November 3 (cont'd)

Special Session on Commutative Algebra, III

8:30 a.m.–10:50 a.m. Gold Eagle Suite C, University Union Building

8:30 a.m. (147) *On polynomial extensions of atomic domains.* Preliminary report.
Moshe Roitman, University of Haifa, Israel and University of North Carolina, Charlotte (861-13-220)

9:00 a.m. (148) *Infinite integral extensions and Cohen-Macaulay algebras.*
Melvin Hochster, University of Michigan, Ann Arbor, and **Craig Huneke***, Purdue University, West Lafayette (861-13-187)

9:30 a.m. (149) *Powers of ideals having small analytic deviation.*
Sam Huckaba*, Florida State University, and **Craig Huneke**, Purdue University, West Lafayette (861-13-208)

10:00 a.m. (150) *Uniform annihilation of local cohomology and of Koszul homology.*
K. N. Raghavan, Purdue University, West Lafayette (861-13-186)

10:30 a.m. (151) *Tight closure, joint reductions, and the Briançon-Skoda theorem.*
Irena Swanson, Purdue University, West Lafayette (861-13-194) (Sponsored by Scott T. Chapman)

Special Session on Several Complex Variables, II

8:30 a.m.–10:50 a.m. Room 413, University Union Building

8:30 a.m. (152) *Local analyticity for $\Box_b$ and the $\overline{\partial}$-Neumann problem for some weakly pseudo-convex domains.*
David S. Tartakoff, University of Illinois, Chicago (861-32-145)

9:00 a.m. (153) *Estimates for the Bergman metric.*
Jeffery McNeal, Princeton University (861-32-167)

9:30 a.m. (154) *L^2-solvability and boundary regularity of the $\overline{\partial}_b$-problem on some pseudoconvex CR-manifolds with boundary.*
Ricardo L. Diaz, Texas A & M University, College Station (861-32-173)

10:00 a.m. (155) *The Cauchy-Riemann equations in convex domains.*
John C. Polking, Rice University (861-32-203)

10:30 a.m. (156) *Sobolev estimates for the complex Green operator on a class of weakly pseudoconvex boundaries.* Preliminary report.
Harold P. Boas* and **Emil J. Straube**, Texas A & M University, College Station (861-32-133)

Special Session on The Probability Theory of Patterns and Runs, III

9:00 a.m.–10:50 a.m. Room 415, University Union Building

9:00 a.m. (157) *Distribution of balls into urns, where a specific number of urns contains a prescribed number of balls.*
S. G. Papastavridis, University of Patras, Greece (861-60-102) (Sponsored by Anant P. Godbole)

9:30 a.m. (158) *On reliabilities of certain large linearly connected engineering systems.*
James C. Fu, University of Manitoba (861-60-100) (Sponsored by Anant P. Godbole)

10:00 a.m. (159) *Consecutive k-out-of-n systems and some generalizations.*
William S. Griffith, University of Kentucky (861-60-109) (Sponsored by Anant P. Godbole)

10:30 a.m. (160) *Patterns and runs in probability theory.*
Anant P. Godbole, Michigan Technological University (861-60-106)

Session on Geometry

9:00 a.m.–10:30 a.m. Ponder Room, University Union Building

9:00 a.m. (161) *A new stability problem of ULAM.* Preliminary report.
John M. Rassias, American College of Greece (861-47-126)

9:20 a.m. (162) *Non-lattice packings and coverings with congruent copies of certain convex bodies.*
András Bezdek, Hungarian Academy of Science, Hungary, **Gábor Fejes Tóth**, Hungarian Academy of Sciences, Cornell University, and **Wlodzimierz Kuperberg***, Auburn University, Auburn (861-52-113)

9:40 a.m. (163) *Saturated packings and reduced coverings.*
Gábor Fejes Tóth*, Hungarian Academy of Sciences, Cornell University, and **Wlodzimierz Kuperberg**, Auburn University, Auburn (861-52-112)

10:00 a.m. (164) *Flat radon transforms.* Preliminary report.
Eric L. Grinberg, Temple University, Philadelphia (861-53-110)

10:20 a.m. (165) *A combinatorial unknot detector.*
Randall H. Weiss, Blackburn College (861-55-216)

Invited Address

11:00 a.m.–11:50 a.m. Lyceum Room, University Union Building

(166) *Galois representations attached to $GL(n, \mathbf{Z})$.*
Avner D. Ash, Ohio State University, Columbus (861-11-33)

Invited Address

1:30 p.m.–2:20 p.m. Lyceum Room, University Union Building

(167) *Combinatorics of intersecting surfaces in 3-manifolds.*
John E. Luecke, University of Texas, Austin (861-99-221)

Special Session on Arithmetic Groups, III

3:00 p.m.–4:50 p.m. Room 417, University Union Building

3:00 p.m. Informal Discussion

3:30 p.m. (168) *Examples of discrete subgroups of $SU(2,1)$.*
William M. Goldman, University of Maryland, College Park (861-57-41)

4:00 p.m. (169) *Compactifications of quotient spaces of $GL(n,R)$.*
Douglas Grenier, Johns Hopkins University (861-22-40)

4:30 p.m. (170) *Finite upper half planes.*
Audrey Terras, University of California at San Diego, La Jolla (861-11-85)

Special Session on Banach Spaces-Functional Analysis, IV

3:00 p.m.–5:20 p.m. Gold Eagle Suite B, University Union Building

3:00 p.m. (171) *Compacta in Banach spaces.* Preliminary report.
J. H. M. Whitfield, Lakehead University (861-46-79)

3:30 p.m. (172) *Pettis integrable functions as a.e. weak sequential limits of simple functions.*
Gunnar Stefansson, Pennsylvania State University, Altoona (861-46-75)

4:00 p.m. (173) *Spectral theory in Banach algebras related by a continuous homomorphism.* Preliminary report.
Timothy W. Randolph, University of Missouri, Rolla (861-47-76)

4:30 p.m. (174) *Isometric involutions on group algebras.* Preliminary report.
Paul Patterson, Saint Louis University (861-46-73)

5:00 p.m. (175) *Equicontinuous and relatively weakly compact subsets of the space of Bochner integrable functions $L_1(\mu, X)$.*
Mark Gruenwald*, University of Evansville, and **Georg Schlüchtermann**, Math. Institut der Universität München, Germany (861-46-72)

Special Session on Geometric Inequalities and Convex Bodies, IV

3:00 p.m.–5:50 p.m. Room 412, University Union Building

3:00 p.m. (176) *Harmonic maps with nontrivial higher dimensional singularities.* Preliminary report.
G. Liao*, University of Texas, Arlington, and **N. Smale**, University of Utah (861-58-10)

3:30 p.m. (177) *Instability of an equilibrium in a potential field.*
Steven D. Taliaferro, Texas A & M University, College Station (861-70-17)

4:00 p.m. (178) *Stability and bifurcation of constant mean curvature surfaces in a wedge.*
Thomas I. Vogel, Texas A & M University, College Station (861-53-19)

4:30 p.m. (179) *Differential and integral inequalities.*
S. Walter Wei, University of Oklahoma (861-53-18)

5:00 p.m. (180) *A note on the stability theorem of J. L. Barbosa and M. Do Carmo for closed surfaces of constant mean curvature.*
Henry C. Wente, University of Toledo (861-53-20)

5:30 p.m. (181) *Estimate on the singular set of heat-flow problem for harmonic maps.*
Xiaoxi Cheng, Rice University (861-58-29)

Special Session on Commutative Algebra, IV

3:00 p.m.–5:20 p.m. Gold Eagle Suite C, University Union Building

3:00 p.m. (182) *Power-generated valuations.* Preliminary report.
K. Alan Loper, Lawrence University (861-13-209)

3:30 p.m. (183) *Hilbert functions and local cohomology.*
Thomas Marley, University of Nebraska, Lincoln (861-13-172)

4:00 p.m. (184) *One-dimensional local rings of finite Cohen-Macaulay type.* Preliminary report.
Roger Wiegand, University of Nebraska, Lincoln (861-13-188)

4:30 p.m. (185) *Indecomposable modules over one-dimensional local rings.* Preliminary report.
Roger Wiegand and **Sylvia Wiegand***, University of Nebraska, Lincoln (861-13-189)

5:00 p.m. (186) *Weakly Krull domains and the t-class groups.* Preliminary report.
D. D. Anderson, University of Iowa, **E. G. Houston**, University of North Carolina, Charlotte, and **M. Zafrullah***, Winthrop College (861-13-210)

Saturday, November 3 (cont'd)

Special Session on Texas Topology and Geometry, IV

3:00 p.m.–5:50 p.m. Room 410, University Union Building

3:00 p.m. (187) *The Denjoy problem in two dimensions.* Preliminary report.
Alec Norton, University of Texas, Austin (861-58-31)

3:30 p.m. (188) *Topological properties of some attractors for cylinder maps.* Preliminary report.
R. Daniel Mauldin, University of North Texas (861-54-98)

4:00 p.m. (189) *Lattice invariants for sofic shifts.*
Susan G. Williams, University of South Alabama (861-54-144)

4:30 p.m. (190) *The p-Yang-Mills equations.* Preliminary report.
Thomas Otway* and **Karen Uhlenbeck**, University of Texas, Austin (861-35-97)

5:00 p.m. (191) *Growth rates and knots.*
Daniel S. Silver, University of South Alabama (861-57-143)

5:30 p.m. (192) *The observation of saddle periodic orbits in physical systems.* Preliminary report.
Daniel P. Lathrop, University of Texas, Austin (861-70-148) (Sponsored by Robert F. Williams)

Special Session on Low Dimensional Topology, IV

3:00 p.m.–5:50 p.m. Room 411, University Union Building

3:00 p.m. (193) *Progress on the homotopy implies isotopy conjecture of laminated 3-manifolds.*
Will Kazez*, University of Georgia, and **Dave Gabai**, California Institute of Technology (861-57-200)

3:30 p.m. (194) *Knots yielding lens spaces.*
John Berge, University of Texas, Austin (861-57-199)

4:00 p.m. (195) *Dehn surgery and spherical space forms.* Preliminary report.
Steven A. Bleiler*, Portland State University, and **Craig Hodgson**, Columbia University (861-57-62)

4:30 p.m. (196) *The calculus of curves immersed in surfaces.*
J. Scott Carter, University of South Alabama (861-57-201)

5:00 p.m. (197) *The Reidemeister and Markov theorems in 3-manifolds.*
Paul Sundheim, University of Texas, Austin (861-57-61)

5:30 p.m. (198) *The cohopficity problem for 3-manifold groups.* Preliminary report.
F. González-Acuña, Universidad Nacional Autonoma de Mexico, and **Wilbur Whitten***, Louisiana State University, Baton Rouge (861-57-65)

Special Session on Representation Theory of Lie Groups, IV

3:00 p.m.–6:20 p.m. Gold Eagle Suite A, University Union Building

3:00 p.m. (199) *Invariant forms for subs and quotients of principal series.* Preliminary report.
Ray A. Kunze, University of Georgia (861-22-158)

3:30 p.m. (200) *Explicit realizations of unitarizable exceptional representations of real rank one semi-simple Lie groups.*
John E. Gilbert*, University of Texas, Austin, and **Christopher Meaney**, Australian National University, Australia (861-22-136)

4:00 p.m. (201) *Szegö mappings into representations in cohomology.* Preliminary report.
Leticia Barchini* and **A. W. Knapp**, State University of New York, Stony Brook (861-22-161) (Sponsored by Lisa Mantini)

4:30 p.m. (202) *K-bi-finite and $\mathbb{Z}(\mathfrak{g})$-finite functions.* Preliminary report.
Jing-Song Huang, University of Utah (861-22-54)

5:00 p.m. (203) *Completely prime primitive ideals and quantization.* Preliminary report.
William McGovern, University of Washington (861-17-121)

5:30 p.m. (204) *Vogan's problem #3 and Enright-Shelton theory.* Preliminary report.
Brian D. Boe*, University of Georgia, and **David H. Collingwood**, University of Washington (861-22-132)

6:00 p.m. Informal Discussion

Special Session on Differential Equations, IV

3:00 p.m.–6:20 p.m. Silver Eagle Suite C, University Union Building

3:00 p.m. (205) *Flow in fractured porous media.*
Jim Douglas, Jr., Purdue University, West Lafayette (861-76-51)

3:30 p.m. (206) *An efficient Runge-Kutta (4, 5) pair.*
P. Bogacki, Old Dominion University, and **L. F. Shampine***, Southern Methodist University (861-34-44)

4:00 p.m. (207) *Continuity of sets of optimal estimators for an output least squares estimation problem.*
Luther White, University of Oklahoma (861-35-168) (Sponsored by Henry A. Warchall)

4:30 p.m. (208) *Geometric algorithms for developable surfaces.*
G. J. Fix, University of Texas, Arlington (861-53-175)

5:00 p.m. (209) *Stefan problem with convection.*
John R. Cannon, Lamar University (861-35-48)

5:30 p.m. (210) *Vector valued test functions and elliptic systems.* Preliminary report.
Ruediger Landes, University of Oklahoma (861-35-131)

6:00 p.m. (211) *Study of a class of singular boundary value problems arising in heat transfer.*
R. Kannan, University of Texas, Arlington (861-34-217)

Special Session on Algebraic Geometry, IV

3:00 p.m.–5:20 p.m. Room 418, University Union Building

3:00 p.m. (212) *Spaces of rational functions on curves over finite fields.*
Stephen A. DiPippo, Brigham Young University (861-14-174)

3:30 p.m. (213) *Embeddings of rational surfaces as Cohen-Macaulay varieties.*
A. V. Geramita, Queen's University, **A. Gimigliano**, Universitá di Genova, Italy, and **B. Harbourne***, University of Nebraska, Lincoln (861-14-159)

4:00 p.m. (214) *The arithmetic of the Jacobian of a Fermat curve.* Preliminary report.
William G. McCallum, University of Arizona (861-14-171)

4:30 p.m. (215) *Elliptic surfaces.*
Peter F. Stiller, Texas A & M University, College Station (861-14-195)

5:00 p.m. Informal Discussion

Special Session on Several Complex Variables, III

3:00 p.m.–5:20 p.m. Room 413, University Union Building

3:00 p.m. (216) *Zeroes of the Szegő kernel function.* Preliminary report.
Steve Bell, Purdue University, West Lafayette (861-32-37)

3:30 p.m. (217) *Characterizations of the unit ball and circular domains in C^n.*
So-Chin Chen, State University of New York, Albany (861-32-35)

4:00 p.m. (218) *Proper holomorphic mappings between domains in different dimensions.*
Stephen A. Chiappari, University of Illinois, Urbana-Champaign (861-32-09)

4:30 p.m. (219) *Fatou-Bieberbach domains.*
John Erik Fornaess, Princeton University (861-32-146)

5:00 p.m. (220) *Complex structures on the tangent bundle of a Riemann manifold.*
László Lempert*, Purdue University, West Lafayette, and **Róbert Szöke**, University of Notre Dame (861-32-36)

Andy Roy Magid
Associate Secretary
Norman, Oklahoma

Presenters of Papers

Numbers following the names indicate the speakers' positions on the program.
• AMS Invited Lecturer
* AMS Special Session Speaker

* Adolphson, A., 78
* Agin, M. A., 67
* Ahlbrandt, C. D., 100
* Ahmad, S., 130
* Albert, J. P., 97
* Alspach, D. E., 16
* Aluffi, P., 79
* Anderson, D. D., 58
* Anderson, D. F., 59
* Andrews, K. T., 17
• Ash, A. D., 166
* Bakelman, I. J., 1
* Barchini, L., 201
* Barrett, D. E., 85
* Basmajian, A., 109
* Bator, E. M., 18
* Bauman, P., 2
* Beatrous, F., 89
* Beem, J. K., 51
* Bell, S., 216
* Berge, J., 194
* Binegar, B. T., 34
* Bleiler, S. A., 195
* Boas, H. P., 156
* Boe, B. D., 204
* Borcea, C., 131
* Boyer, C. P., 27
* Brick, S. G., 31

Irvine, California
University of California, Irvine
November 10 – 11

Program

The eight-hundred-and-sixty-second meeting of the American Mathematical Society will be held at the University of California, Irvine (UCI) campus at Campus Blvd in Irvine, California on Saturday, November 10, and Sunday, November 11, 1990. All Special Sessions and sessions for contributed papers will be held in the Physical Sciences complex: Physical Sciences I or II, the Physical Sciences Lecture Hall or the Physical Sciences Lecture Facility. This meeting will be held in conjunction with a meeting of the Southern California Section of the Mathematical Association of America (MAA).

Invited Addresses

By invitation of the Western Section Program Committee, there will be three invited one-hour addresses. The speakers, their affiliations, and the titles of their talks are:

JENNIFER T. CHAYES, University of California, Los Angeles, *Nature of the critical phenomenon in self-organized criticality*, 11:00 a.m. Sunday

MICHAEL D. FRIED, University of California, Irvine, *Parameter spaces in the inverse Galois problem*, 11:00 a.m. Saturday

NICHOLAS J. KOREVAAR, University of Utah, *Constant mean curvature surfaces*, 2:00 p.m. Sunday

Special Sessions

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

Probability theory in mathematical physics, JENNIFER T. CHAYES, and GLEN H. SWINDLE, University of California, Los Angeles.

Interactions between group theory and logic, PAUL C. EKLOF, University of California, Irvine.

Interactions between group theory and geometry/number theory, MICHAEL D. FRIED and ROBERT M. GURALNICK, University of California, Irvine.

Moduli space applications, MICHAEL D. FRIED and DAVID HARBATER, University of California, Irvine.

Quantum and statistical mechanics, ABEL KLEIN, University of California, Irvine.

Geometric p.d.e.'s: mean and scalar curvature problems, NICHOLAS J. KOREVAAR and ANDREJS E. TREIBERGS, University of Utah.

Operator theory/operator algebras, BERNARD RUSSO, University of California, Irvine.

Abstracts for consideration for these sessions should have been submitted by the **July 16, 1990** deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited Speakers and Special Sessions section of *Notices*.

Contributed Papers

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

Registration

The meeting registration desk will be located in the lobby of the Physical Sciences II building, near Parking Lot 12, and will be open from 8:00 a.m. to 4:00 p.m. on Saturday, and 8:00 a.m. to noon on Sunday. The registration fees are $30 for members of the AMS, $45 for nonmembers, and $10 for students or unemployed mathematicians. There is a special one-day fee of $15 for MAA members on Saturday only.

Activities of Other Organizations

The Mathematical Association of America will meet on Saturday, November 10. JOHN DE PILLIS, University of California, Riverside, and K. BROOKS REID, Louisiana State University, Baton Rouge, will give invited addresses. HARVEY KEYNES, University of Minnesota, Minneapolis, will be the luncheon speaker. The National Year of Dialogue declared by the Mathematical Sciences Education Board will provide a central theme for this meeting, and there will be a panel discussion and

small discussion groups to consider important aspects of mathematics education reform. There will also be two contributed paper sessions titled *Mathematical notes* and *The teaching of mathematics.*

Social Event

There will be a joint luncheon for AMS and MAA participants on Saturday, November 10, on the university campus. Harvey Keynes will speak on the question "Can mathematicians be involved in education and still survive in the profession?". Advance purchase of luncheon tickets is encouraged, as there will be limited seating. Contact Dan Kalman, Mail Stop M1/102, The Aerospace Corporation, P.O. Box 92957, Los Angeles, CA 90009-2957; phone 213-336-6128; email kalman@aerospace.aero.org. On Saturday night, various Special Session organizers have been encouraged to arrange a dinner of Special Session attendees and speakers. Participants are encouraged to ask any Special Session organizer about this event.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the announcement of the Columbus meetings in the April 1990 issue of *Notices.*

Accommodations

Unfortunately, there is no housing available on the campus during the year; however, four of the hotels do offer shuttle service to UCI. Some hotels offer shuttle service to and from Orange County Airport (on MacArthur Boulevard) and taxi service is available from each hotel to the UCI campus. Participants should be sure to mention the UCI when making reservations to obtain the special rate. The AMS is not responsible for rate changes or the quality of the accommodations offered by these hotels/motels.

The following hotels offer shuttle service to UCI.

Sheraton Newport Beach
4545 MacArthur Boulevard
Newport Beach, CA 92660
Telephone: 714-833-0570

Single or Double $65

The Irvine Hilton and Towers
17900 Jamboree Boulevard
Irvine, CA 92714
Telephone: 714-863-3111

Single or Double $68

Marriott Suites Newport Beach
500 Bayview Circle
Newport Beach, CA 92660
Telephone: 714-854-4500

Single or Double $79

The following hotels are within walking distance or require taxi service to UCI.

The Airporter Inn Hotel
18700 MacArthur Boulevard
Irvine, CA 92715
Telephone: 714-833-2770 or 800-432-7018 (in California) or 800-854-3012 (outside California)

Single or double $49

Participants are urged to make reservations at this hotel as soon as possible to insure the above rate. Taxi service to campus is approximately $6.50.

Comfort Suites
2620 Hotel Terrace Drive
Santa Ana, CA 92705
Telephone: 714-966-5200

Single, per suite $49
Double, per suite $54

Taxi service to campus is approximately $10.

Country-Side Inn
325 Bristol Street
P.O. Box 10117
Newport Beach, CA 92658-0117
Telephone: 714-549-0300

Single $55 Double $60

Taxi service to campus is approximately $10.

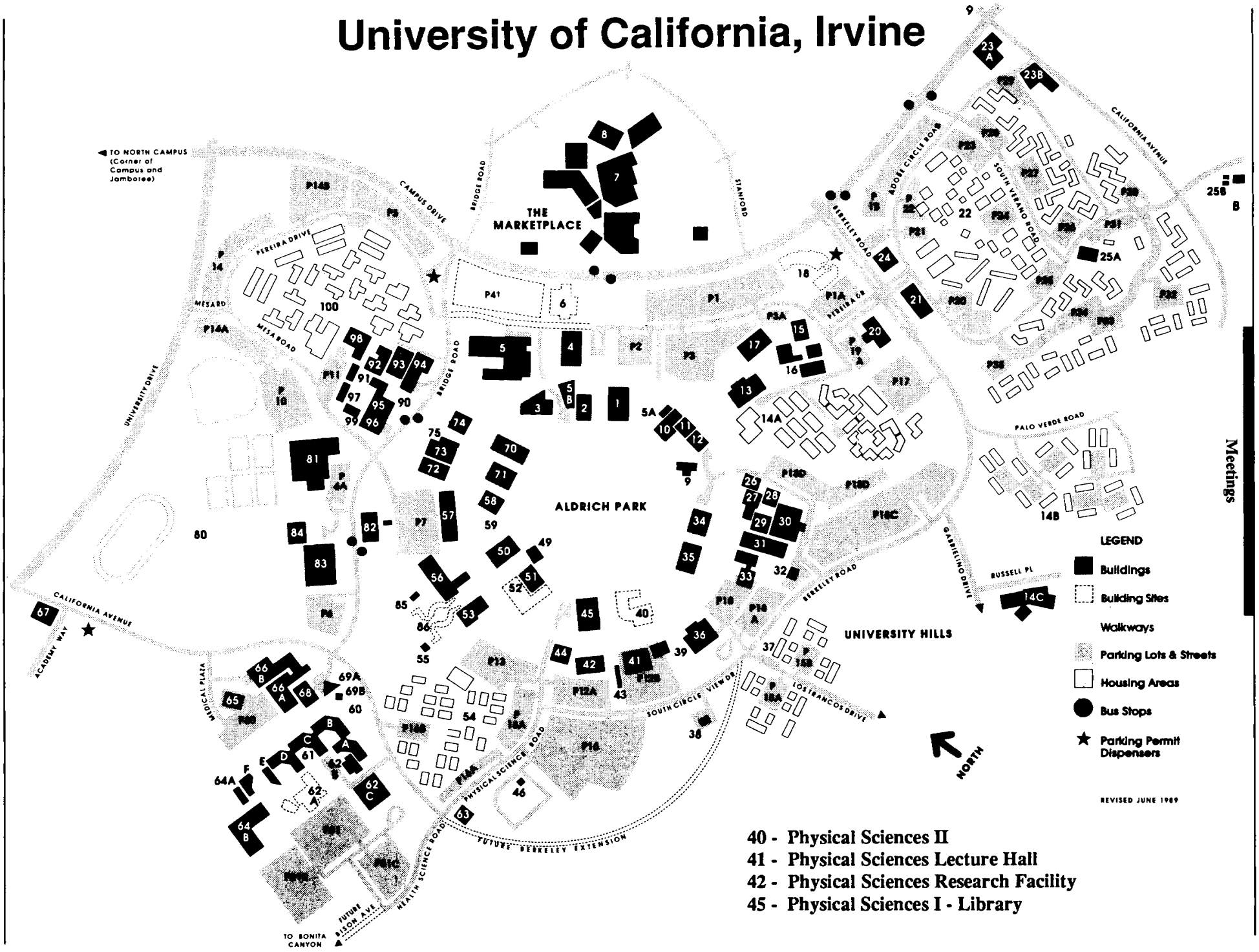
Radisson Plaza Hotel Orange County Airport
18800 MacArthur Boulevard
Irvine, CA 92715
Telephone: 714-833-9999

Single or Double $70

Taxi service to campus is approximately $6.50.

Food Service

On the UCI campus, lunch will be available at Joe's on the Green, which serves hefty sandwiches, and many flavors of pizza, pasta, beer, wine, etc. It will be open especially for the conference, and service is expected to be excellent. For more formal dining, the Market Place across from Campus Boulevard has wonderful shops and at least four restaurants, one of them serving Chinese food.


University of California, Irvine
TO NORTH CAMPUS (Corner of Campus and Jamboree)
THE MARKETPLACE
ALDRICH PARK
UNIVERSITY HILLS
CAMPUS DRIVE
BRIDGE ROAD
STANFORD
PEREIRA DRIVE
MESA RD
MESA ROAD
UNIVERSITY DRIVE
CALIFORNIA AVENUE
ACADEMY WAY
MEDICAL PLAZA
SOUTH CIRCLE VIEW DR
PHYSICAL SCIENCE ROAD
HEALTH SCIENCE ROAD
FUTURE BERKELEY EXTENSION
FUTURE BISON AVE.
TO BONITA CANYON
ADOBE CIRCLE ROAD
BERKELEY ROAD
SOUTH VERANO ROAD
PEREIRA DR
PALO VERDE ROAD
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REVISED JUNE 1989
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45 - Physical Sciences I - Library

Travel

There are two convenient airports to the conference: Los Angeles International Airport (LAX) and Orange County Airport (OCA)) also known as the **John Wayne Airport**. Shuttle service is available to UCI or to any of the hotels from OCA. There is also a convenient shuttle or bus service from LAX to OCA. Participants driving to the the campus from the airport or the Los Angeles area should use the following directions:

LAX to MacArthur Boulevard: When leaving LAX, take the Sepulveda exit. Stay in the right lane on Sepulveda until you see a sign that says **405 South**. Turn right at that corner and then immediately get in the left lane for the marker indicating the entrance to the freeway. After merging into the freeway traffic, drive (for approximately 45 minutes) until you see the exit across from OCA. The streets for Irvine include MacArthur Blvd, Jamboree, and Culver. Turn left on **MacArthur Blvd**, heading for the beach. Drive approximately five minutes past Jamboree and under a viaduct, to **University Ave** exit. At that point, you will see a sign for UCI; turn right and drive down the long exit ramp to the bottom of the hill. Turn right and enter the campus on the first street, **California Street**. Follow the signs to the parking Kiosk, the Sciences Complex and Parking Lot 12.

DRIVING FROM THE SAN DIEGO AREA: Santa Ana Freeway (5) North to the San Diego Freeway (405) North. Exit at Jamboree Road and turn left. Continue to Campus Drive and turn left. Continue on Campus Drive to Bridge Road and turn right. Continue on Bridge Road to California Avenune and turn left. Folllow California Ave to Physical Sciences Road and turn left. Turn right on to South Circle View Drive. The Physical Sciences Plaza is on the left side of South Circle View Drive.

DRIVING FROM THE RIVERSIDE AREA: Riverside Freeway (91) West to the Newport Freeway (55) South to the San Diego Freeway (405) South. Exit at Jamboree Road and turn right. Continue to Campus Drive and turn left. Continue on Campus Drive to Bridge Road and turn right. Continue on Bridge Road to California Avenue and make a left turn. Follow California Avenue to Physical Sciences Road nad turn left. Turn right on to South Circle View Drive. The Physical Sciences Plaza is on the left.

Participants should park in lots 12A, 12B, or 16 (**DO NOT PARK IN RESERVED SPACES**).

Parking

The UCI Physical Sciences Complex is located near a collection of large parking lots on Circle Drive. Principal among these is Parking Lot 12. There is no parking fee on Sunday. Kiosks for the parking stickers for Saturday are located at all three large entrance streets (California, Bridge, and Berkeley) to the university. Parking stickers are $4 for all day and $3 for half a day.

Weather and Local Attractions

The famous Southern California weather is characterized by warm breezes during the day—dare we say balmy—followed by cool exotic nights. Even in November, one can expect comfortable temperatures (75°F in the afternoon, 65°F in the evening). It is as advertised. The local attractions are of the nature of amusement park type: the renowned beaches (especially Main beach in Laguna Beach), the marsh lands tour on UCI campus, Disneyland, and Knotts Berry Farm (only 15 minutes from the campus). A special tour of the marsh lands has been arranged for Saturday, November 10, at 10:00 a.m. For the serious shopper, *Fashion Island* is the place to go. It is the closest thing in the UCI area to Rodeo Drive and it is much prettier. Finally, the search for quintissential Southern California ends at Balboa Island. This combines fantastic dining and viewing on an inlet.

Program of the Sessions

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

Abstracts of papers presented in the sessions at this meeting will be found in the October 1990 issue of *Abstracts of papers presented to the American Mathematical Society*, ordered according to the numbers in parentheses following the listings below.

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

Saturday, November 10

Special Session on Interactions Between Group Theory and Geometry/Number Theory, I

8:00 a.m.–10:50 a.m. Room 108, Physical Sciences I

8:00 a.m. (1) *p-Algebras over maximally complete fields.* Preliminary report.
Bill Jacob, University of California, Santa Barbara (862-16-22)

8:30 a.m. (2) *K-admissibility of A_6 and A_7.* Preliminary report.
Murray Schacher, University of California, Los Angeles (862-12-23)

9:00 a.m. (3) *Maximal subfields of division algebras over rational function fields.* Preliminary report.
Burton Fein, Oregon State University (862-12-19)

9:30 a.m. (4) *The genus zero problem for M_{24}.*
Geoffrey Mason, University of California, Santa Cruz (862-20-34)

10:00 a.m. (5) *On multiplication by n in the Jacobians of hyperelliptic curves.* Preliminary report.
David G. Cantor, University of California, Los Angeles (862-20-49)

10:30 a.m. (6) *Solvable algebras and weight vectors for group geometries.* Preliminary report.
Stephen D. Smith, University of Illinois, Chicago (862-20-25)

Special Session on Operator Theory/Operator Algebras, I

8:00 a.m.–10:50 a.m. Room 114, Physical Sciences I

8:00 a.m. (7) *A Hankel matrix approach to truncated moment problems.*
Raul E. Curto, University of Iowa (862-47-57)

8:30 a.m. (8) *Function algebras on Riemann surfaces and their representations: Induction and dilation.*
Palle E. T. Jørgensen, University of Iowa (862-46-89)

9:00 a.m. (9) *M-ideals and quotients of subdiagonal algebras.*
Yiu Tung Poon, Iowa State University, and **Zhong-Jin Ruan***, University of Illinois, Urbana-Champaign (862-47-55)

9:30 a.m. (10) *The structure of twisted SU(3) groups.*
Albert Jeu-Liang Sheu, University of Kansas (862-46-27)

10:00 a.m. (11) *Properties of the Haagerup tensor product.*
Roger R. Smith, Texas A & M University, College Station (862-46-01)

10:30 a.m. (12) *A Riesz decomposition property and its consequences.*
Shuang Zhang, University of Cincinnati (862-46-06)

Special Session on Probability Theory in Mathematical Physics, I

8:30 a.m.–10:50 a.m. Room 230, Physical Sciences Classroom Facility

8:30 a.m. (13) *Forest fires with regrowth in $D = 2$.*
C. Neuhauser*, University of Southern California, and **R. Durrett**, Cornell University (862-60-44)

9:00 a.m. (14) *Hydrodynamics for totally asymmetric attractive particle system with general initial profiles.*
Jean-Pierre Fouque, University of California, Irvine (862-60-40) (Sponsored by Glen H. Swindle)

9:30 a.m. (15) *Mathematical models of catalytic surfaces.*
Eric Grannan*, AT&T Bell Laboratories, Murray Hill, New Jersey, and **Glen Swindle**, University of California, Santa Barbara (862-60-41)

10:00 a.m. (16) *The contact process in a random environment.*
Thomas M. Liggett, University of California, Los Angeles (862-60-47)

10:30 a.m. (17) *Droplet model for autocorrelation functions in an Ising ferromagnet.*
C. Tang*, **H. Nakanishi** and **J. S. Langer**, University of California, Santa Barbara (862-60-43) (Sponsored by Glen H. Swindle)

Saturday, November 10 (cont'd)

Special Session on Interactions Between Group Theory and Logic, I

9:00 a.m.–10:50 a.m. Room 210, Physical Sciences Classroom Facility

9:00 a.m. (18) *On a class of abelian p-groups.*
Manfred Dugas*, Baylor University, and **John Irwin**, Wayne State University (862-20-70)

9:30 a.m. (19) *Infinite rank Butler groups, III.*
K. M. Rangaswamy, University of Colorado, Colorado Springs (862-20-10)

10:00 a.m. (20) *A class of groups characterized by their socles.* Preliminary report.
Patrick Keef, Whitman College (862-20-83) (Sponsored by Paul C. Eklof)

10:30 a.m. (21) *Superstable differential fields.* Preliminary report.
Željko Sokolović, University of Notre Dame (862-03-74)

Special Session on Geometric P.D.E.'s: Mean and Scalar Curvature Problems, I

9:00 a.m.–10:50 a.m. Room 158, Physical Sciences I

9:00 a.m. (22) *Harmonic maps on noncompact manifolds.* Preliminary report.
Peter Li, University of Arizona, and **Luen-Fai Tam***, University of California, Irvine (862-53-52)

9:40 a.m. (23) *Mean curvature evolution and front movement for the bistable equation.* Preliminary report.
L. C. Evans, University of California, Berkeley (862-35-86)

10:20 a.m. (24) *Curvature-dependent motion of curves and surfaces.* Preliminary report.
J. A. Sethian, University of California, Berkeley (862-35-33)

Invited Address

11:00 a.m.–11:50 a.m. Physical Sciences Lecture Hall

(25) *Parameter spaces in the inverse Galois problem.*
Michael D. Fried, University of California, Irvine (862-12-12)

Special Session on Interactions Between Group Theory and Logic, II

2:00 p.m.–4:30 p.m. Room 210, Physical Sciences Classroom Facility

2:00 p.m. (26) *Involutions in groups of finite Morley rank.* Preliminary report.
Alexandre Borovik, Omsk University, USSR and University of California, Irvine (862-20-09) (Sponsored by Paul C. Eklof)

2:30 p.m. (27) *Model theory of Lie algebras.* Preliminary report.
Richard Rosengarden, Rutgers University, New Brunswick (862-03-77) (Sponsored by Paul C. Eklof)

3:00 p.m. (28) *The cohomological dimension of locally finite groups.* Preliminary report.
Peter Kropholler, Queen Mary College, England, and **Simon Thomas***, Rutgers University, New Brunswick (862-20-96)

3:30 p.m. (29) *Arities of finite permutation groups.* Preliminary report.
Gary A. Martin*, Southeastern Massachusetts University, and **Gregory Cherlin**, Rutgers University, New Brunswick (862-20-59)

4:00 p.m. Discussion

Special Session on Interactions Between Group Theory and Geometry/Number Theory, II

2:00 p.m.–3:20 p.m. Room 108, Physical Sciences I

2:00 p.m. (30) *Fixedpoint ratios for finite groups.*
Michael Aschbacher, California Institute of Technology (862-20-60)

2:30 p.m. (31) *Extensions of simple modules for* $SL_3(2^n)$, $SU_3(2^n)$, $Sp_4(2^n)$ *and* $Sz(2^m)$.
Peter Sin, University of Florida (862-20-48) (Sponsored by Michael D. Fried)

3:00 p.m. (32) *Some examples of infinite Frobenius groups.*
Michael J. Collins, California Institute of Technology (862-20-30) (Sponsored by Michael D. Fried)

Special Session on Quantum and Statistical Mechanics, I

2:00 p.m.–5:00 p.m. Room 230, Physical Sciences Classroom Facility

2:00 p.m. (33) *Droplet shape, droplet condensation and large deviation estimates.*
Senya Shlosman, Academy of Science of the USSR (862-82-66) (Sponsored by Abel Klein)

2:30 p.m. (34) *Effects of static disorder in statistical mechanics.*
Jan Wehr, Institute for Advanced Study (862-82-68)

3:00 p.m. (35) *One dimensional Anderson models in the weak disorder limit.*
Athanasios Speis, University of Michigan (862-81-67) (Sponsored by Abel Klein)

3:30 p.m. (36) *Orstein-Zernike decay in the ground state of the Ising model in a strong transverse field.*
Tom Kennedy, University of Arizona (862-82-73) (Sponsored by Abel Klein)

4:00 p.m. (37) *Quantum spin systems with disorder.*
Abel Klein, University of California, Irvine (862-82-63)

4:30 p.m. Discussion

Special Session on Operator Theory/Operator Algebras, II

2:00 p.m.–5:50 p.m. Room 114, Physical Sciences I

2:00 p.m. (38) *Facial structure in operator algebra theory.*
Charles A. Akemann*, University of California, Santa Barbara, and **Gert K. Pedersen**, Matematisk Institut, Denmark (862-46-05)

2:30 p.m. (39) *C^*-algebras associated with sets of semigroups of isometries.*
William Arveson, University of California, Berkeley (862-46-91)

3:00 p.m. (40) *Projective tensor products for operator spaces and non-commutative coactions.*
Edward Effros*, University of California, Los Angeles, and **Zhong-Jin Ruan**, University of Illinois, Urbana-Champaign (862-46-93)

3:30 p.m. (41) *A dense set of operators with tiny commutants.*
Domingo A. Herrero, Arizona State University (862-47-03)

4:00 p.m. (42) *The derived tower of certain type III_λ inclusions of index 4.*
Phan H. Loi, University of California, Los Angeles (862-46-04) (Sponsored by David R. Pitts)

4:30 p.m. (43) *C^*-algebras generated by the elements of a unitary matrix.*
Kevin P. McClanahan, University of California, Los Angeles (862-46-90)

5:00 p.m. (44) *Almost multiplicative maps between operator algebras.*
Barry E. Johnson, University of Newcastle Upon Tyne, England (862-46-87) (Sponsored by Bernard Russo)

5:30 p.m. (45) *Cohomology for operator algebras.* Preliminary report.
Frank L. Gilfeather, University of New Mexico (862-47-100)

Special Session on Geometric P.D.E.'s: Mean and Scalar Curvature Problems, II

2:00 p.m.–4:30 p.m. Room 158, Physical Sciences I

2:00 p.m. (46) *Recent results on scalar curvature.* Preliminary report.
R. Schoen, Stanford University (862-53-50)

2:40 p.m. (47) *Higher order conformal invariants on $\mathbf{S}^n$.* Preliminary report.
Sun-Yung A. Chang, University of California, Los Angeles (862-53-85)

3:20 p.m. (48) *The singular Yamabe problem on the sphere.* Preliminary report.
Rafe Mazzeo*, Stanford University, and **Nat Smale**, University of Utah (862-53-51)

4:00 p.m. (49) *Gaussian curvature on $\mathbf{S}^2$—rotationally symmetric case.* Preliminary report.
Xingwang Xu, University of California, Los Angeles (862-53-81) (Sponsored by Andrejs E. Treibergs)

Special Session on Moduli Space Applications, I

3:30 p.m.–6:20 p.m. Room 108, Physical Sciences I

3:30 p.m. (50) *Extensions of number fields arising from branched coverings.*
Sybilla Beckmann, University of Georgia (862-14-17)

4:00 p.m. (51) *Universal Cayley-Hamilton algebras.* Preliminary report.
Zinovy Reichstein, Mathematical Sciences Research Institute, Berkeley (862-14-101) (Sponsored by David Harbater)

4:30 p.m. (52) *Canonical bundle and deformations.* Preliminary report.
Ziv Ran, University of California, Riverside (862-14-35) (Sponsored by David Harbater)

5:00 p.m. (53) *Vanishing theorems and the equations defining projective varieties.*
Robert Lazarsfeld, University of California, Los Angeles (862-14-28)

5:30 p.m. (54) *Curves as Hurwitz spaces.* Preliminary report.
David Harbater, University of Pennsylvania (862-14-15)

6:00 p.m. (55) *Singular hyperbolic structures.* Preliminary report.
Steve Kerckhoff, Stanford University (862-58-16)

Sunday, November 11

Special Session on Interactions Between Group Theory and Geometry/Number Theory, III

8:00 a.m.–10:50 a.m. Room 108, Physical Sciences I

8:00 a.m. (56) *Planar difference sets and multipliers.* Preliminary report.
Chat Y. Ho, University of Florida (862-20-53)

8:30 a.m. (57) *On monodromy groups of fixed genus.*
Michael G. Neubauer, University of Texas, Austin (862-20-56) (Sponsored by Michael D. Fried)

9:00 a.m. (58) *Central extensions as Galois groups.*
H. Völklein, University of Florida (862-11-21) (Sponsored by Michael D. Fried)

9:30 a.m. (59) *Disconnected groups of Lie type as Galois groups.*
Gunter Malle, IWR, Federal Republic of Germany (862-20-20) (Sponsored by Michael D. Fried)

Sunday, November 11 (cont'd)

10:00 a.m. (60) *Algebraic fundamental groups.*
Shreeram S. Abhyankar, Purdue University, West Lafayette (862-14-18)

10:30 a.m. (61) *Kloosterman sums for Chevalley groups.* Preliminary report.
Romuald Dabrowski, Indiana University, Bloomington (862-20-24)

Special Session on Operator Theory/Operator Algebras, III

8:00 a.m.–10:50 a.m. Room 114, Physical Sciences I

8:00 a.m. (62) *Surjective isometries of real C^*-algebras.*
Cho-Ho Chu, University of London, England, **Truong Dang***, Irvine, CA, **Bernard Russo**, University of California, Irvine, and **Belisario Ventura**, California State University, San Bernardino (862-46-92)

8:30 a.m. (63) *How many exponentials?* Preliminary report.
N. Christopher Phillips, University of Oregon (862-46-02)

9:00 a.m. (64) *Analyticity in triangular UHF algebras.* Preliminary report.
Baruch Solel, University of Haifa, Israel, and **Belisario A. Ventura***, California State University, San Bernardino (862-46-88)

9:30 a.m. (65) *Triangular AF algebras.*
Alan Hopenwasser, University of Alabama, Tuscaloosa (862-47-08)

10:00 a.m. (66) *Duality and harmonic analysis for groups, hypergroups, and groupoids.* Preliminary report.
Martin E. Walter, University of Colorado, Boulder (862-43-97)

10:30 a.m. (67) *Geometric characterization of $B(H, K)$.*
Yaakov Friedman, Jerusalem College of Technology, Israel, and **Bernard Russo***, University of California, Irvine (862-46-94)

General Session

8:00 a.m.–10:50 a.m. Room 240, Physical Sciences I

8:00 a.m. (68) *Generalized integral Iwasawa and Bruhat-Steinberg decompositions for semisimple groups.*
Yevsey Nisnevich, Johns Hopkins University (862-11-58)

8:20 a.m. (69) *On differential algebraic groups.* Preliminary report.
Anand Pillay and **Željko Sokolović***, University of Notre Dame (862-03-62)

8:40 a.m. (70) *Certain Todd-Coxeter approximations and universal covers of 3-manifolds.*
John R. Stallings, University of California, Berkeley (862-20-11)

9:00 a.m. (71) *Counting subgroups of given index and orbit structure in free groups.*
Reinhard O. W. Franz, University of Bielefeld, Federal Republic of Germany (862-20-79)

9:20 a.m. (72) *Generalized translational spaces.*
C. R. Giardina, City College, City University of New York (862-94-69)

9:40 a.m. (73) *Conditioning infinitely monotone capacities.*
Carl G. Wagner, University of Tennessee, Knoxville (862-60-07) (Sponsored by Balram S. Rajput)

10:00 a.m. (74) *Transient solutions of the $M/M/1$ queueing system using Taylor series.*
Alan Krinik, California Polytechnic State University (862-60-54)

10:20 a.m. (75) *A f-distance property of d-symbol aperiodic sequences arising from a cut-and-project method.*
Ramin Vakilian, University of California, Davis (862-82-71)

10:40 a.m. (76) *Information, complexity and meaning*
Ben Goertzel, University of Nevada, Las Vegas (862-68-95) (Sponsored by Peter Shiue)

Special Session on Geometric P.D.E.'s: Mean and Scalar Curvature Problems, III

8:30 a.m.–10:50 a.m. Room 158, Physical Sciences I

8:30 a.m. Discussion

9:00 a.m. (77) *Minimal submanifolds with isolated singularities.* Preliminary report.
N. Smale, University of Utah (862-35-80)

9:40 a.m. (78) *Conformal deformation of metrics to constant mean curvature.*
José F. Escobar, Indiana University, Bloomington (862-53-98)

10:20 a.m. (79) *Existence of the general constant mean curvature torus.* Preliminary report.
N. Ercolani*, University of Arizona, **H. Knorrer** and **E. Trubowitz**, Eidgenössische Technische Hochschule, Switzerland (862-53-84) (Sponsored by Nicholas J. Korevaar)

Special Session on Interactions Between Group Theory and Logic, III

9:00 a.m.–10:50 a.m. Room 210, Physical Sciences Classroom Facility

9:00 a.m. (80) *Solvable groups of finite Morley rank.* Preliminary report.
Luis-Jaime Corredor, University of California, Irvine (862-20-78) (Sponsored by Paul C. Eklof)

9:30 a.m. *Groups and long Ehrenfeucht-Fraïssé games.*
(81) Preliminary report.
Alan H. Mekler, Simon Fraser University (862-03-76)

10:00 a.m. *The generalized Saffe condition.* Preliminary report.
(82) **Ivo Herzog**, University of California, Irvine (862-03-75)

10:30 a.m. *Finite matrix groups and representation theory of*
(83) *artinian rings.*
Birge Zimmermann Huisgen, University of Utah (862-16-26)

Special Session on Probability Theory in Mathematical Physics, II

9:00 a.m.–10:50 a.m. Room 230, Physical Sciences Classroom Facility

9:00 a.m. *Symmetry and change of measure.*
(84) **Joe Watkins**, University of Southern California (862-60-39)

9:30 a.m. *Random laws for stationary processes.*
(85) **Kenneth S. Alexander*** and **Steven A. Kalikow**, University of Southern California (862-60-45)

10:00 a.m. *Continuity of the percolation transition.*
(86) **David Barsky**, University of California, Davis (862-60-46)

10:30 a.m. *Quantum sticky spheres and Bessel bridges.*
(87) **Mathew Penrose***, **O. Penrose**, **G. Stell** and **R. Pemantle**, University of California, Santa Barbara (862-60-42) (Sponsored by Glen H. Swindle)

Invited Address

11:00 a.m.–11:50 a.m. Physical Sciences Lecture Hall

(88) *Nature of the critical phenomenon in self-organized criticality.*
Jennifer T. Chayes, University of California, Los Angeles (862-60-102)

Invited Address

2:00 p.m.–2:50 p.m. Physical Sciences Lecture Hall

(89) *Constant mean curvature surfaces.*
Nicholas Jacob Korevaar, University of Utah (862-99-103)

Special Session on Quantum and Statistical Mechanics, II

3:00 p.m.–5:20 p.m. Room 230, Physical Sciences Classroom Facility

3:00 p.m. *Finite size scaling behavior of a biased majority rule*
(90) *cellular automation.*
Roberto H. Schonmann, University of California, Los Angeles (862-82-65) (Sponsored by Abel Klein)

3:30 p.m. *Stability of a self-organizing process.*
(91) **William G. Faris**, University of Arizona (862-82-72)

4:00 p.m. *Renormalizations and thermodynamic formalism.*
(92) **Konstantin M. Khanin**, Academy of Science of the USSR (862-82-64) (Sponsored by Abel Klein)

4:30 p.m. *Tau-functions and isomonodromy.* Preliminary report.
(93) **Craig A. Tracy**, University of California, Davis (862-35-99)

5:00 p.m. *Essential selfadjointness of relativistic Schrödinger*
(94) *operators: Path integral methods.*
Rene Carmona, University of California, Irvine (862-81-61)

Special Session on Geometric P.D.E.'s: Mean and Scalar Curvature Problems, IV

3:00 p.m.–5:30 p.m. Room 158, Physical Sciences I

3:00 p.m. *The pendent liquid drop.* Preliminary report.
(95) **Robert Finn**, Stanford University (862-35-38) (Sponsored by Andrejs E. Treibergs)

3:40 p.m. *The structure of the space of complete embedded*
(96) *minimal surfaces of finite topology: A first report.*
Preliminary report.
David Hoffman, University of Massachusetts, Amherst (862-53-82)

4:20 p.m. *Embedded minimal surfaces and quadratic area*
(97) *growth.* Preliminary report.
Robert B. Kusner* and **William H. Meeks, III**, University of Massachusetts, Amherst (862-53-36)

5:00 p.m. *The Gauss map of constant mean curvature surfaces*
(98) *of Minkowski space.* Preliminary report.
H. I. Choi, University of Iowa, and **Andrejs E. Treibergs***, University of Utah (862-53-37)

Special Session on Moduli Space Applications, II

3:00 p.m.–5:20 p.m. Room 108, Physical Sciences I

3:00 p.m. *Circle packings as moduli for Riemann surfaces.*
(99) **Robert Brooks**, University of Southern California (862-22-14)

3:30 p.m. *On the Hilbert scheme of codimension 2 subvarieties.*
(100) Preliminary report.
Mei-Chu Chang, University of California, Riverside (862-14-31) (Sponsored by David Harbater)

Sunday, November 11 (cont'd)

4:00 p.m. (101) *Diffeomorphism types of varieties.* Preliminary report. **Robert Friedman**, Columbia University (862-14-32)

4:30 p.m. (102) *Moduli of rational double points and small resolutions.* **Sheldon Katz***, Oklahoma State University, Stillwater, and **David R. Morrison**, Duke University (862-14-29)

5:00 p.m. (103) *A new super KP system and a characterization of the Jacobians of arbitrary algebraic super curves.* **Motohico Mulase**, University of California, Davis (862-22-13)

Lance W. Small
Associate Secretary
La Jolla, California

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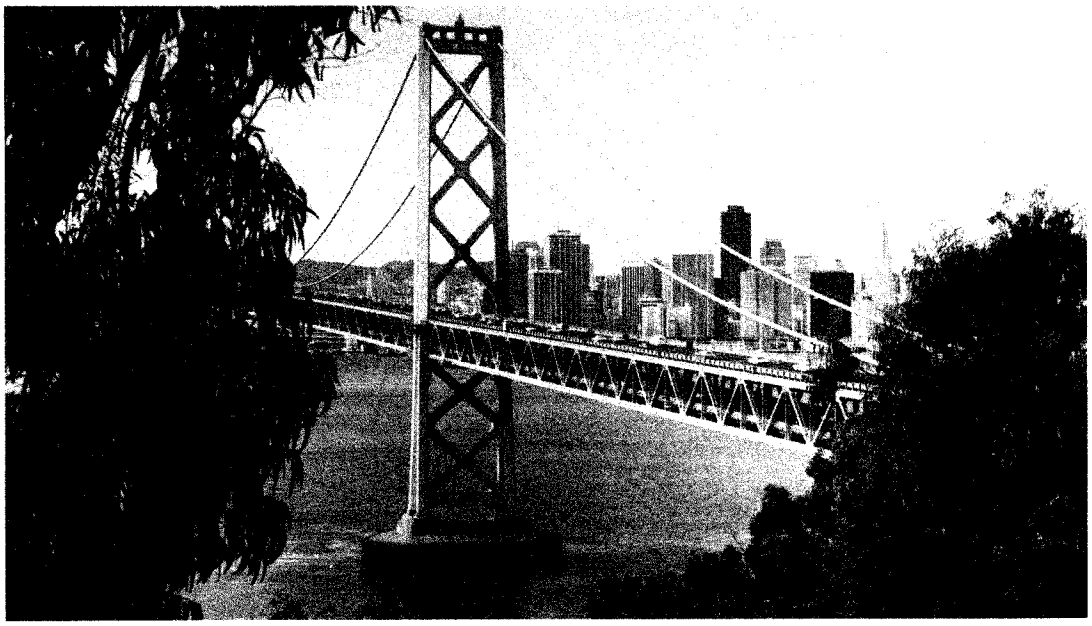
San Francisco Meetings
January 16–19, 1991

First Announcement



San Francisco Convention & Visitors Bureau photo

IMPORTANT DEADLINES

AMS Abstracts	
For Consideration for Special Sessions	September 19
Of Contributed Papers	October 10
MAA Abstracts	
Of Contributed Papers	September 25
Employment Register	
(Applicants & Employers)	November 16
EARLY Preregistration and Housing	November 9
ORDINARY Preregistration and Housing	November 16
MAA Minicourse Preregistration	November 16
FINAL Preregistration	December 17
Motions for AMS Business Meeting	December 10
Housing Changes/Cancellations with Housing Bureau	December 12
Preregistration Cancellations (50% refund)	January 11
Employment Register Cancellations (50% refund)	January 11
AMS Banquet (50% refund)	January 2
AWM Banquet (50% refund)	January 2
MER Banquet (50% refund)	January 2
NAM Banquet (50% refund)	January 2

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The Scientific Program

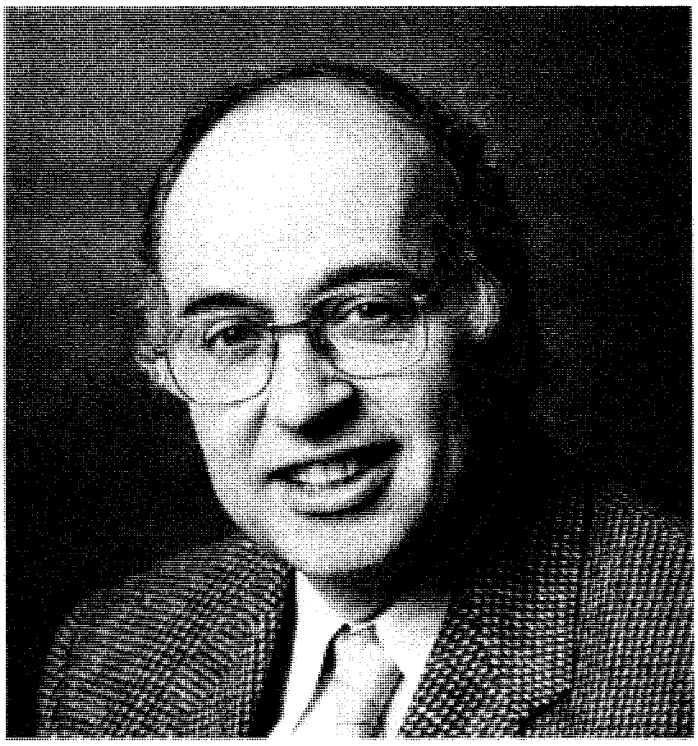
The January 1991 Joint Mathematics Meetings, including the 97th Annual Meeting of the AMS, the 74th Annual Meeting of the Mathematical Association of America, the 1991 annual meeting of the National Association for Mathematicians, and the 20th Anniversary Celebration of the Association for Women in Mathematics, will be held January 16 – 19 (Wednesday – Saturday), 1991, in San Francisco, California. Sessions, for the most part, will take place in the San Francisco Hilton on Hilton Square.

AMS-AWM-MAA Invited Address

In honor of the 20th anniversary of the founding of the **Association for Women in Mathematics**, there will be a special Joint AMS-AWM-MAA Invited Address by CRISTEL ROTTHAUS, Michigan State University, on *Some nonstandard construction methods for local noetherian rings* at 11:10 a.m. Thursday, January 17.

AMS-MAA Invited Addresses

By invitation of the AMS-MAA Joint Program Committee (Peter B. Gilkey, George A. Hagedorn, chair, David P. Roselle, and Audrey A. Terras), three speakers will address the AMS and MAA on some history or development of mathematics. The names of the speakers, their affiliations, the titles, dates, and times of their talks follow:



Sir Michael Atiyah, Gibbs Lecturer

G. D. Mostow

SHING S. CHERN, Mathematical Sciences Research Institute, University of California, Berkeley, *Characteristic forms*, 11:10 a.m. Friday;

REBECCA A. HERB, University of Maryland, College Park, *Harish-Chandra and his work*, 11:10 a.m. Wednesday;

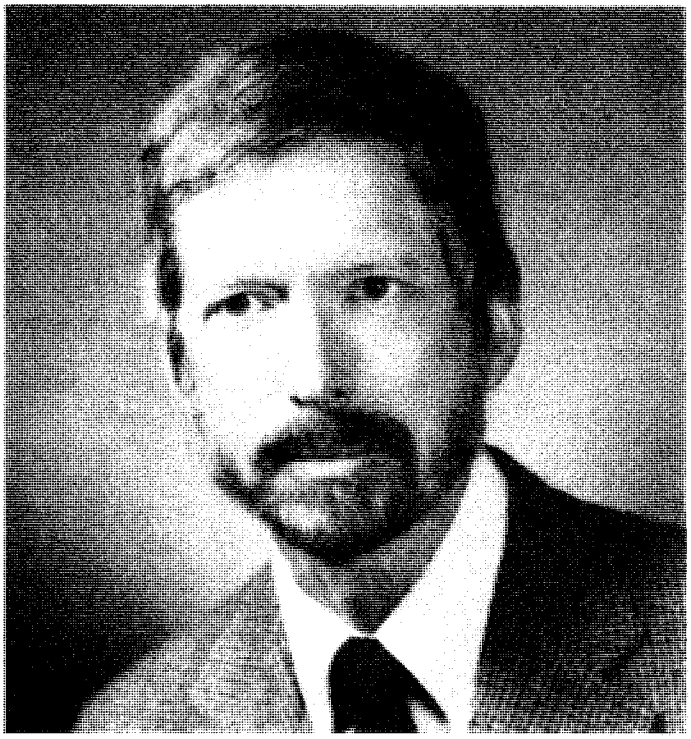
FRANK MORGAN, Williams College and Institute for Advanced Study, *Compound soap bubbles, shortest networks, and minimal surfaces*, 11:10 a.m. Saturday.

97th Annual Meeting of the AMS
January 16 – 19, 1991

Sixty-Fourth Josiah Willard Gibbs Lecture: The 1991 Gibbs Lecture will be presented at 8:30 p.m. on Wednesday, January 16, by SIR MICHAEL ATIYAH, Master of Trinity College. The title of his lecture is *Physics and the mysteries of space.*

Retiring Presidential Address: G. D. MOSTOW, Yale University, will deliver his Retiring Presidential Address on *From Coxeter diagrams to Kummer identities* at 2:15 p.m. on Saturday, January 19. Professor Mostow was President of the Society 1987 – 1988.

Colloquium Lectures: A series of three Colloquium Lectures will be given by ROBERT D. MACPHERSON, Massachusetts Institute of Technology. The lectures will be given at 1:00 p.m. daily, Wednesday through Friday, January 16 – 18.



Robert D. Macpherson, Colloquium Lecturer

Prizes: The 1991 Oswald Veblen Prize in Geometry will be awarded at 4:35 p.m. on Thursday, January 17.

At this same session, the first Ruth Lyttle Satter Prize in Mathematics will be also awarded. This prize was funded by a contribution from JOAN BIRMAN to honor the memory of Ruth Lyttle Satter and is awarded to a woman mathematician for an outstanding contribution to research in mathematics during the past five years.

In addition, the Council and Board of Trustees of the Society have established a Citation for Public Service, one to three of which will be presented annually for notable contributions to the mathematical profession through public service. These citations will be presented for the first time in San Francisco.

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

NOAM D. ELKIES, Harvard University, *Lattices and elliptic curves*, Wednesday 10:05 a.m.;

MARIA M. KLAWE, University of British Columbia, *Matrix searching and its applications*, Thursday 3:20 p.m.;

GRIGORII ALEKSANDROVIČ MARGULIS, Institute of Problems of Communication, Moscow, *Subgroup actions on homogeneous spaces and number theory*, Friday 9:00 a.m.;

KENNETH A. RIBET, University of California, Berkeley, *Two-dimensional modular representations of the Galois group of* **Q**, Wednesday 4:25 p.m.;

HÉCTOR J. SUSSMANN, Rutgers University *Recent results and open problems in deterministic nonlinear control theory*, Thursday 2:15 p.m.

AMS Committee on Science Policy Government Speaker: The AMS Committee on Science Policy will sponsor a session on Friday at 10:05 a.m.

AMS Committee on Science Policy Panel Discussion: The AMS Committee on Science Policy will also sponsor a panel discussion on Saturday at 3:30 p.m.

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

Matrix searching, Monge arrays and Ackemann's inverse: algorithms and lower bounds, ALOK AGGARWAL, IBM, Yorktown Heights, and MARIA M. KLAWE, Friday afternoon and Saturday morning

Computing optimal geometries, FREDERICK J. ALMGREN, Princeton University; ALBERT MARDEN, University of Minnesota; and JEAN E. TAYLOR, Rutgers University, Thursday afternoon, Friday morning and afternoon, and Saturday morning

Geometric Fourier analysis, WILLIAM BECKNER, University of Chicago, and J. MICHAEL PEARSON, Florida International University, Friday afternoon, Saturday morning and afternoon

Turbulence, MELVYN S. BERGER, University of Massachusetts, Amherst, Friday afternoon, Saturday morning and afternoon

C-algebras and noncommutative topology*, BRUCE E. BLACKADAR, University of Nevada, Reno, Wednesday morning and afternoon, Thursday morning

Oscillation and dynamics in delay equations, JOHN R. GRAEF, Mississippi State University, and JACK K. HALE, Georgia Institute of Technology, Wednesday afternoon, Thursday morning and afternoon

Deterministic nonlinear control theory and related topics, KEVIN A. GRASSE, University of Oklahoma, and HÉCTOR J. SUSSMANN, Friday afternoon, Saturday morning and afternoon

Analytical methods in convexity, HELMUT GROEMER, University of Arizona, Tucson, and JANE SANGWINE-YAGER, St. Mary's College, Friday afternoon, Saturday morning and afternoon

Real algebraic geometry, WILLIAM B. JACOB, University of California, Santa Barbara, Wednesday afternoon, Thursday morning, Friday morning

History of mathematics, FLORENCE FASANELLI, George Washington University; VICTOR J. KATZ, University of

the District of Columbia; and DAVID E. ROWE, Pace University, Wednesday afternoon and Thursday morning

Combinatorial design theory, ESTHER R. LAMKEN, Institute for Defense Analyses, Wednesday morning and afternoon and Thursday morning

Boundary behavior in partial differential equations, KIRK E. LANCASTER, Wichita State University, Wednesday morning and afternoon and Thursday morning

Hopf algebras, M. SUSAN MONTGOMERY, University of Southern California, and EARL J. TAFT, Rutgers University, Wednesday morning and afternoon and Thursday morning

Automatic theorem proving, DAVID MUMFORD, Harvard University, Friday evening. The Current and Milestone Prizes in this area will be awarded at this session and the prize winners will speak.

Arithmetical algebraic geometry, KENNETH A. RIBET, Thursday afternoon, Friday morning and afternoon, and Saturday morning

Entire function theory, ANTOINETTE TREMBINSKA, John Jay College of Criminal Justice, CUNY, Wednesday afternoon and Thursday morning.

Abstracts for consideration for these sessions should have been submitted by the September 19 deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences, in the Invited Speakers and Special Sessions section, and the Meetings section of *Notices*.

Please refer to the section on **Other AMS-MAA Sessions** for a list of joint special sessions being cosponsored by the AMS and MAA.

Contributed Papers: There will be sessions for contributed papers on Wednesday, Thursday, Friday and Saturday.

Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in departments of mathematics and should be sent to Abstracts, Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, **so as to arrive by the abstract deadline of October 10, 1990.** A charge of $16 is imposed for retyping abstracts that are not in camera-ready form. **Late papers will not be accepted.**

Participants planning to submit abstracts for AMS ten-minute contributed papers by the October 10 deadline should be sure to indicate on the abstract any special scheduling requests. Failing that, these requests should be communicated to the AMS Associate Secretary, Andy R. Magid, Department of Mathematics, University of Oklahoma, 601 Elm PHSC 423, Norman, OK 73019, Electronic mail: g_magid@math.ams.com, (Telephone 405-325-6711). These individuals should also be aware that, because of time and space limitations and an anticipated higher number of abstracts being submitted (based on the numbers submitting for meetings in San Francisco in the past), it may be necessary to schedule some sessions of AMS Contributed Papers on Thursday and Friday evenings, January 17 and 18.

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. Requests to obtain the package of files may be sent by electronic mail to **abs-request@math.ams.com**. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Secretary to Director of Publication, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940. When requesting the abstracts package, users should be sure to specify whether they want the plain TEX, AMS-TEX, or the LATEX package. Again, late papers will not be accepted.

Other AMS Events

Council Meeting: The Council of the Society will meet at 2:00 p.m. on Tuesday, January 15.

Business Meeting: The Business Meeting of the Society will take place immediately following the award of the prizes at 4:35 p.m. on Thursday, January 17. For additional information on the Business Meeting, please refer to the box titled Committee on the Agenda for Business Meetings.

Other AMS - MAA Sessions

AMS-MAA Special Sessions: There will be three special sessions jointly sponsored by the AMS and MAA. The topics of these special sessions, the names and affiliations of the mathematicians arranging them, and the dates and times they will meet, are as follows:

Research in undergraduate mathematics education, ED DUBINSKY, Purdue University, and JAMES J. KAPUT, Southeastern Massachusetts University, Wednesday afternoon, Thursday morning and afternoon, Friday and Saturday morning

Mathematics and education reform, NAOMI D. FISHER, University of Illinois at Chicago and MER Network; HARVEY B. KEYNES, University of Minnesota; and PHILIP D. WAGREICH, University of Illinois at Chicago, Thursday afternoon, Friday morning and afternoon, and Saturday morning

Research papers by undergraduates, LESTER J. SENECHAL, Mount Holyoke College, Friday afternoon, Saturday morning and afternoon

AMS-MAA Committee on Employment and Educational Policy Panel Discussion: The AMS-MAA Committee on Employment and Educational Policy (CEEP)

will sponsor a panel discussion on Saturday, January 19, from 1:00 p.m. to 3:00 p.m. The title of the panel is *The employment process: How can we do better?*. Panelists include KENNETH P. BOGART, Dartmouth College; EDWARD A. CONNORS, Joint Policy Board for Mathematics (moderator); DONALD J. LEWIS, University of Michigan; EILEEN L. POIANI, St. Peter's College; and DONALD C. RUNG, Pennsylvania State University.

AMS-MAA Panel Discussion: The AMS and MAA are cosponsoring a panel discussion on *The undergraduate linear algebra curriculum* on Thursday from 7:00 p.m. to 10:00 p.m. An NSF funded workshop *The undergraduate linear algebra curriculum* was held at The College of William and Mary early in August 1990. Information and proposals from that workshop will be presented in a panel discussion format. Among the panelists will be the workshop organizers: DAVID H. CARLSON, San Diego State University; DAVID C. LAY, University of Maryland; CHARLES R. JOHNSON, The College of William and Mary; and A. DUANE PORTER, University of Wyoming (moderator). This session will include a brief demonstration of examples of appropriate computer technology in teaching.

AMS-MAA-SIAM Panel Discussion: AMS-MAA-SIAM Committee on Preparation for College Teaching Dialogue: Paradigm meets reality

What do future college teachers need? What is feasible in Ph.D. programs?

This panel discussion is scheduled from 9:30 a.m. to 10:55 a.m. on Wednesday, January 16. The organizer is the chair of the committee, BETTYE ANNE CASE, Florida State University.

Estate Planning for AMS and MAA Members: From 6:00 p.m. to 8:00 p.m. on Wednesday there will be a discussion of estate planning via wills and bequests, revocable living trusts, annuities, and other planned giving strategies. Come and learn how to achieve personal financial objectives *and* provide for future endowments for charitable organizations. The discussion leaders are RICHARD WITTER, MAA Development Consultant and TIMOTHY J. GOGGINS, AMS Development Officer.

74th Annual Meeting of the MAA
January 16 - 19, 1991

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

HAROLD M. EDWARDS, Courant Institute for Mathematical Sciences, New York University, *What was Abel's theorem?*, 10:05 a.m. Thursday;

JILL P. MESIROV, Thinking Machines Corporation, *The N-body problem: Where parallel algorithms, graph theory, and fluid dynamics meet*, 10:05 a.m. Saturday;

CARLOS MORENO, Baruch College, CUNY, *Algebraic curves and error correcting codes from a modern point of view*, 2:15 p.m. Friday;

URI TREISMAN, Swarthmore College, *Developing the next generation of mathematicians*, 2:15 p.m. Wednesday;

FLOYD WILLIAMS, University of Massachusetts, Amherst, *An analogue of Hüber's formula for Riemann's zeta function*, 3:20 p.m. Wednesday.

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

Minicourse #1: *Calculus as a laboratory science* organized by MARCELLE BESSMAN, Frostburg State University. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Tuesday, January 15, and part B is scheduled from 2:15 p.m. to 4:15 p.m. on Wednesday, January 16. Enrollment is limited to 30.

Participants will work in the IBM Calculus laboratory (laboratory = computer + software) using MicroCalc as a tool for exploring such concepts as limits, derivatives, integrals, curve sketching, infinite sequences and series. Derive, MathCAD and GraphKit (shareware) will also be available for use and demonstration. These explorations will be guided by laboratory assignments designed to support observation and promote "what-if" responses. The advantages and disadvantages of the software used will be discussed. The use of IBM's hypermedia software, Linkway, to develop instructor-designed interactive computer-assisted instruction will be demonstrated. Ways to integrate these tools into the teaching of calculus will be illustrated and sample exercises will be distributed.

Minicourse #2: *The use of computing in teaching linear algebra* organized by EUGENE A. HERMAN and CHARLES H. JEPSEN, Grinnell College. Part A is scheduled from 8:00 a.m. to 10:00 a.m. on Wednesday, January 16, and part B is scheduled from 8:00 a.m. to 10:00 a.m. on Thursday, January 17. Enrollment is limited to 30.

We will discuss ways in which modern computer software allows one to change the content and tone of the undergraduate linear algebra course. One aspect that we will especially emphasize will be new kinds of exercises, including exploratory exercises and more substantial applications. We will also discuss the numerical linear algebra algorithms built into the software and the extent to which these might be studied in an undergraduate course. Participants will get hands-on experience using the MAX package and perhaps MATLAB.

Minicourse #3: *The mathematics of computer graphics* organized by JACK GOLDFEATHER, Carleton College. Part A is scheduled from 8:00 a.m. to 10:00 a.m. on Wednesday, January 16, and part B is scheduled from 2:15 p.m.

to 4:15 p.m. on Wednesday, January 16. Enrollment is limited to 80.

This Minicourse covers the fundamental mathematical principles associated with modern three-dimensional computer graphics and the adaptation of these principles to the design of efficient computer algorithms. Topics: line-drawing, viewing transformations and projections, hidden surface algorithms, lighting models, raytracing, antialiasing, generation of complex images. The course will be in a lecture format and will not use or depend on any particular graphics system. Prerequisites are linear algebra and familiarity with programming concepts like algorithms, loops and recursion.

Minicourse #4: *Elementary robotics* organized by WALTER MEYER, Adelphi University. Part A is scheduled from 8:00 a.m. to 10:00 a.m. on Wednesday, January 16, and part B is scheduled from 4:30 p.m. to 6:30 p.m. on Wednesday, January 16. Enrollment is limited to 80.

This Minicourse will show how elementary models of mobile robots and robot arms can be used in various undergraduate courses, especially geometry, combinatorics, linear algebra and calculus. Much of the mathematics is traditional and will be familiar to all, but some has been developed recently. This Minicourse will be concrete as opposed to abstract. Copies of slides and exercise sets will be available.

Minicourse #5: *Using pocket computers to enhance the teaching and learning of precalculus and calculus* organized by BERT K. WAITS and FRANKLIN DEMANA, The Ohio State University. Part A is scheduled from 8:00 a.m. to 10:00 a.m. on Wednesday, January 16, and part B is scheduled from 8:00 a.m. to 10:00 a.m. on Thursday, January 17. Enrollment is limited to 40.

Participants will learn how to use "state of the art" Texas Instruments graphing calculators (really pocket computers). They are powerful tools that promote student investigation and exploration. More realistic problems and applications can be used when students use graphing calculators. Mathematical topics will include solving equations and inequalities, theory of equations, analytic geometry, polar and parametric equations, maximum and minimum problems, systems of equations, matrix algebra, motion simulation, limits, and differential and integral calculus.

Minicourse #6: *Pedagogical uses of Derive and GyroGraphics* organized by JERRY JOHNSON and BENNY EVANS, Oklahoma State University. Part A is scheduled from 4:30 p.m. to 6:30 p.m. on Wednesday, January 16, and part B is scheduled from 7:00 p.m. to 9:00 p.m. on Thursday, January 17. Enrollment is limited to 30.

The computer algebra system Derive has become very popular because it is inexpensive, easy to use, and handles sophisticated symbolic calculations along with two- and three-dimensional plotting. We will focus on how it can be used in both laboratory and classroom settings to enhance student understanding of undergraduate mathematics. Calculus will be emphasized, but other core subjects will be given attention. Familiarity with Derive is desirable, but not necessary. Also included will be a short session using the new animated 3D graphing software GyroGraphics. (Both products require only a 512K MS-DOS machine with a standard graphics adapter.) Participants will do hands-on work and will receive a free book of laboratory exercises and classroom demonstrations.

Minicourse #7: *Symmetry analysis of repeated patterns* organized by DONALD W. CROWE, University of Wisconsin, Madison. Part A is scheduled from 2:15 p.m. to 4:15 p.m. on Thursday, January 17, and part B is scheduled from 8:00 a.m. to 10:00 a.m. on Friday, January 18. Enrollment is limited to 50.

Patterned art appears in many industrial and preindustrial artifacts. Pattern analysis, using the classification by isometries developed for crystallography, has archaeological and anthropological applications. The course mentions such applications, but emphasizes proofs of basic properties of isometries; the classification of the 7 + 17 one- and two-dimensional patterns, and the 17 + 46 two-color versions of these patterns; and hands-on identification of real-world patterns. Useful flowcharts from Washburn-Crowe "Symmetries of Culture: Theory and Practice of Plane Pattern Analysis" (1988) will be provided. Preferably, each participant should have a copy of that book. The material requires no specialized knowledge beyond high school geometry.

Minicourse #8: *The theory and application of discrete dynamics* organized by JAMES T. SANDEFUR, Georgetown University. Part A is scheduled from 2:15 p.m. to 4:15 p.m. on Thursday, January 17, and part B is scheduled from 8:00 a.m. to 10:00 a.m. on Friday, January 18. Enrollment is limited to 80.

Courses on discrete dynamics have been appearing at both the freshman and upperclass levels. Among the reasons for this are the connections with chaos, the numerous applications, and the beauty of the mathematics. This course will discuss the theory of discrete dynamical systems and will demonstrate how that theory can be applied to areas such as genetics, economics, and population growth. We will find solutions to linear systems, use linearization and graphing techniques to study stability for nonlinear systems, and discuss how chaos may arise when stability fails. Ideas will also be given on how to develop courses on this subject and where to find materials.

Minicourse #9: *Combinatorial designs* organized by WALTER D. WALLIS, Southern Illinois University. Part A

is scheduled from 2:15 p.m. to 4:15 p.m. on Thursday, January 17, and part B is scheduled from 8:00 a.m. to 10:00 a.m. on Friday, January 18. Enrollment is limited to 80.

Although they form a basic area of combinatorics, combinatorial designs have appeared in undergraduate discrete mathematics and combinatorics courses only in a fragmented and disconnected way, if at all. This course introduces the main areas of design theory (including Latin squares, finite geometries, block designs and one-factorizations) and discusses ways to teach them to undergraduates.

Minicourse #10: *Chaotic dynamical systems* organized by ROBERT L. DEVANEY, Boston University. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Thursday, January 17; part B is scheduled from 7:00 p.m. to 9:00 p.m. on Friday, January 18; and part C is scheduled from 1:00 p.m. to 3:00 p.m. on Saturday, January 19. Enrollment is limited to 120.

The goal of this Minicourse will be to introduce some of the main ideas of dynamics in as simple a setting as possible, namely, iteration of functions of a single real or complex variable. Lectures will be devoted to such topics as chaos, Julia sets, the Mandelbrot set, and bifurcations. Computer graphics experiments which yield the fascinating images from dynamics will be described. Most of the lectures will be aimed at describing the mathematical ideas behind "chaos," but some time will be devoted to ways to incorporate these ideas into the undergraduate curriculum, ranging from calculus courses to advanced student projects.

Minicourse #11: *A survey of educational software* organized by VIRGINIA KNIGHT and VIVIAN KRAINES, Meredith College. Part A is scheduled from 2:15 p.m. to 4:15 p.m. on Friday, January 18 and part B is scheduled from 8:00 a.m. to 10:00 a.m. on Saturday, January 19. Enrollment is limited to 30.

An increasing variety of software is available for the IBM PC and compatibles which enhances the instruction of college mathematics courses. The organizers will demonstrate ways to use various programs in precalculus, calculus, and other courses. The participants can then try these and other programs themselves. Handouts and brochures will be provided which will give more information on the software. No computer experience is required.

Minicourse #12: *Writing in mathematics courses* organized by GEORGE D. GOPEN and DAVID A. SMITH, Duke University. Part A is scheduled from 8:00 a.m. to 10:00 a.m. on Friday, January 18; part B is scheduled from 8:00 a.m. to 10:00 a.m. on Saturday, January 19, and part C from 3:15 p.m. to 5:15 p.m. on Saturday, January 19. Enrollment is limited to 80.

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

Minicourse #13: *Great theorems from mathematical analysis: 1689-1881* organized by WILLIAM DUNHAM, Hanover College. Part A is scheduled from 2:15 p.m. to 4:15 p.m. on Friday, January 18 and part B is scheduled from 1:00 p.m. to 3:00 p.m. on Saturday, January 19. Enrollment is limited to 80.

We examine original proofs of four historically significant theorems: the Bernoulli brothers' proofs of the divergence of the harmonic series (1689); Euler's summation of $1+\frac{1}{4}+\frac{1}{9}+\ldots+\frac{1}{n^2}+\ldots$ and related series (1734); Weierstrass' everywhere continuous, nowhere differentiable function (1872); and Volterra's proof of the non-existence of a function continuous precisely on the rationals (1881). Each theorem is accompanied by brief biographies of key individuals and placed in appropriate historical context.

Minicourse #14: *Actuarial mathematics* organized by JONATHAN KANE, University of Wisconsin, Whitewater. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Friday, January 18 and part B is scheduled from 1:00 p.m. to 3:00 p.m. on Saturday, January 19. Enrollment is limited to 80.

The actuarial career offers one of the most attractive opportunities available for undergraduate mathematics majors. This course describes the actuarial profession, discusses the Society of Actuaries' examinations, and concentrates on some of the mathematical concepts unique to the field. It gives an introduction to actuarial mathematics with emphasis on the solutions of mathematically interesting problems. It prepares teachers to advise students interested in becoming actuaries. An undergraduate course in probability theory is assumed.

Minicourse #15: *Learning abstract algebra by programming in ISETL* organized by ED DUBINSKY, Purdue University, and URI LERON, Technion - IIT. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Friday, January 18; part B is scheduled from 1:00 p.m. to 3:00

p.m. on Saturday, January 19; and part C is scheduled from 3:15 p.m. to 5:15 p.m. on Saturday, January 19. Enrollment is limited to 30.

We believe that undergraduates' difficulty in learning abstract algebra has less to do with the complexity of the theorems than with the abstract nature of the mathematical objects involved. Programming in a mathematical language can help by getting students to construct those objects on the computer, allowing mathematical operations to be, for them, activities about meaningful objects. The Minicourse is a hands-on experience in doing this with ISETL. No previous programming background is necessary.

***Minicourse #16**: A mathematician's introduction to the HP-48SX scientific expandable calculator for first-time users* organized by JOHN KENELLY and DON LATORRE, Clemson University. Part A is scheduled from 8:00 a.m. to 10:00 a.m. on Saturday, January 19 and part B is scheduled from 3:15 p.m. to 5:15 p.m. on Saturday, January 19. An HP-48SX calculator will be loaned to each participant and enrollment is limited to 30.

The Minicourse will be a mathematician's hands-on introduction to the HP-48SX and some of the new features which make it so powerful — like the Equation Writer, the HP Solve and Plot applications, and the Matrix Writer. The course will illustrate uses of the 48SX in several undergraduate courses: calculus, linear algebra, and differential equations. Participants will be given a handout that includes several customized programs for use in these courses. The transfer of data from one 48SX to another and between the 48SX and a microcomputer will be demonstrated, and the use of plug-in cards to expand memory — both ROM and RAM — will be discussed.

***Minicourse #17**: Instituting a mathematics placement program: Creating order out of chaos in freshman mathematics* organized by MARY MCCAMMON, Pennsylvania State University and is sponsored by the Committee on Testing. Part A is scheduled from 2:15 p.m. to 4:15 p.m. on Friday, January 18, and part B is scheduled from 3:15 p.m. to 5:15 p.m. on Saturday, January 19. Enrollment is limited to 40.

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

How to Preregister for Minicourses

Participants interested in attending any of the MAA Minicourses should complete the MAA Minicourse Preregistration Form **and send it directly to the MAA office at the address given on the form so as to arrive prior to the November 16 deadline. Please note that these MAA Minicourses are NOT the AMS Short Course.** After the deadline, interested participants are encouraged to call the MAA headquarters at 800-331-1622.

DO NOT SEND THIS FORM TO PROVIDENCE.

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

The MAA Minicourses are open only to persons who register for the Joint Mathematics Meetings and pay the Joint Meetings registration fee. **If the only reason for registering for the Joint Meetings is to gain admission to an MAA Minicourse, this should have been indicated by checking the appropriate box on the MAA Minicourse Preregistration Form. Then, if the Minicourse is fully subscribed, full refund can be made of the Joint Meetings preregistration fee. Otherwise, the Joint Meetings preregistration will be processed, and then be subject to the 50 percent refund rule. Participants should take care when canceling Minicourse preregistration to make clear their intention as to their Joint Meetings preregistration, since if no instruction is given, the Joint Meetings registration will also be canceled. PREREGISTRATION FORMS FOR THE JOINT MEETINGS SHOULD BE MAILED TO PROVIDENCE PRIOR TO THE DEADLINE OF NOVEMBER 16.**

The registration fee for MAA Minicourses #1, 2, 6, 11, and 15 is $60 each. The registration fee for all other MAA Minicourses is $36 each.

Contributed Papers: Contributed papers have been accepted on several topics in collegiate mathematics for presentation in contributed paper sessions at the meeting. The topics, organizers, their affiliations, and the days they will meet are:

- *Professional development for teachers of mathematics*, JOHN DOSSEY, Illinois State University, and ELIZABETH J. TELES, Montgomery College, Maryland. Wednesday and/or Thursday.

This session is sponsored by the Committee on Faculty Development (John Dossey, chair). Papers are invited that describe departmental, system, state, regional, or sectional programs aimed at promoting continued faculty growth in mathematics or its teaching. Special consideration will be given to programs which are easily transported from one setting to another. Topics to be discussed can include, but are not limited to, the following: special faculty study programs, focused colloquia series, reading/study groups, teaching improvement programs,

and the development and use of technological aids.

- *Statistics and probability*, SHELDON P. GORDON, Suffolk Community College, and FLORENCE S. GORDON, New York Institute of Technology. Friday and/or Saturday.

Contributed papers on any issue relating to statistics and probability courses in the mathematics curriculum are welcome. For instance, 1.) What are some innovative approaches to teaching these courses (such as the use of computers and other technology, simulations, exploratory data analysis or student "research" projects)? 2.) What does statistical literacy mean for liberal arts, science, mathematics, business or social science students? 3.) What statistical ideas are being introduced into the secondary curriculum and what are the implications for the undergraduate curriculum?

- *Alternatives to the lecture method*, JAMES R.C. LEITZEL, The Ohio State University. Friday and/or Saturday.

This session, sponsored by the Committee on the Mathematical Education of Teachers (COMET), will be devoted to classroom practices which provide alternatives to a strictly lecture approach. Papers are solicited which address strategies and techniques for classroom practice across a variety of topics in the undergraduate curriculum. Presentations which represent large and small class size and upper division as well as lower division courses are desired.

- *Humanistic mathematics*, ALVIN WHITE, Harvey Mudd College and Humanistic Math Network; MARILYN FRANKENSTEIN, University of Massachusetts, Boston; and JOAN COUNTRYMAN, Germantown Friends High School. Wednesday and/or Thursday

Contributions are invited that describe teaching, using, or creating mathematics as a humanistic discipline. The paper should describe the experience and its effect, if any, on the point of view. Philosophical and/or historical papers that contribute to mathematics as a humanistic discipline are also welcome.

- *Lesser known geometrical gems*, DON CHAKERIAN, University of California, Davis; RICHARD PFEIFER, San Jose State University; and JANE SANGWINE-YAGER, Saint Mary's College. Wednesday and/or Thursday

Contributed papers are invited which illustrate interesting but not widely known results which may be used by the teacher to enliven an upper division geometry course. These may include new insights and forgotten classics in geometry that deserve wider appreciation.

- *Using history in the teaching of mathematics*, DAVID E. ZITARELLI, Temple University. Friday and/or Saturday.

The history of mathematics is used in various ways to enrich and to teach mathematics. Papers in this session should address such uses in courses ranging from liberal arts courses for non-science majors to required courses for mathematics majors. Of particular interest are descriptions of history of mathematics courses, including graduate level courses and those designed for education majors.

The deadline for submitting papers for these sessions was **September 25**.

Other MAA Sessions

Mathematicians and State Governments: The MAA Science Policy Committee is sponsoring this special presentation scheduled from 8:00 a.m. to 9:20 a.m. on Wednesday. The main speaker will be a current or former state government official who will describe effective ways to bring important issues to the attention of government leaders and to advocate actions to address these issues. Two mathematicians will act as respondents. The organizer is JOHN A. THORPE, State University of New York at Buffalo.

Perspectives on Service Courses for Business Students: The MAA CUPM Subcommittee on Service Courses (Barbara A. Jur, chair) is sponsoring a panel discussion on Wednesday, January 16, from 9:30 a.m. to 10:55 a.m. The objective is to present the mathematical needs for business majors as perceived by schools and departments of business and interpreted by teachers, publishers, and authors. Current practice and future directions will be explored. The moderator is BARBARA A. JUR, University of Tennessee at Chattanooga, and the panelists are JOE FIEDLER, California State University, Bakersfield; JAMES MINATEL, developmental editor at Richard D. Irwin, Inc.; and BARRY SCHOLLER, Rhode Island College.

Reception for Elementary School Teachers: By invitation of the MAA, a reception for elementary school teachers will be held on Wednesday from 4:30 p.m. to 6:00 p.m.

Two-Year College Reception: The Committee on Two-Year Colleges is sponsoring an informal reception for two-year college faculty from 4:30 p.m. to 6:00 p.m. on Wednesday, January 16.

A Call for Change: An open discussion about this document is being sponsored by COMET, the Committee on the Mathematical Education of Teachers (James R.C. Leitzel, chair); it is scheduled from 7:00 p.m. to 8:00 p.m. on Wednesday.

Archimedean and Archimedean Dual Polyhedra: A video presentation on definition, animated derivation and historical development of these polyhedra is being given by LORRAINE L. FOSTER, California State University, Northridge, at 7:00 p.m. on Wednesday.

CAS Workshop Reunion: A CAS Workshop Reunion organized by DONALD B. SMALL, Colby College, is scheduled at 7:00 p.m. on Wednesday.

Hints for Consultants: A panel discussion aimed at training consultants is scheduled from 8:15 a.m. to 9:15 a.m. on Thursday. This panel discussion is sponsored by the Committee on Consultants (Richard S. Millman, chair) and will be led by three people who have had a great deal of experience with consulting visits.

Mathematics and the Environment: BEN FUSARO, Salisbury State University, and MARCIA P. SWARD, MAA Executive Director, are organizing a panel discussion on *Mathematics and the environment*, which is scheduled from 9:30 a.m. to 10:55 a.m. on Thursday. Part of the time will be devoted to an open planning session on possible MAA activities.

The Laboratory Approach to Teaching Calculus: This is a panel discussion sponsored by CCIME, the Committee on Computers in Mathematics Education (Eugene A. Herman, chair) and organized by CARL LEINBACH, Gettysburg College. It is scheduled from 2:15 p.m. to 4:20 p.m. on Thursday.

Student Projects Poster Session: A poster session for undergraduate student projects is scheduled from 2:15 p.m. to 4:20 p.m. on Thursday. Each poster will describe a specific research project, whether it is carried out by a group or by an individual. Some of the posters will be presented by students, others by faculty sponsors. This session is sponsored by the CUPM Subcommittee on Undergraduate Research in Mathematics (Lester J. Senechal, chair).

Student Activities: A student workshop, sponsored by the Committee on Student Chapters (Howard Anton, chair), is planned for Thursday afternoon from 2:15 p.m. to 4:15 p.m. and Friday morning from 8:00 a.m. to 10:55 a.m. Enrollment is limited to 20 students in each of the two sections. There is no charge for attending. Those interested should indicate this on the Minicourse Form. A special lecture by LESTER H. LANGE, San Jose State University and Moss Landing Marine Labs, is scheduled from 7:30 p.m. to 8:30 p.m. on Friday; it will be followed by a student reception. A hospitality/information center for students will be located in the Hilton.

Environmental Modeling: Ben Fusaro, Salisbury State University, is organizing a session scheduled from 8:00 a.m. to 9:20 a.m. on Friday, which will include the following presentation: *Viability analysis of endangered species* by ROLAND H. LAMBERSON, Humboldt State University; *Rainfall, probability and the environment* by ROY B. LEIPNIK, University of California, Santa Barbara; and *Conservation of biological diversity* by ROBERT W. MCKELVEY, University of Montana.

WAM: Yesterday, Today and Tomorrow – In Commemoration of WAM's 15 Years of Service: This is a session sponsored by Women and Mathematics and is scheduled from 8:00 a.m. to 9:20 a.m. on Friday. The moderator is WAM director ALICE KELLY, University of Santa Clara. Panelists will be Mary Hesselgrave, AT&T Bell Labs; VIRGINIA E. KNIGHT, Meredith College; EILEEN L. POIANI, St. Peter's College; and ROSEANNA F. TORRETTO, State of California.

Models for Undergraduate Research: The CUPM Subcommittee on Undergraduate Research in Mathematics (Lester J. Senechal, chair) is sponsoring a panel discussion from 9:30 a.m. to 10:55 a.m. on Friday. The panelists will be JOSEPH GALLIAN, ROBBIE ROBSON, and DEBORAH BERGSTRAND. LIDA K. BARRETT will serve as moderator.

Undergraduate Curriculum Initiatives – from Ideas to Action: CUPM (Committee on Undergraduate Program in Mathematics, Lynn A. Steen, chair) is sponsoring a panel discussion from 9:30 a.m. to 10:55 a.m. on Friday.

MAA-NAM Panel Discussion on Nurturing Minority Graduate Students in Mathematics: This panel discussion is organized and moderated by SYLVIA T. BOZEMAN, Spelman College, and is scheduled from 1:00 p.m. to 2:30 p.m. on Friday. Participants will be MARY W. GRAY, American University; RAYMOND L. JOHNSON, University of Maryland; ABDULALIOM SHABAZZ, Clark Atlanta University; RICHARD A. TAPIA, Rice University; and the moderator.

Calculus Poster Session II: The CUPM Subcommittee on Calculus Reform and the First Two Years (CRAFTY) is organizing another poster session for calculus projects from 1:00 p.m. to 4:20 p.m. on Friday. This is a sequel to the one held at the Louisville meeting and will provide an afternoon of informal discussion and dissemination of calculus reform efforts. Although participants in the last poster session are welcome, projects that have not taken part in previous CRAFTY sessions are particularly encouraged to take advantage of this opportunity to show what they are doing. Each presenter be given a table and a sheet of poster board with supports, but no computer support other than electrical outlets. If you are interested in being an presenter, send a one-page description of your project to Thomas W. Tucker, Mathematics Department, Colgate University, Hamilton, NY 13346 (phone 315-824-1000, electronic mail TTUCKER@COLGATEU). Space will be limited to 30 or 40 presenters, so send applications as soon as possible but no later than **November 1**. The last hour of this poster session is meant as a general reception for anyone involved in calculus reform. Participants interested in comparing experiences, successes, and failures, should plan to drop in for this last hour.

Student Presentation – Mathematical Contest in Modeling: These presentations will be given from 1:30 p.m. to 2:30 p.m. on Friday, January 18, and are organized by BEN FUSARO, Salisbury State University.

RESOLVED – All college graduates should know college algebra: A debate sponsored by the CUPM Subcommittee on Quantitative Literacy is scheduled on Friday from 3:20 p.m. to 4:15 p.m. The chair of the committee, LINDA R. SONS, Illinois State University, is the moderator. Here are some pertinent facts: Some legislatures mandate it. Exams can test it. And it's a collge level mathematics class.

Changing the climate – Skits and discussion: A special presentation scheduled from 7:00 p.m. to 8:30 p.m. on Friday and sponsored by the Committee on the Participation of Women in Mathematics. The moderator is PATRICIA C. KENSCHAFT, Montclair State College. Mathematicians will dramatize micro-inequities that actually happened to women mathematicians in 1990. Micro-inequities are small slights that individually are not of great consequence but cumulatively wear down a person's ability to pursue a serious career. Many are funny in retrospect. After laughing at ourselves, we will have small group discussions about day-to-day professional interactions and ways that we can change our own behavior and the patterns of our community so that we may all be more comfortable and our community more welcoming.

The National Center for the Teaching of Undergraduate Mathematics: An open discussion on "What is it and what should it be?" is scheduled from 8:00 p.m. to 9:30 p.m. on Friday. The moderator is ROBERT BUMCROT, chair of the ad hoc Committee on a National Center for the Teaching of Undergraduate Mathematics. All committee members (who attend the meeting) will be on the platform. Some may give short presentations; all will be invited to comment and to respond to questions and comments. The idea of a NCTUM, first formally proposed to the MAA in August 1989, has been enthusiastically received by a wide range of mathematics teachers and scholars. In this discussion the MAA committee charged with developing the concept will present a brief progress report and will respond to questions and comments from the audience. Anyone wishing to prepare questions or comments in advance is invited to send them to Robert Bumcrot, Department of Mathematics, Hofstra University, Hempstead, NY 11550.

Assessment: Definitions and Examples: This panel discussion is scheduled from 8:00 a.m. to 9:20 a.m. on Saturday. It is sponsored by the CUPM Subcommittee on Assessment of Undergraduate Majors and is organized by the chair, BERNARD L. MADISON, University of Arkansas. This subcommittee began its work in the summer of 1990 as a first step toward meeting its charge "To examine and make recommendations concerning all aspects of assessment of undergraduate majors in the mathematical sciences..." The panelists will present models of assessment of the learning of individuals and models of assessment of programs.

Symbolic Computation in Geometry and Algebra: A special presentation by DANA SCOTT, Carnegie Mellon University, scheduled from 9:00 a.m. to 9:50 a.m. on Saturday. This is sponsored by the CUPM Subcommittee on Symbolic Computation (Zaven Karian, chair).

MAA-NCTM Panel Discussion on Discrete Mathematics: The MAA and the National Council of Teachers of Mathematics are jointly sponsoring a panel discussion on *Discrete mathematics: Making the connection between the high school and college curricula.* This panel is scheduled from 1:00 p.m. to 3:00 p.m. on Saturday. The moderator is DON S. BALKA, Saint Mary's College. Other panelists will include ROBERT DEVANEY, Boston University; STEPHEN B. MAURER, Swarthmore College; and BERNADETTE H. PERHAM, Ball State University. Panel members will focus on Standard 12: Discrete Mathematics from the NCTM Curriculum and Evaluation Standards, presenting individual views of the content of discrete mathematics, followed by questions regarding high school and college curricula. Time will be available for questions from the audience.

Informal Workshop on the Teaching of Calculus: An informal workshop on the teaching of calculus will be held from 9:00 a.m. to 11:00 a.m. on Sunday morning, January 20, the day after the meeting. The discussion will be led by GILBERT STRANG, Massachusetts Institute of Technology. The workshop is open without advance registration to participants who choose to remain in San Francisco over Saturday night.

Prize Session and Business Meeting: The MAA Prize Session and Business Meeting is scheduled from 4:35 p.m. to 5:40 p.m. on Friday, January 18. The Chauvenet Prize, the Yueh-Gin Gung & Dr. Charles Y. Hu Award for Distinguished Service to Mathematics and several Certificates of Meritorious Service will be presented. This meeting is open to all members of the Association.

Board of Governors: The MAA Board of Governors will meet at 8:30 a.m. on Tuesday, January 15. This meeting is open to all members of the Association.

Section Officers: There will be a Section Officers' meeting at 7:00 p.m. on Tuesday, January 15.

Activities of Other Organizations

The **Association of Research Libraries** (ARL) is sponsoring a session on *Delivering information to researchers: Opportunities and impediments* on Friday at 6:00 p.m. The session features talks by a librarian, a mathematician, and a publisher and is organized by ANN OKERSON, ARL Office of Scientific & Academic Publishing. Research libraries and the scholars and researchers that rely upon them face a major crisis. The crisis is that the escalating prices of serials are eroding the purchasing power of the research library collections budget, resulting in a loss of information to the scholar and researcher. Even the largest libraries can no longer afford to maintain

comprehensive research collections because the cost of purchasing scientific, technical, and medical (STM) research results published in journals has skyrocketed. Both the loss of information and ready-access to a comprehensive collection have a direct bearing on the creation of ideas, research and development, and the movement of these results into the marketplace. These factors, in turn, influence the ability of the U.S. and Canada to compete in a technologically-based world economy.

The **Association for Women in Mathematics** (AWM) will celebrate its 20th Anniversary at the Joint Mathematics Meetings in San Francisco. AWM was established in 1971 to serve and encourage women to study and have active careers in the mathematical sciences. Its efforts have led to a greater participation by women in the mathematical community, especially as speakers at mathematics meetings and as members of committees of mathematical societies. Through cooperation with outside funding, AWM is able to produce career materials for the AWM Resource Center, provide travel grants for women to attend research conferences, support high school mathematics days, sponsor a mathematics prize for undergraduate women, produce a directory of women in the mathematical sciences, and encourage a variety of other activities aimed at promoting women and mathematics.

AWM is sponsoring the twelfth annual Emmy Noether Lecture at 9:00 a.m. on Thursday, January 17. The lecture will be given by ALEXANDRA BELLOW, Northwestern University.

Plans for the 20th Anniversary celebration include a strong technical program. A symposium on Wednesday at 8:00 a.m. and on Thursday at 3:20 p.m. on *The future of women in mathematics* features young women from a variety of mathematical fields within 10 years of their PhD degree. The speakers who have accepted include LYNN BUTLER, Princeton University; ELISE CAWLEY, City University of New York; CAROLYN DEAN, University of Michigan; SHAFI GOLDWASSER, Massachusetts Institute of Technology; JIANG-HUA LU, Massachusetts Institute of Technology; BERNADETTE PERRIN-RIOU, University of Paris; JILL PIPHER, Brown University; MEI CHI SHAW, Notre Dame; LAURETTE TUCKERMAN, University of Texas at Austin; and RUTH WILLIAMS, University of California, San Diego. This symposium is also part of a workshop for graduate students and postdocs on Thursday afternoon.

The AWM Business Meeting will be held at 10:00 a.m. on Thursday, January 17, where the first annual Louise Hay Award for Contributions to Mathematics Education will be given.

An open reception is planned for 9:30 p.m. on Wednesday, January 16.

Information on the AWM 20th Anniversary Banquet can be found in the **Social Events** section of this announcement.

The **Board on Mathematical Sciences** (BMS) is sponsoring a session on *Using the DAVID II Report* on Friday at 6:00 p.m. This session is organized by LAWRENCE H. COX, Director, Board on Mathematical Sciences. The 1984 National Research Council (NRC) report *Renewing U.S. Mathematics: Critical Resource for the Future* documented serious problems in research support in the mathematical sciences. This spring the NRC Board on Mathematical Sciences issued a second report updating the first report but going beyond it, into the attracting and training of PhD's. This new report found improved funding and continuing research advances. However, severe problems remain, especially in support for principal investigators and in attracting new talent, particularly women and minorities. An overview of this new report will be given, plus suggestions for its use, followed by a floor discussion.

The **Interagency Commission for Extramural Mathematics Programs** (ICEMAP) is a coordinating group of Federal agencies that sponsor basic research in mathematical sciences. These agencies include NSF, DOE, and various DOD agencies (ARO, AFOSR, ONR, DARPA and NSA). An information exchange meeting of this committee is scheduled for Wednesday at 7:15 p.m. The meeting will be chaired by JAGDISH CHANDRA, Director, Mathematical and Computer Sciences Division, U.S. Army Research Office, and will provide a forum where interested persons can obtain information about current and planned programs sponsored by these funding agencies. This meeting is of particular importance to the mathematical science community in view of the major changes taking place in DOD and general federal budgetary constraints.

The **Joint Policy Board for Mathematics** and the **Office of Governmental and Public Affairs** (JPBM/OGPA) are sponsoring a session on Thursday evening.

The **National Association of Mathematicians** (NAM) will receive the William W. S. Claytor Lecture at 1:00 p.m. on Saturday, January 19.

NAM is also co-sponsoring a panel discussion with MAA on Friday. Further information can be found in the section **Other MAA Sessions**.

NAM will also sponsor a contributed paper session at 8:00 a.m. on Friday, January 18, titled *Presentations by recent doctoral recipients*, moderated by GERALD CHACHERE, Howard University.

The NAM Business Meeting will take place at 10:00 a.m. on Saturday, January 19. ROGERS J. NEWMAN, Southern University, will preside.

Information on the NAM Banquet can be found in the **Social Events** section of this announcement.

The **National Science Foundation** (NSF) invites participants at the Joint Mathematics Meetings to meet informally with staff members over the lunch hour (noon to 1:00 p.m.) daily, Wednesday–Saturday, January 16-19. Short presentations on proposal writing and processing and Foundation priorities will be followed by the opportunity for individual questions. The Thursday session will focus on education, the Friday session will focus on research, and the Saturday session will include discussions of education and research. Friday will also provide an opportunity to discuss priorities and processes at other Federal agencies funding mathematics research.

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

The **Rocky Mountain Mathematics Consortium** (RMMC) Board of Directors will meet on Friday, January 18, from 2:15 p.m. to 4:10 p.m.

Other Events of Interest

Book Sales and Exhibits

AMS Information Booth: All meeting participants are invited to visit the AMS Information Booth in the exhibit area during the meeting. Complimentary coffee and tea will be served. A 1991 pocket calendar will be available for participants, compliments of the AMS. The Society's Membership Manager will be at the booth to answer questions about membership in the AMS.

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

Exhibits: The book, educational media and software exhibits are open Wednesday through Saturday, January 16–19. The hours they are open are 1:00 p.m. to 5:00 p.m. on Wednesday, 9:00 a.m. to 5:00 p.m. on Thursday and Friday, and 9:00 a.m. to noon on Saturday. All participants are encouraged to visit the exhibits during the meeting. **Participants visiting the exhibits will be asked to display their meeting badge or acknowledgment of preregistration from the Mathematics Meetings Service Bureau in order to enter the exhibit area.**

Mathematical Sciences Employment Register: Those wishing to participate in the Employment Register at the San Francisco meetings should read carefully the important article about the Register which follows this meeting announcement.

Social Events

It is strongly recommended that tickets for these banquets be purchased through preregistration, since only a very limited number of tickets will be available for sale on-site. Tickets purchased through preregistration will be mailed with the badge and program unless the participant instructs otherwise on the Preregistration/Housing Form. In that case, participants can pick up their ticket(s) at the meeting at the same time as their badge and program. To get a 50% refund on any tickets, the participant **must return the ticket(s)** to the Mathematics Meetings Service Bureau by **January 2**. After that date, no refunds can be made. Special meals are available at all banquets, upon request, including vegetarian, but this must be indicated on the Preregistration/Housing Form.

AMS 25-Year-Member Banquet: All meeting participants are invited to attend the third annual banquet to honor individuals who have been members of the Society for twenty-five years or more. This banquet provides an excellent opportunity to socialize with fellow participants in a relaxed atmosphere. If comments from attendees of the first two banquets are any indication, a good time will be had by all. The banquet will be held on Saturday, January 19, with a cash bar reception at 7:00 p.m. and dinner at 7:30 p.m. The principal speaker will be PAUL R. HALMOS of Santa Clara University. The title of his talk will be *Why did you come to this meeting?* The attendee who has been a member of the Society for the greatest number of years will receive a special tribute. Each attendee will receive a memento of the occasion and there will be a drawing for door prizes.

The menu includes Hilton salad, chicken piccata topped with capers, lemon butter sauce, pomme savoy, seasonal vegetables, chocolate raspberry mousse cake, and nonalcoholic beverages. Tickets are $30 each; the price includes tax and gratuity.

AWM 20th Anniversary Banquet: In celebration of their 20th Anniversary, AWM is holding a banquet on Thursday evening beginning with a reception at 6:15 p.m. followed by dinner at 7:00 p.m. The menu includes California spring salad, medallions of chicken complimented with dry vermouth and fresh chervil sauce, pomme savoy, seasonal vegetables, cherries jubilee, and nonalcoholic beverages. Tickets are $30; the price includes tax and gratuity.

MER Banquet: The Mathematicians and Education Reform (MER) Network welcomes all mathematicians who are interested in issues in precollege mathematics education to attend the MER Banquet on Wednesday at 6:00 p.m. This is an opportunity to make or renew

ties with other mathematicians who are involved in educational projects. There will be a brief presentation of the current activities and future plans of the MER Network, but the evening's main feature promises to be lively conversation among the participants. The menu includes caesar salad, sauteed breast of chicken with three peppercorn sauce, wild mushrooms, diced tomato and chive linguini, seasonal vegetables, grand marnier cake, and nonalcoholic beverages. Tickets are $30; the price includes tax and gratuity.

NAM Banquet: The NAM banquet will be held on Friday evening from 6:00 p.m. to 8:00 p.m. The menu consists of caesar salad, linguini entangled with bay shrimp, shitake mushrooms, spinach, pancetta, tomatoes and parmesan cheese with a fresh cream sauce, open face fruite torte, and nonalcoholic beverages. Tickets are $32; the price includes tax and gratuity.

How to Preregister and Get a Room

How to Preregister

The importance of preregistration cannot be overemphasized. Those who preregister pay fees considerably lower than the fees that will be charged for registration at the meetings and will receive typeset badges instead of typewritten ones. Participants who preregister by the ORDINARY deadline of November 16 may utilize the housing services offered by the Mathematics Meetings Service Bureau.

Preregistration fees: The AMS-MAA Joint Meetings Committee is responsible for maintaining a sound fiscal position for these meetings and keeping the deficits at a reasonable level, while still providing the very best meeting facilities and services to the participants. The committee has had to raise meeting registration fees, effective with this meeting. A discourse on the new fees appears in the **Inside the AMS** section of this issue. The registration fees at the meetings will be 30% higher than the preregistration fees listed below.

Joint Mathematics Meetings	
Member of AMS, Canadian Mathematical Society, MAA, NCTM	$105
Emeritus Member of AMS, MAA	$ 25
Nonmember	$163
Student/Unemployed	$ 25
Employment Register	
Employer	$120
Additional interviewer (each)	$ 60
Applicant	$ 25
Employer posting fee	$ 25
AMS Short Course	
Student/Unemployed	$ 25
All Other Participants	$ 55
Emeritus	$ 25
MAA Minicourses	
(if openings available)	
Minicourses # 3, 4, 5, 7, 8, 9, 10, 12, 13, 14, 16, 17	$ 36
Minicourses #1, 2, 6, 11, 15	$ 60

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

A $5 charge will be imposed for all invoices prepared when preregistration forms are submitted without accompanying check(s) for the preregistration fee(s) or are accompanied by an amount insufficient to cover the total payments due. We are sorry, but it is not possible for the Mathematics Meetings Service Bureau to refund amounts less than $2. Preregistration forms received well before the deadline of December 17 which are not accompanied by correct payment will be returned to the participant with a request for resubmission with full payment. This will, of course, delay the processing of any housing request.

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

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

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

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

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

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

Preregistration deadlines: There are three separate preregistration deadlines, each with its own advantages and benefits.

EARLY Preregistration	November 9
ORDINARY Preregistration (and Housing)	November 16
FINAL Preregistration (no Housing)	December 17

EARLY Preregistration: Those who preregister by the **EARLY** deadline of November 9 will be eligible for a drawing to select the winners of complimentary hotel rooms in San Francisco. Multiple occupancy of these rooms is permissible. The location of rooms to be used in this lottery will be based on the number of complimentary rooms available in the various hotels. Therefore, the free room may not necessarily be in the winner's first choice hotel. Winners will be randomly selected from the names of all participants who preregister by November 9. The winners will be notified by mail prior to December 31. **So preregister early!** (A list of the winners in Louisville appears in the section titled **How to Get a Room**).

ORDINARY Preregistration: Those who preregister by the **ORDINARY** deadline of November 16 may utilize the housing services offered by the Mathematics Meetings Service Bureau.

FINAL Preregistration: Those who preregister by the **FINAL** deadline of December 17 must pick up their badge and program at the meetings. Unfortunately, it is not possible to provide **FINAL** preregistrants with housing or tickets to special events, although the latter may still be available for purchase at the meetings. **Please note that the December 17 deadline is firm and any forms received after that date must be returned and full refunds issued.**

ELECTRONIC Preregistration: Preregistration through electronic mail is also available. Anyone wishing to preregister through this method should send a message to MEET@MATH.AMS.COM requesting this service. A message will be sent back within 24 hours with instructions on how to complete the format required. **Credit card is the ONLY method of payment which can be accepted for electronic preregistration.** Forms received through this method will be treated in the same manner as forms received through U.S. mail. Receipt of the Preregistration/Housing Form and payment will be acknowledged by the Mathematics Meetings Service Bureau. Participants are advised to bring a copy of this acknowledgement with them to San Francisco. The same deadlines apply as for normal preregistration. **Please note that forms for the Employment Register cannot be sent through electronic mail.** Only the form(s) found elsewhere in this announcement can be accepted.

All **EARLY** and **ORDINARY** preregistrants will receive formal acknowledgements prior to the meetings. **FINAL** preregistrants will receive instead a letter from the Mathematics Meetings Service Bureau (including receipt of payment) prior to the meetings. Both **EARLY** and **ORDINARY** preregistrants will receive their badge, program, and prepurchased tickets by mail two to three weeks before the meeting, unless they check the appropriate box to the contrary on the Preregistration/Housing Form.

So, it is extremely important that the mailing address given on the Preregistration/Housing Form be one at which the participant can receive this mailing. There will be a special Registration Assistance desk at the meetings to assist individuals who either do not receive this mailing or who have a problem with their registration. Please note that a $2 replacement fee will be charged for programs and badges that are mailed but not taken to the meetings. Unfortunately, it will not be possible to make changes at the meeting to badges received through the mail before the meetings.

Please note that requests for housing through the Mathematics Meetings Service Bureau and forms for the Employment Register must be received by the ORDINARY deadline of November 16.

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

Participants wishing their nickname to appear on their badge should provide this information on the

Preregistration/Housing Form.

It is planned to make available at the meetings a list of preregistrants by area of interest. If you wish to be included in this list, please provide the *Mathematical Reviews* classification number of your major area of interest on the Preregistration/Housing Form. (A list of these numbers appears on the back of the AMS abstract form.) The master copy of this list will be available for review by participants at the Directory of Registrants located near the registration area.

How to Get a Room

Participants must preregister by the **ORDINARY** deadline of November 16 in order to obtain hotel accommodations through the Mathematics Meetings Service Bureau. Be sure to complete the Housing section of the Preregistration/Housing Form completely, after reading the information in this section thoroughly. Participants are asked to rank all hotels on the form after reviewing the following page.

Handicapped: People with special requirements for housing should make these clear when submitting the Preregistration/Housing Form.

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

All participants wishing to preregister for the San Francisco meetings are urged to consider the **EARLY deadline of November 9** in order to qualify for the San Francisco Room Lottery. (See the section titled **How To Preregister.**)

The Brown

John W. Neuberger
Bruce Ramsay
Olaf P. Stackelberg

Galt House

Jan Jaworski
Meyer Jerison
Michael McAsey
Joan McCarter
Phyllis K. Metzler
Philip R. Montgomery
Lawrence Schovanec
Diane M. Spresser

Galt House East

Clifton A. Lando
George E. Lang
Carolyn R. Mahoney
William A. Marion
Phillip McNeil
Reese T. Prosser
Abdulalim A. Shabazz
Ralph C. Steinlage
Marilyn Zweng

Seelbach

Joseph F. Kent
Efim Khalimsky
Bernadette H. Perham
Margaret L. Reese

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

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

Miscellaneous Information

Audio-Visual Equipment: Standard equipment in all session rooms is one overhead projector and screen. (Invited 50-minute speakers are automatically provided with two overhead projectors.) **Blackboards are not available.**

AMS speakers requiring additional equipment should contact the Audio-Visual Coordinator for the meeting, at the AMS office in Providence by calling 401-455-4140 or electronic mail WSD@MATH.AMS.COM **by November 1.**

MAA speakers requiring additional equipment may make written request for one additional overhead projector/screen, 35mm carousel slide projector, 16mm sound film projector, or VHS video cassette recorder with one color monitor. Such requests should be addressed to the Audio-Visual Coordinator for the meeting who will forward them to the MAA Secretary for possible approval. These requests should also be received **by November 1.**

Child Care: The following are local child care centers. Participants should contact these agencies directly.

Temporary Tot Tending. On site children sitting by arrangement, 415-355-7377, 415-871-5790 after 6:00 p.m.

How to Obtain Hotel Accommodations

The rates listed below are subject to a 11 percent sales/occupancy tax. Checkin time for the Mark Twain and Handlery is 3:00 p.m., for the Hilton and King George 2:00 p.m., and for the Raphael any time. Checkout time for the Mark Twain, Handlery, Hilton, and King George is noon and for the Raphael 1:00 p.m.

Participants desiring confirmed reservations for the following hotels **must** make the reservations through the Meetings Service Bureau **prior to the November 16, 1990 deadline. Reservations at these hotels CANNOT be made by calling the hotel directly until after December 26, 1990. Please make all changes to or cancellations of hotel reservations with the Mathematics Service Bureau in Providence through December 12, 1990. The telephone number in Providence is 401-455-4143. The Service Bureau cannot accept changes after December 12, 1990; however, changes and cancellations can be called in directly to the hotels after December 26, 1990. Please allow the Service Bureau from December 13 to December 26 to get all final housing lists and changes sent to the hotels. It is imperative that all hotels listed on the back of the preregistration form be numbered in order of preference to insure accurate hotel assignments.**

The hotels listed below are full service hotels. The Hilton, Handlery, and Raphael offer a **LIMITED** number of nonsmoking rooms. All of the rooms in the King George have windows that open. The Mark Twain does not have nonsmoking rooms. The hotels listed below are equipped for handicapped; however, the King George is not equipped for the handicapped with wheelchairs. Special attention will be given to participants with special needs. Please note that the King George and the Raphael offer a limited number of twin beds.

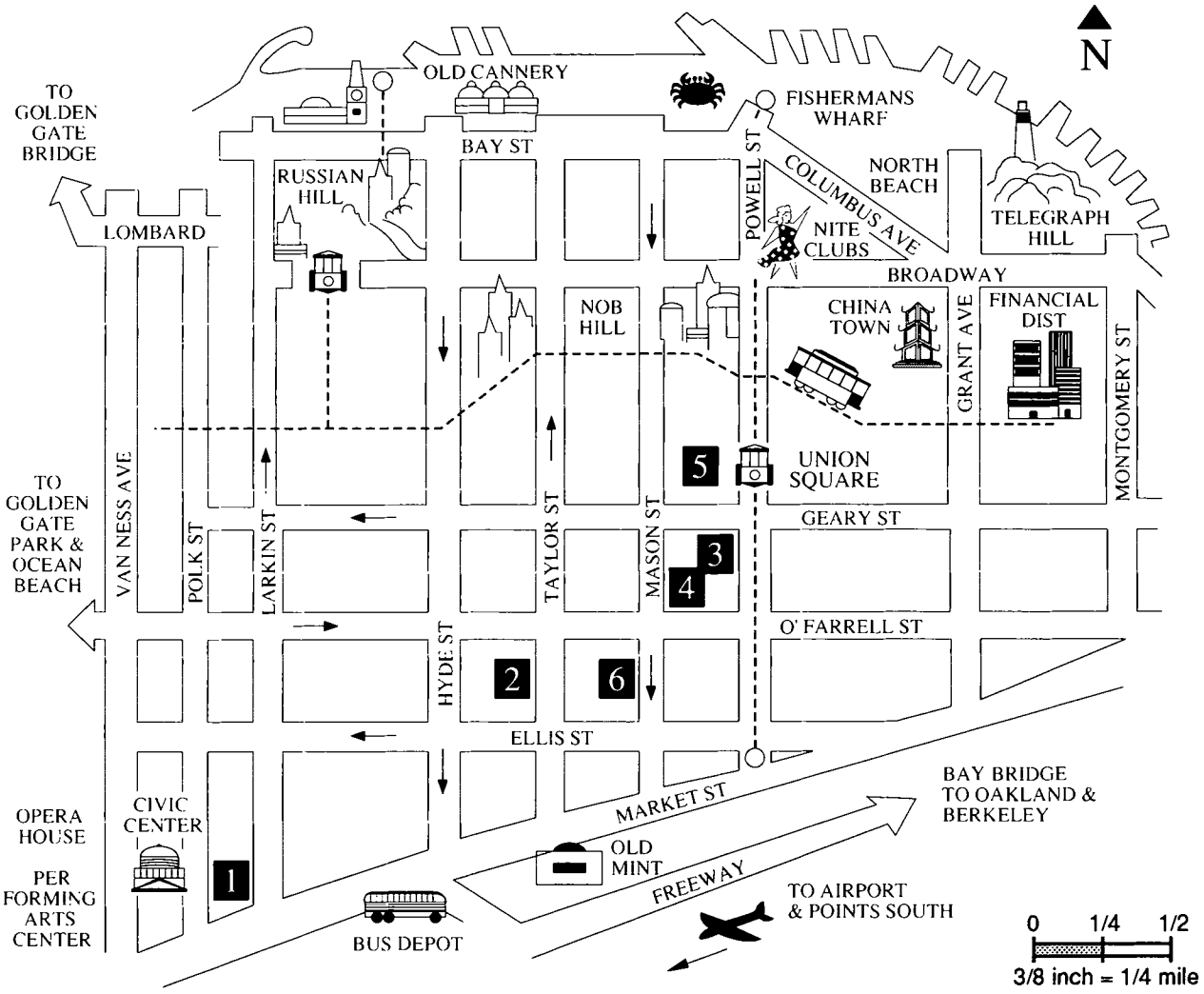
GUARANTEE REQUIREMENTS: $50 by check **OR** a credit card guarantee with VISA, MasterCard, or American Express (for housing only). No other credit cards will be accepted. **American Express cards may be used for housing guarantees only and not for preregistration.** For room payments, the hotels accept all major credit cards. Personal checks are accepted with personal identification and a credit card backup at the Handlery, Hilton, and Raphael. Personal checks are accepted with American Express or a driver's liscense at the King George. Personal checks are not accepted at the Mark Twain.

	Location	Description	Single	Double	Double 2 beds	Triple 2 beds	Triple 2 beds w/cot	Quad 2 beds	Quad 2 beds w/cot	Suites* (starting rates)
Hilton Hotel on Hilton Square (Headquarters)	One Hilton Square San Francisco, CA 94102 415-771-1400	Restaurants, Health Club, Sauna, Heated Outdoor Pool, Parking $16 per day (In/Out - Self or Valet), Children free								
DELUXE			$ 107	$ 120	$ 120	$ 140	$ N/A	$ 160	$ N/A	$ 192+
SUPERIOR			95	107	107	127	N/A	147	N/A	192+
STANDARD - REGULAR			82	95	95	115	N/A	135	N/A	192+
STANDARD - STUDENT OR UNEMPLOYED**			65	65	65	65	N/A	65	N/A	192+
The Handlery Union Square	351 Geary Street San Francisco, CA 94102 415-781-7800	Restaurant, Heated Outdoor Pool, Parking $8.50 per day (In/Out), Children 14 yrs. & younger free	75	75	75	85	N/A	95	N/A	125+
The King George Hotel	334 Mason Street San Francisco, CA 94102 415-781-5050	Restaurant, English High Tea served, Parking $14 per day - across street (In/Out), Children under 12 yrs. free	71	75	N/A	N/A	N/A	N/A	N/A	178
Hotel Mark Twain	345 Taylor Street San Francisco, CA 94102 415-673-2332	Restaurant, Parking on corner - Valet $19/Self $10 per day (In/Out), Children 12 yrs. & younger free	70	70	70	N/A	85	N/A	N/A	165
The Raphael	386 Geary Street San Francisco, CA 94102 415-986-2000	Restaurant, Parking around corner $14 per day (In/Out), Children 17 yrs. & younger free	69	69	N/A	N/A	N/A	N/A	N/A	110+

* All reservations for suites must be made directly with the Service Bureau. The hotel can supply general information only.

** Participant must be a certified student or unemployed to qualify for these rates.

Downtown San Francisco



1 - Civic Auditorium (Location of Employment Register)
2 - Hotel Mark Twain
3 - The Handlery Union Square Hotel
4 - The King George Hotel
5 - The Raphael Hotel
6 - San Francisco Hilton on Hilton Square

→ Indicate directions on oneway streets

--- Cable Car Line

Aunt Ann's Agency, 415-421-8442
Bay Area Baby Sitters Agency, 415-991-7474
The San Francisco Hilton on Hilton Square will also make referrals.

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

Information Distribution: A table is set up in the registration area of the Joint Mathematics Meetings for dissemination of information of a **nonmathematical** nature of possible interest to the members.

A second table is set up in the exhibit area for the dissemination of information of a **mathematical** nature **not** promoting a product or program for sale.

If a person or group wishes to display information of a mathematical nature promoting a product or program for sale, they may do so in the exhibit area at the Joint Books, Journals and Promotional Materials exhibit for a fee of $30 per item.

If a person or group would like to display material in the exhibit area separate from the Joint Books table, the proponent must reimburse the AMS and MAA for any extra furnishings requested (tables, chairs, easels, etc.) in addition to payment of the $30 per item fee.

The administration of these tables is in the hands of the AMS-MAA Joint Meetings Committee, as are all arrangements for Joint Mathematics Meetings. The following rules and procedures apply.

1. Announcements submitted by participants should ordinarily be limited to a single sheet no more than $8\frac{1}{2}'' \times 14''$.

2. A copy of any announcement proposed for either table is to be sent to the Director of Meetings, American Mathematical Society, Post Office Box 6887, Providence, Rhode Island 02940 to arrive at least one week before the first day of the scientific sessions.

3. The judgment on the suitability of an announcement for display rests with the Joint Meetings Committee. It will make its judgments on a case-by-case basis to establish precedents.

4. Announcements of events competing in time or place with the scheduled scientific program will not be accepted.

5. Copies of an accepted announcement for either table are to be provided by the proponent. Announcements are not to be distributed in any other way at the meeting (for example, not by posting or personal distribution of handbills).

6. It may be necessary to limit the number of events or the quantity of announcements distributed at a meeting.

7. At the close of registration, both tables will be swept clean. A proponent who wishes the return of extra copies should remove them.

Mail: All mail and telegrams for persons attending the meetings should be addressed as follows: Name of Participant, Joint Mathematics Meetings, c/o San Francisco Hilton on Hilton Square, One Hilton Square, San Francisco, CA 94102. Mail and telegrams so addressed may be picked up at the mailbox in the meetings registration area during the hours the registration desk is open. U.S. mail not picked up will be forwarded after the meeting to the mailing address given on the participant's registration record.

Telephone Messages: A telephone message center is located in the registration area to receive incoming calls for participants. **The center is open from January 17 through 20, during the hours that the Joint Mathematics Meetings registration desk is open.** Messages will be taken and the name of any individual for whom a message has been received will be posted until the message has been picked up at the message center. Once the registration desk has closed for the day there is no mechanism for contacting participants other than calling them directly at their hotel. The telephone number of the message center is 415-923-7540.

Travel: San Francisco International Airport is 14 miles south of the city and served by the major airlines. The AirporterBus is $6 with pick-up every 10 to 20 minutes at upper level, center island, blue column. Drop off is on the Mason Street side of the San Francisco Hilton on Hilton Square. The SuperShuttle is $10 per person and pick-up is at upper level American Airlines and USAir every ten minutes. Travel by airport limousine to convention area hotels is $45 for up to six passengers. Reservations are required and can be made by calling 415-761-1717. The taxi trip should cost no more than $30.

The Oakland International Airport is located south of Oakland alongside San Francisco Bay and served by twelve airlines. Airport limousine to convention area hotels is $39 for up to 6 people. Reservation is suggested (415-569-LIMO). The taxi trip is $35. Public transportation via AirBART shuttle and BART (Bay Area Rapid Transit) is available. Exit the San Francisco BART train at Powell Street. The San Francisco Hilton on Hilton Square is four blocks away.

Directions for traveling by car follow. The San Francisco Hilton on Hilton Square is at Mason between Ellis and O'Farrell.

From the North: Golden Gate Bridge to Lombard Street; thence to Van Ness, right on Van Ness, left off Van Ness onto Bush, Bush to Mason, right onto Mason.

From the East: San Francisco-Oakland Bay Bridge. Exit at 5th Street, cross Market Street. After about two blocks, left onto Ellis to the hotel.

From the South: Take U.S. 101 North, follow Civic Center signs, exit Ninth Street. At bottom of off ramp (traffic light), bend slightly to the left onto Ninth; head north on Ninth until Market Street, moving over to second lane from the right. Cross Market Street and make slight bend to right along Larkin until O'Farrell (about seven blocks–one block beyond Ellis). Right turn on O'Farrell until Taylor (four blocks); hotel is between Taylor and Mason with entrance curved inward for passenger drop-off.

Please note the following freeway closures:

In San Francisco: Stretch of U.S. 280 from Silver Avenue to Army Street; Franklin Street off-ramp; and Embarcadero Freeway.

In Oakland: Nimitz Freeway along Cypress.

For some years now, the AMS-MAA Joint Meetings Committee has engaged a travel agent for the January and August Joint Meetings in an effort to ensure that everyone attending these meetings is able to obtain the best possible airfare. This service is being performed by TRAVCON; their advertisement can be found elsewhere in this meeting announcement. Although any travel agent can obtain Supersaver or other such published promotional fares, only TRAVCON can obtain the special additional 5% discount over and above these fares and the 45% off regular coach fare. The latter, of course, is financially beneficial only when one does not qualify for one of the promotional fares. Participants should pay particular attention to the policies stated in the ad.

Weather: In January, San Francisco is on Pacific Daylight Time. The daily mean temperature varies from 46°F to 56°F with an average rainfall of 4.48 inches. Do not bring summer clothes. Dial 415-936-1212 in San Francisco for weather information.

Local Arrangements Committee

The members of the Local Arrangements Committee are William G. Chinn, Guy M. De Primo, Judith Ekstrand, Newman H. Fisher (chair), William H. Jaco (ex-officio), Millianne G. Lehman, Andy R. Magid (ex-officio), Peter S. Pacheco, Kenneth A. Ross (ex-officio), Franklin F. Sheehan, and Edward T. Walsh.

Petition Table

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

Signs of moderate size may be displayed at the table, but must not represent that the case of the individual in question is backed by the Committee on Human Rights unless it has, in fact, so voted. Volunteers may be present at the table to provide information on individual cases, but notice must be sent at least seven (7) days in advance of the meetings to the Director of Meetings in Providence (telephone 401-455-4137). Since space is limited, it may also be necessary to limit the number of volunteers present at the table at any one time. The Committee on Human Rights may delegate a person to be present at the table at any or all times, taking precedence over other volunteers.

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

Committee on the Agenda for Business Meetings

The Society has a Committee on the Agenda for Business Meetings. The purpose is to make Business Meetings orderly and effective. The committee does not have legal or administrative power. It is intended that the committee consider what may be called "quasi-political" motions. The committee has several possible courses of action on a proposed motion, including but not restricted to

(a) doing nothing;

(b) conferring with supporters and opponents to arrive at a mutually accepted amended version to be circulated in advance of the meeting;

(c) recommending and planning a format for debate to suggest to a Business Meeting;

(d) recommending referral to a committee;

(e) recommending debate followed by referral to a committee.

There is no mechanism that requires automatic submission of a motion to the committee. However, if a motion has not been submitted through the committee, it may be thought reasonable by a Business Meeting to refer it rather than to act on it without benefit of the advice of the committee.

The committee consists of M. Salah Baouendi, Robert M. Fossum (chairman), and Carol L. Walker.

In order that a motion for the Business Meeting of January 17, 1991, receive the service offered by the committee in the most effective manner, it should have been in the hands of the secretary by December 10, 1990.

Robert M. Fossum, Secretary

THE LEGACY OF
John von Neumann

James G. Glimm, John Impagliazzo, and Isadore Singer, Editors

Proceedings of Symposia in Pure Mathematics

Volume

50

The ideas of John von Neumann have had a profound influence on modern mathematics and science. One of the great thinkers of our century, von Neumann initiated major branches of mathematics—from operator algebras to game theory to scientific computing—and had a fundamental impact on such areas as self-adjoint operators, ergodic theory and the foundations of quantum mechanics, and numerical analysis and the design of the modern computer.

This volume contains the proceedings of an AMS Symposium in Pure Mathematics, held at Hofstra University, in May 1988. The symposium brought together some of the foremost researchers in the wide range of areas in which von Neumann worked. These articles illustrate the sweep of von Neumann's ideas and thinking and document their influence on contemporary mathematics. In addition, some of those who knew von Neumann when he was alive have presented here personal reminiscences about him. This book is directed to those interested in operator theory, game theory, ergodic theory, and scientific computing, as well as to historians of mathematics and others having an interest in the contemporary history of the mathematical sciences. This book will give readers an appreciation for the workings of the mind of one of the mathematical giants of our time.

1980 *Mathematics Subject Classification*: 28DXX, 46LXX, 65XX, 76XX, 81XX
ISBN 0-8218-1487-7 , LC 90-33765, ISSN 0082-0717
334 pages (hardcover), July 1990
Individual member $34, List price $56,
Institutional member $45
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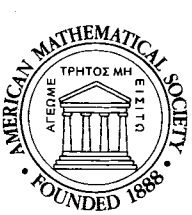

All prices subject to change. Free shipment by surface; for air delivery, please add $6.50 per title. *Prepayment required.* **Order from** American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, or call toll free 800-321-4AMS (321-4267) in the continental U.S. and Canada to charge with VISA or MasterCard.

Timetable

(Pacific Daylight Time)

The purpose of this timetable is to provide assistance to preregistrants in the selection of arrival and departure dates. The program, as outlined below, is based on information at press time.

Monday, January 14

AMS SHORT COURSE SERIES
PROBABILISTIC COMBINATORICS AND ITS APPLICATIONS

MORNING

9:45 a.m. - 2:30 p.m.	SHORT COURSE REGISTRATION Outside Plaza A, San Francisco Hilton
10:45 a.m. - noon	SHORT COURSE LECTURE #1 *Random graphs* **Béla Bollobás**

AFTERNOON

2:00 p.m. - 3:15 p.m.	SHORT COURSE LECTURE #2 *Constructing random-like graphs* **Fan R. K. Chung**
3:45 p.m. - 5:00 p.m.	SHORT COURSE LECTURE #3 *Discrete isoperimetric inequalities* **Imre Leader**
5:00 p.m. - 5:30 p.m.	Discussion period

Tuesday, January 15

MORNING

American Mathematical Society	Mathematical Association of America	Other Organizations
	8:30 a.m. - 4:00 p.m. BOARD OF GOVERNORS' MEETING	
9:00 a.m. - 10:15 a.m. SHORT COURSE LECTURE #4 *Random graphs revisited* **Béla Bollobás**		
10:45 a.m. - noon SHORT COURSE LECTURE #5 *Rapidly mixing Markov chains* **Umesh Vazirani**		

AFTERNOON

American Mathematical Society	Mathematical Association of America	Other Organizations
2:00 p.m. - 3:15 p.m. SHORT COURSE LECTURE #6 *Computing the volume of convex bodies* **Alan Frieze**		
2:00 p.m. - 7:00 p.m. COUNCIL MEETING		
3:00 p.m. - 7:00 p.m. REGISTRATION FOR JOINT MEETINGS Tower Room, San Francisco Hilton		
3:45 p.m. - 5:00 p.m. SHORT COURSE LECTURE #7 *Fourier analysis* **Persi Diaconis**		
5:00 p.m. - 5:30 p.m. Discussion period		

Tuesday, January 15 (cont'd)

	American Mathematical Society	Mathematical Association of America	Other Organizations
EVENING			
7:00 p.m. - 9:00 p.m.		SECTION OFFICERS' MEETING	
7:00 p.m. - 9:00 p.m.		MINICOURSE #1 (Part A) *Calculus as a laboratory science* **Marcelle Bessman**	

Wednesday, January 16

	American Mathematical Society	Mathematical Association of America	Other Organizations
MORNING			
7:30 a.m. - 4:00 p.m.		REGISTRATION Tower Room, San Francisco Hilton	
8:00 a.m. - 10:55 a.m.	SPECIAL SESSIONS *C*-algebras and noncommutative topology, I* *Combinatorial design theory, I* *Boundary behavior in partial differential equations, I* *Hopf algebras, I* SESSIONS FOR CONTRIBUTED PAPERS	CONTRIBUTED PAPER SESSIONS *Professional development for teachers of mathematics*, Part A **John Dossey** **Elizabeth J. Teles** *Humanistic mathematics*, Part A **Alvin White** **Marilyn Frankenstein** **Joan Countryman** *Lesser known geometrical gems*, Part A **Don Chakerian** **Richard Pfeifer** **Jane Sangwine-Yager**	ASSOCIATION FOR WOMEN IN MATHEMATICS SYMPOSIUM *The future of women in mathematics*
8:00 a.m. - 10:00 a.m.		MINICOURSE #2 (Part A) *The use of computing in teaching linear algebra* **Eugene A. Herman** **Charles H. Jepsen** MINICOURSE #3 (Part A) *The mathematics of computer graphics* **Jack Goldfeather** MINICOURSE #4 (Part A) *Elementary robotics* **Walter Meyer** MINICOURSE #5 (Part A) *Using pocket computers to enhance the teaching and learning of precalculus and calculus* **Bert K. Waits** **Franklin Demana**	

Wednesday, January 16 (cont'd)

American Mathematical Society | Mathematical Association of America | Other Organizations

MORNING (cont'd)

8:00 a.m. - 9:20 a.m.

COMMITEE ON SCIENCE POLICY
SPECIAL PRESENTATION
Mathematicians and state governments
John A. Thorpe, organizer

9:00 a.m. - 9:30 a.m.

EMPLOYMENT REGISTER ORIENTATION SESSION

9:30 a.m. - 4:00 p.m.

EMPLOYMENT REGISTER REGISTRATION
Civic Auditorium

9:30 a.m. - 10:55 a.m.

AMS-MAA-SIAM COMMITTEE ON PREPARATION FOR COLLEGE TEACHING PANEL DISCUSSION
Dialogue: Paradigm meets reality
Bettye Anne Case, organizer

CUPM SUBCOMMITTEE ON SERVICE COURSES PANEL DISCUSSION
Perspectives on service courses for business students
Joe Fiedler
Barbara A. Jur, moderator
James Minatel
Barry Scholler

10:05 a.m. - 10:55 a.m.

INVITED ADDRESS
Lattices and elliptic curves
Noam D. Elkies

11:10 a.m. - noon

AMS-MAA INVITED ADDRESS
Harish-Chandra and his work
Rebecca A. Herb

AFTERNOON

noon - 1:00 p.m.

NATIONAL SCIENCE FOUNDATION
Informal Discussion Group

1:00 p.m. - 2:00 p.m.

COLLOQUIUM LECTURE I
Title to be announced
Robert Macpherson

1:00 p.m. - 5:00 p.m.

EXHIBIT AND BOOK SALE

BOOK SALE

EXHIBITS

2:15 p.m. - 3:05 p.m.

INVITED ADDRESS
Developing the next generation of mathematicians
Uri Treisman

Wednesday January 16 (cont'd)

AFTERNOON (cont'd)

2:15 p.m. - 6:05 p.m.

AMS-MAA SPECIAL SESSION
Research in undergraduate mathematics education, I

American Mathematical Society

SPECIAL SESSIONS
C-algebras and noncommutative topology, II*

Oscillation and dynamics in delay equations, I

Real algebraic geometry, I

History of mathematics, I

Combinatorial design theory, II

Boundary behavior in partial differential equations, II

Hopf algebras, II

Entire function theory, I

SESSIONS FOR CONTRIBUTED PAPERS

Mathematical Association of America

CONTRIBUTED PAPER SESSIONS
Professional development for teachers of mathematics, Part B
John Dossey
Elizabeth J. Teles

Humanistic mathematics, Part B
Alvin White
Marilyn Frankenstein
Joan Countryman

Lesser known geometrical gems, Part B
Don Chakerian
Richard Pfeifer
Jane Sangwine-Yager

2:15 p.m. - 4:15 p.m.

MINICOURSE #1 (Part B)
Calculus as a laboratory science
Marcelle Bessman

MINICOURSE #3 (Part B)
The mathematics of computer graphics
Jack Goldfeather

3:20 p.m. - 4:10 p.m.

INVITED ADDRESS
An analogue of Huber's formula for Riemann's zeta function
Floyd Williams

3:20 p.m. - 5:20 p.m.

Other Organizations

AWM SYMPOSIUM
The future of women in mathematics

4:25 p.m. - 5:15 p.m.

INVITED ADDRESS
Two-dimensional modular representations of the Galois group of **Q**
Kenneth A. Ribet

4:30 p.m. - 6:30 p.m.

MINICOURSE #4 (Part B)
Elementary robotics
Walter Meyer

MINICOURSE #6 (Part A)
Pedagogical uses of Derive and GyroGraphics
Jerry Johnson
Benny Evans

Wednesday, January 16 (cont'd)

	American Mathematical Society	Mathematical Association of America	Other Organizations
EVENING			
4:30 p.m. - 6:00 p.m.		TWO-YEAR COLLEGE RECEPTION ELEMENTARY SCHOOL TEACHERS' RECEPTION	
6:00 p.m. - 8:00 p.m.	AMS-MAA DISCUSSION *Estate planning for AMS & MAA members* **Richard Witter** **Timothy J. Goggins**		MATHEMATICIANS AND EDUCATION REFORM BANQUET
7:00 p.m. - 8:00 p.m.		COMMITTEE ON THE MATHEMATICAL EDUCATION OF TEACHERS OPEN DISCUSSION *A call for change* **James R.C. Leitzel**	
7:00 p.m. - 8:00 p.m.		VIDEO PRESENTATION *Archimedean and Archimedean dual polyhedra* **Lorraine L. Foster**	
7:00 p.m. - 8:00 p.m.		CAS WORKSHOP REUNION **Donald B. Small, organizer**	
7:15 p.m. - 8:15 p.m.	INTERAGENCY COMMISSION FOR EXTRAMURAL MATHEMATICS PROGRAMS (ICEMAP)		
8:30 p.m. - 9:30 p.m.	JOSIAH WILLARD GIBBS LECTURE *Physics and the mysteries of space* **Sir Michael Atiyah**		
9:30 p.m. - 11:00 p.m.			AWM OPEN RECEPTION

Thursday, January 17

	American Mathematical Society	Mathematical Association of America	Other Organizations
MORNING			
7:30 a.m. - 4:00 p.m.	REGISTRATION Tower Room, San Francisco Hilton		
8:00 a.m. - 10:55 a.m.	AMS-MAA SPECIAL SESSION *Research in undergraduate mathematics education, II*		
	SPECIAL SESSIONS *C*-algebras and noncommutative topology, III* *Oscillation and dynamics in delay equations, II* *Real algebraic geometry, II* *History of mathematics, II*	CONTRIBUTED PAPER SESSIONS *Professional development for teachers of mathematics,* Part C **John Dossey** **Elizabeth J. Teles** *Humanistic mathematics,* Part C **Alvin White** **Marilyn Frankenstein** **Joan Countryman**	

Thursday, January 17 (cont'd)

MORNING (cont'd)

	American Mathematical Society	Mathematical Association of America	Other Organizations
8:00 a.m. - 10:55 a.m.	SPECIAL SESSIONS *Combinatorial design theory, III* *Boundary behavior in partial differential equations, III* *Hopf algebras, III* *Entire function theory, II* SESSIONS FOR CONTRIBUTED PAPERS	CONTRIBUTED PAPER SESSIONS *Lesser known geometrical gems*, Part C **Don Chakerian** **Richard Pfeifer** **Jane Sangwine-Yager**	
8:00 a.m. - 10:00 a.m.		MINICOURSE #2 (Part B) *The use of computing in teaching linear algebra* **Eugene A. Herman** **Charles H. Jepsen** MINICOURSE #5 (Part B) *Using pocket computers to enhance the teaching and learning of precalculus and calculus* **Bert K. Waits** **Franklin Demana**	
8:15 a.m. - 9:15 a.m.		COMMITTEE ON CONSULTANTS PANEL DISCUSSION *Hints for consultants* **Richard S. Millman**	
9:00 a.m. - 9:50 a.m.			AWM EMMY NOETHER LECTURE *Title to be announced* **Alexandra Bellow**
9:00 a.m. - 5:00 p.m.	EXHIBIT AND BOOK SALE	BOOK SALE	
9:00 a.m. - 5:00 p.m.	EXHIBITS		
9:00 a.m.	EMPLOYMENT REGISTER DISTRIBUTION OF SCHEDULES		
9:30 a.m. - 5:30 p.m.	EMPLOYMENT REGISTER INTERVIEWS		
9:30 a.m. - 10:55 a.m.		PANEL DISCUSSION *Mathematics and the environment* **Ben Fusaro** **Marcia P. Sward**	
10:00 a.m. - 11:00 a.m.			AWM BUSINESS MEETING
10:05 a.m. - 10:55 a.m.		INVITED ADDRESS *What was Abel's theorem?* **Harold M. Edwards**	
11:10 a.m. - noon	AMS-AWM-MAA INVITED ADDRESS *Some nonstandard construction methods for local noetherian rings* **Cristel Rotthaus**		

Thursday, January 17 (cont'd)

	American Mathematical Society	Mathematical Association of America	Other Organizations
AFTERNOON			
noon - 1:00 p.m.		NATIONAL SCIENCE FOUNDATION Informal Discussion Group	
1:00 p.m. - 2:00 p.m.	COLLOQUIUM LECTURE II *Title to be announced* **Robert Macpherson**		
2:15 p.m. - 3:05 p.m.	INVITED ADDRESS *Recent results and open problems in deterministic nonlinear control theory* **Héctor J. Sussmann**		
2:15 p.m. - 4:20 p.m.	AMS-MAA SPECIAL SESSIONS *Research in undergraduate mathematics education, III* *Mathematics and education reform, I*		
	SPECIAL SESSIONS *Computing optimal geometries, I* *Oscillation and dynamics in delay equations, III* *Arithmetical algebraic geometry, I* SESSIONS FOR CONTRIBUTED PAPERS	CONTRIBUTED PAPER SESSIONS *Professional development for teachers of mathematics*, Part D **John Dossey** **Elizabeth J. Teles** *Humanistic mathematics*, Part D **Alvin White** **Marilyn Frankenstein** **Joan Countryman** *Lesser known geometrical gems*, Part D **Don Chakerian** **Richard Pfeifer** **Jane Sangwine-Yager**	AWM WORKSHOP
2:15 p.m. - 4:15 p.m.		MINICOURSE #7 (Part A) *Symmetry analysis of repeated patterns* **Donald W. Crowe** MINICOURSE #8 (Part A) *The theory and application of discrete dynamics* **James T. Sandefur** MINICOURSE #9 (Part A) *Combinatorial designs* **Walter D. Wallis**	

Thursday, January 17 (cont'd)

	American Mathematical Society	Mathematical Association of America	Other Organizations
AFTERNOON (cont'd)			
2:15 p.m. - 4:15 p.m.		COMMITTEE ON STUDENT CHAPTERS WORKSHOP	
2:15 p.m. - 4:20 p.m.		COMMITTEE ON COMPUTERS IN MATHEMATICS EDUCATION PANEL DISCUSSION *The laboratory approach to teaching calculus* **Carl Leinbach, organizer**	
2:15 p.m. - 4:15 p.m.		CUPM SUBCOMMITTEE ON UNDERGRADUATE RESEARCH IN MATHEMATICS STUDENT PROJECTS POSTER SESSION	
3:20 p.m. - 4:10 p.m.	INVITED ADDRESS *Matrix searching and its applications* **Maria M. Klawe**		
4:35 p.m. - 6:10 p.m.	PRIZE SESSION AND BUSINESS MEETING		
EVENING			
6:00 p.m. - 10:00 p.m.			AWM 20TH ANNIVERSARY BANQUET
7:00 p.m. - 9:00 p.m.	JOINT POLICY BOARD FOR MATHEMATICS AND OFFICE OF GOVERNMENTAL AND PUBLIC AFFAIRS SESSION		
7:00 p.m. - 9:00 p.m.		MINICOURSE #6 (Part B) *Pedagogical uses of Derive and GyroGraphics* **Jerry Johnson** **Benny Evans** MINICOURSE #10 (Part A) *Chaotic dynamical systems* **Robert L. Devaney**	
7:00 p.m. - 10:00 p.m.	AMS-MAA PANEL DISCUSSON *The undergraduate linear algebra curriculum* **David H. Carlson** **Charles R. Johnson** **David C. Lay** **A. Duane Porter, moderator**		

Friday, January 18

MORNING

	American Mathematical Society	Mathematical Association of America	Other Organizations
7:30 a.m. - 4:00 p.m.		REGISTRATION Tower Room, San Francisco Hilton	
8:00 a.m. - 10:55 a.m.		AMS-MAA SPECIAL SESSIONS *Research in undergraduate mathematics education, IV* *Mathematics and education reform, II*	
	SPECIAL SESSIONS *Computing optimal geometries, II* *Real algebraic geometry, III* *Arithmetical algebraic geometry, II* SESSIONS FOR CONTRIBUTED PAPERS	CONTRIBUTED PAPER SESSIONS *Statistics and probability*, Part A **Sheldon P. Gordon** **Florence S. Gordon** *Alternatives to the lecture method*, Part A **James R.C. Leitzel** *Using history in the teaching of mathematics*, Part A **David E. Zitarelli**	NATIONAL ASSOCIATION OF MATHEMATICIANS (NAM) CONTRIBUTED PAPER SESSION *Presentations by recent doctoral recipients* **Gerald Chachere, moderator**
8:00 a.m. - 10:00 a.m.		MINICOURSE #7 (Part B) *Symmetry analysis of repeated patterns* **Donald W. Crowe** MINICOURSE #8 (Part B) *The theory and application of discrete dynamics* **James T. Sandefur** MINICOURSE #9 (Part B) *Combinatorial designs* **Walter D. Wallis** MINICOURSE #12 (Part A) *Writing in mathematics courses* **George D. Gopen** **David A. Smith**	
8:00 a.m. - 10:55 a.m.		COMMITTEE ON STUDENT CHAPTERS WORKSHOP	
8:00 a.m. - 9:20 a.m.		SESSION *Environmental modeling* **Ben Fusaro, organizer** **Roland H. Lamberson** **Roy B. Leipnik** **Robert W. McKelvey**	

Friday, January 18 (cont'd)

	American Mathematical Society	Mathematical Association of America	Other Organizations
MORNING (cont'd)			
8:00 a.m. - 9:20 a.m.		WOMEN AND MATHEMATICS SESSION *WAM: Yesterday, today and tomorrow--In commemoration of WAM's 15 years of service* **Alice Kelly, moderator** **Virginia E. Knight** **Eileen L. Poiani** **Roseanna F. Torretto**	
9:00 a.m. - 9:50 a.m.	INVITED ADDRESS *Subgroup actions on homogeneous spaces and number theory* **Grigorii Aleksandrovič Margulis**		
9:00 a.m. - 5:00 p.m.	EXHIBIT AND BOOK SALE	BOOK SALE	
9:00 a.m. - 5:00 p.m.	EXHIBITS		
9:00 a.m.	EMPLOYMENT REGISTER DISTRIBUTION OF SCHEDULES		
9:30 a.m. - 5:30 p.m.	EMPLOYMENT REGISTER INTERVIEWS		
9:30 a.m. - 10:55 a.m.		CUPM SUBCOMMITTEE ON UNDERGRADUATE RESEARCH IN MATHEMATICS PANEL DISCUSSION *Models for undergraduate research* **Lida K. Barrett, moderator** **Deborah Bergstrand** **Joseph Gallian** **Robbie Robson**	
9:30 a.m. - 10:55 a.m.		COMMITTEE ON THE UNDERGRADUATE PROGRAM IN MATHEMATICS PANEL DISCUSSION *Undergraduate curriculum iniatives--from ideas to action* **Lynn A. Steen**	
10:05 a.m. - 10:55 a.m.	COMMITTEE ON SCIENCE POLICY GOVERNMENT SPEAKER		
11:10 a.m. - noon	AMS-MAA INVITED ADDRESS *Characteristic forms* **Shing S. Chern**		
AFTERNOON			
noon - 1:00 p.m.	NATIONAL SCIENCE FOUNDATION Informal Discussion Group		
1:00 p.m. - 2:00 p.m.	COLLOQUIUM LECTURE III *Title to be announced* **Robert D. Macpherson**		

Friday, January 18 (cont'd)

	American Mathematical Society	Mathematical Association of America	Other Organizations
AFTERNOON (cont'd)			
1:00 p.m. - 4:20 p.m.	AMS-MAA SPECIAL SESSIONS *Mathematics and education reform, III* *Research papers by undergraduates, I*		
	SPECIAL SESSIONS *Matrix searching, Monge arrays and Ackemann's inverse: algorithms and lower bounds, I* *Computing optimal geometries, III* *Geometric Fourier analysis, I* *Turbulence, I* *Deterministic nonlinear control theory and related topics, I* *Analytical methods in convexity, I* *Arithmetical algebraic geometry, III* SESSIONS FOR CONTRIBUTED PAPERS	CONTRIBUTED PAPER SESSIONS *Statistics and probability,* Part B **Sheldon P. Gordon** **Florence S. Gordon** *Alternatives to the lecture method,* Part B **James R.C. Leitzel** *Using history in the teaching of mathematics,* Part B **David E. Zitarelli**	
1:00 p.m. - 2:30 p.m.		MAA-NAM PANEL DISCUSSION Nurturing minority graduate students in mathematics **Sylvia T. Bozeman, moderator** **Mary W. Gray** **Raymond L. Johnson** **Abdulalion M. Shabazz** **Richard A. Tapia**	
1:00 p.m. - 4:20 p.m.		CUPM SUBCOMMITTEE ON CALCULUS REFORM AND THE FIRST TWO YEARS POSTER SESSION **Thomas W. Tucker, organizer**	
1:30 p.m. - 2:30 p.m.		STUDENT PRESENTATION *Mathematical contest in modeling* **Ben Fusaro, organizer**	
2:15 p.m. - 3:05 p.m.		INVITED ADDRESS *Algebraic curves and error correcting codes from a modern point of view* **Carlos Moreno**	
2:15 p.m. - 4:10 p.m.			ROCKY MOUNTAIN MATHEMATICS CONSORTIUM BOARD OF DIRECTORS' MEETING

Friday, January 18 (cont'd)	American Mathematical Society	Mathematical Association of America	Other Organizations
AFTERNOON (cont'd)			
2:15 p.m. - 4:15 p.m.		MINICOURSE #11 (Part A) *A survey of educational software* **Virginia Knight** **Vivian Kraines** MINICOURSE #13 (Part A) *Great theorems from mathematical analysis: 1689-1881* **William Dunham** MINICOURSE #17 (Part A) *Instituting a mathematics placement program: Creating order out of chaos in freshman mathematics* **Mary McCammon**	
3:20 p.m. - 4:15 p.m.		CUPM SUBCOMMITTEE ON QUANTITATIVE LITERACY DEBATE *RESOLVED - All college graduates should know college algebra* **Linda R. Sons, moderator**	
4:35 p.m. - 5:40 p.m.		PRIZE SESSION AND BUSINESS MEETING	
EVENING			
6:00 p.m. - 7:00 p.m.			BOARD ON MATHEMATICAL SCIENCES SESSION *Using the DAVID II Report* **Lawrence H. Cox, organizer**
6:00 p.m. - 8:00 p.m.			NAM BANQUET
6:00 p.m. - 8:00 p.m.			ASSOCIATION OF RESEARCH LIBRARIES SESSION *Delivering information to researchers: Opportunities and impediments* **Ann Okerson, organizer**
7:00 p.m. - 9:00 p.m.		MINICOURSE #10 (Part B) *Chaotic dynamical systems* **Robert L. Devaney** MINICOURSE #14 (Part A) *Actuarial mathematics* **Jonathan Kane** MINICOURSE #15 (Part A) *Learning abstract algebra by programming in ISETL* **Ed Dubinsky** **Uri Leron**	

Friday, January 18, (cont'd)

	American Mathematical Society	Mathematical Association of America	Other Organizations
EVENING (cont'd)			
7:00 p.m. - 8:30 p.m.		COMMITTEE ON PARTICIPATION OF WOMEN IN MATHEMATICS SPECIAL PRESENTATION *Changing the climate - Skits and discussion* **Patricia C. Kenschaft, moderator**	
7:30 p.m. - 10:00 p.m.	SPECIAL SESSION *Automatic theorem proving*		
7:30 p.m. - 10:30 p.m.		COMMITTE ON STUDENT CHAPTERS SPECIAL LECTURE AND RECEPTION **Lester H. Lange**	
8:00 p.m. - 9:30 p.m.		NATIONAL CENTER FOR THE TEACHING OF UNDERGRADUATE MATHEMATICS OPEN DISCUSSION *What is it and what should it be?* **Robert Bumcrot, moderator**	

Saturday, January 19

	American Mathematical Society	Mathematical Association of America	Other Organizations
MORNING			
7:30 a.m. - 3:00 p.m.		REGISTRATION Tower Room, San Francisco Hilton	
8:00 a.m. - 10:55 a.m.		AMS-MAA SPECIAL SESSIONS *Research in undergraduate mathematics education, V* *Mathematics and education reform, IV* *Research papers by undergraduates, II*	
	SPECIAL SESSIONS *Matrix searching, Monge arrays and Ackemann's inverse: algorithms and lower bounds, II* *Computing optimal geometries, IV* *Geometric Fourier analysis, II* *Turbulence, II* *Deterministic nonlinear control theory and related topics, II*	CONTRIBUTED PAPER SESSIONS *Statistics and probability,* Part C **Sheldon P. Gordon** **Florence S. Gordon** *Alternatives to the lecture method,* Part C **James R.C. Leitzel** *Using history in the teaching of mathematics,* Part C **David E. Zitarelli**	

Saturday, January 19 (cont'd)

MORNING (cont'd)

	American Mathematical Society	Mathematical Association of America	Other Organizations
8:00 a.m. - 10:55 a.m.	SPECIAL SESSIONS *Analytical methods in convexity, II* *Arithmetical algebraic geometry, IV* SESSIONS FOR CONTRIBUTED PAPERS		
8:00 a.m. - 10:00 a.m.		MINICOURSE #11 (Part B) *A survey of educational software* **Virginia Knight** **Vivian Kraines** MINICOURSE #12 (Part B) *Writing in mathematics courses* **George D. Gopen** **David A. Smith** MINICOURSE #16 (Part A) *A mathematician's introduction to the HP-48SX scientific expandable calculator for first-time users* **John Kenelly** **Don LaTorre**	
8:00 a.m. - 9:20 a.m.		CUPM SUBCOMMITTEE ON ASSESSMENT OF UNDERGRADUATE MAJORS PANEL DISCUSSION *Assessment: Definitions and examples* **Bernard L. Madison, organizer**	
9:00 a.m. - 9:50 a.m.		CUPM SUBCOMMITTEE ON SYMBOLIC COMPUTATION SPECIAL PRESENTATION *Symbolic computation in geometry and algebra* **Dana Scott**	
9:00 a.m. - noon	EXHIBIT AND BOOK SALE	BOOK SALE	
9:00 a.m. - noon	EXHIBITS		
10:00 a.m. - 10:55 a.m.			NAM BUSINESS MEETING
10:05 a.m. - 10:55 a.m.		INVITED ADDRESS *The N-body problem: Where parallel algorithms, graph theory, and fluid dynamics meet* **Jill P. Mesirov**	
11:10 a.m. - noon	AMS-MAA INVITED ADDRESS *Compound soap bubbles, shortest networks, and minimal surfaces* **Frank Morgan**		

Saturday, January 19 (cont'd)

American Mathematical Society | Mathematical Association of America | Other Organizations

AFTERNOON(cont'd)

noon - 1:00 p.m.

NATIONAL SCIENCE FOUNDATION
Informal Discussion Group

1:00 p.m. - 2:00 p.m.

NAM CLAYTOR LECTURE

1:00 p.m. - 5:30 p.m.

AMS-MAA SPECIAL SESSION
Research papers by undergraduates. III

SPECIAL SESSIONS
Geometric Fourier analysis. III

Turbulence. III

Deterministic nonlinear control theory and related topics. III

Analytical methods in convexity. III

SESSIONS FOR CONTRIBUTED PAPERS

CONTRIBUTED PAPER SESSIONS
Statistics and probability. Part D
Sheldon P. Gordon
Florence S. Gordon

Alternatives to the lecture method. Part D
James R.C. Leitzel

Using history in the teaching of mathematics. Part D
David E. Zitarelli

1:00 p.m. - 3:00 p.m.

MINICOURSE #10 (Part C)
Chaotic dynamical systems
Robert L. Devaney

MINICOURSE #13 (Part B)
Great theorems from mathematical analysis: 1689-1881
William Dunham

MINICOURSE #14 (Part B)
Actuarial mathematics
Jonathan Kane

MINICOURSE #15 (Part B)
Learning abstract algebra by programming in ISETL
Ed Dubinsky
Uri Leron

AMS-MAA COMMITTEE ON EMPLOYMENT AND EDUCATIONAL POLICY PANEL DISCUSSION
The employment process: How can we do better?
Kenneth P. Bogart
Edward A. Connors
Donald J. Lewis
Eileen L. Poiani
Donald C. Rung

MAA-NCTM PANEL DISCUSSION
Discrete mathematics: Making the connection between the high school and college curricula
Don S. Balka, moderator
Robert Devaney
Stephen B. Maurer
Bernadette H. Perham

Saturday, January 19 (cont'd)	American Mathematical Society	Mathematical Association of America	Other Organizations
AFTERNOON (cont'd)			
2:15 p.m. - 3:05 p.m.	RETIRING PRESIDENTIAL ADDRESS *From Coxeter diagrams to Kummer identities* **G. D. Mostow**		
3:15 p.m. - 5:15 p.m.		MINICOURSE #12 (Part C) *Writing in mathematics courses* **George D. Gopen** **David A. Smith** MINICOURSE #15 (Part C) *Learning abstract algebra by programming in ISETL* **Ed Dubinsky** **Uri Leron** MINICOURSE #16 (Part B) *A mathematician's introduction to the HP-48SX scientific expandable calculator for first-time users* **John Kenelly** **Don LaTorre** MINICOURSE #17 (Part B) *Instituting a mathematics placement program: Creating order out of chaos in freshman mathematics* **Mary McCammon**	
3:30 p.m. - 5:00 p.m.	COMMITTEE ON SCIENCE POLICY PANEL DISCUSSION		
EVENING			
7:00 p.m. - 10:00 p.m.	25-YEAR-MEMBER BANQUET		

Mathematical Sciences Employment Register January 16, 17, & 18

January 1991 in the Civic Auditorium, San Francisco

The Mathematical Sciences Employment Register (MSER), held annually at the Joint Mathematics Meetings in January, provides opportunities for mathematical scientists seeking professional employment to meet employers who have positions to be filled. Job listings (or descriptions) and résumés prepared by employers and applicants are assigned code numbers, and displayed at the meeting so that members of each group may determine which members of the other group they would like to have an opportunity to interview. Requests for interviews are then submitted, and a computer program assigns the appointments, matching requests submitted by employers and applicants [not areas of interest] to the extent possible, using an algorithm which maximizes the number of interviews which can be scheduled subject to constraints determined by the number of time periods available, the numbers of applicants and employers, and the pattern of requests. The report below outlines the operation of the register, indicating some of the procedures involved for the benefit of those not familiar with its operation.

The Mathematical Sciences Employment Register is apparently unique among employment services offered by professional organizations in the sciences, engineering and the humanities. The computer programs used are constructed around a matching program, devised by Donald R. Morrison, and based on an algorithm described in his paper "Matching Algorithms" in *Journal of Combinatorial Theory*, volume **6** (1969), pages 20 to 32; see also "Matching Algorithms" (abstract) *Notices*, August 1967, page 630. The number of interviews arranged by the program is significantly greater than the number possible at the employment registers of other organizations, in many cases greater by an order of magnitude.

1991 Employment Register in San Francisco

The Employment Register will be held on Wednesday, Thursday, and Friday, January 16, 17, and 18, 1991, in the Main Auditorium in the Civic Auditorium located at 99 Grove Street (between Polk and Larkin). Free shuttle service will be provided for participants using the register, and it will run between the San Francisco Hilton on Hilton Square and the Civic Auditorium. A schedule will be available at a later date. A short (optional) orientation session will be conducted by the AMS-MAA-SIAM Committee on Employment Opportunities at 9:00 a.m. on Wednesday, January 16. The purpose of the orientation session is to familiarize participants with the operation of the Register and with the various forms involved. Computer-scheduled interviews will be held on Thursday and Friday, January 17 and 18. **No interviews will be held on Wednesday.**

Fifteen-minute intervals are allowed for interviews, including two or three minutes between successive interviews. The interviews are scheduled in half-day sessions: Thursday morning and afternoon, and Friday morning and afternoon, amounting to four half-day sessions for interviews. There are ten time periods (9:30 – 11:45 a.m.) in which interviews can be scheduled in the morning and fourteen time periods (1:15 – 5:00 p.m.) in the afternoon. It is possible that an applicant or employer may be scheduled for the maximum number of interviews in a session. Requests for interviews will be accommodated depending on the availability of participants. The scheduling program does not have a provision allowing participants to specify particular times for interviews beyond the choice of session (day, and morning or afternoon). Such requests cannot be accommodated.

IMPORTANT INFORMATION

Requests for interviews taking place during the two sessions on Thursday MUST BE SUBMITTED ON WEDNESDAY between 9:30 a.m. and 4:00 p.m. Requests for interviews to take place during the Friday sessions must be submitted on Thursday before 4:00 p.m. Those who fail to do so cannot be included in the pool of available participants when the matching program which schedules the interviews is run on the computer that night. This applies to all employers and applicants, whether preregistered or on-site registrants. Forms submitted with preregistration achieve registration for the Employment Register only. These forms do not automatically include the participant in the interviewing process. The interview request form must be turned in by 4:00 p.m. in order to receive a computer printed schedule of interviews for the next day.

On Thursday and Friday mornings at 9:00 a.m., all schedules for applicants and employers for the day (both

morning and afternoon sessions) will be available for distribution.

The Friday afternoon session is the annual "employers' choice" session. For this session interviews will be scheduled on the basis of requests made by employers. Applicants do not submit specific interview requests for this session; but, in order to participate, they must indicate their availability for the session by returning the Interview Request Form for Friday, indicating that they will attend the afternoon session that day.

Applicants should be aware of the fact that interviews arranged by the Employment Register represent only an initial contact with employers and that hiring decisions are not ordinarily made during or immediately following such interviews. **Applicants are advised to bring a number of copies of their vitae or résumés so that they may leave them with prospective employers.**

The Mathematical Sciences Employment Register is sponsored by the American Mathematical Society, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics; it is operated by members of the AMS staff under the general supervision of the joint AMS-MAA-SIAM Committee on Employment Opportunities.

Anyone with questions about the Employment Register should contact the Employment Register Coordinator at the American Mathematical Society at 401-455-4142, or by e-mail: CAK@MATH.AMS.COM. The telephone number to be used after the Register begins is 415-978-5900. Participants should note that this number is for those who will be participating in the Employment Register and is not for contacting participants or taking messages. Those who wish to leave messages should call the message center telephone number found in the San Francisco meeting announcement.

Background of Applicants

Statistics from previous Employment Registers have shown employers sought to fill approximately 180 positions, 10 of which were nonacademic jobs. For 98% of the positions, holders of doctoral degrees were preferred; for 65% of the positions only applicants with doctorates were acceptable; for 30% of the positions, holders of masters degrees were considered eligible. Few of the nonacademic employers indicated an interest in holders of bachelors degrees in mathematics.

Preregistered Employers/Applicants

Preregistration for the Mathematical Sciences Employment Register **must be completed by November 16, 1990.** Applicants and employers (including all interviewers) who wish to preregister for the Employment Register must also register for the Joint Mathematics Meetings. Forms for preregistration, housing, the applicant résumé form, and the employer form are located in the back of this issue. Preregistration for the Employment Register, in addition to permitting inclusion in the printed winter lists of Employers, and the *December Issue of EIMS* has the advantage of reduced fees and the services of the Mathematics Meetings Service Bureau and has the further advantage of helping to reduce waiting times at the meeting in San Francisco.

Employer and applicant forms received after the **November 16 deadline cannot** be included in the printed lists. For details on registration and preregistration for the San Francisco Joint Mathematics Meetings, please refer to the information on these subjects which may be found elsewhere in this issue.

Employers' job listings and applicants' résumés with their assigned code numbers will be posted at the meeting, so that applicants and employers may review them.

Those who preregister by the deadline of **November 16** will receive their badge, program and Employment Register material in the mail two to three weeks prior to the meeting, unless they indicate otherwise by checking the appropriate box on the Preregistration/Housing form.

Those who preregister by the FINAL deadline of December 17, will pick up their Employment Register material at the Employment Register area. Employer and applicant forms received after the deadline of November 16 will not appear in the printed lists. Therefore, it is important that one submit these forms by **November 16,** if one wishes to appear in the lists.

Forms received by the **FINAL deadline of December 17** will be assigned code numbers and will be posted in the Employment Register area.

Preregistered Applicants

In addition to the Joint Meetings preregistration fee, there is an applicant fee of $25 payable **prior to the November 16 deadline**. These fees must accompany the Preregistration/Housing Form.

Applicants' résumés will be made available to employers in printed form, so that they may be studied carefully at leisure. The December issue of *Employment Information in the Mathematical Sciences (EIMS)* will contain photographic reproductions of the résumés of applicants who have preregistered **by November 16.** Forms not received in time cannot be included in this issue. **See the section on preparation of résumés elsewhere in this announcement.**

Preregistered Employers

In addition to the Joint Meetings preregistration fee, there is a separate charge for each employer who will be interviewing applicants at the register. There is no additional charge for posting more than one position, provided they are in the same department.

Please refer to the Preregistration/Housing Form for a list of the Joint Mathematics Meetings and Employment Register fees. These fees must accompany the Preregistration/Housing Form. The registration fee for employers covers the cost of a copy of the December Issue of *EIMS*. This publication contains printed copies of the résumés of applicants who preregistered prior to the deadline. **Please note: The Winter List of Applicants will no longer be prepared and, therefore, will not appear in *EIMS* or be distributed at the meeting as in previous years.**

It is requested that employers submit both employer and Preregistration/Housing Forms with appropriate fees in the same envelope. It would also be helpful if the names of cointerviewers are listed on the employer form. If possible, these individuals should also preregister at the same time.

It is the policy of some institutions to pay for employer fees. These payments do not always accompany the preregistration forms but are sent in after the deadline has passed, or when the meeting is over. It is important that the institution's fiscal department indicate the name of the participating employer with their remittance advice or payment order so that proper credit can be made in Providence.

Employers are encouraged to provide more than one interviewer, when they are able to do so, in order to increase the number of interviews which may be scheduled. **Please take care to indicate on the form the number and names of interviewers for whom simultaneous interviews may be scheduled.** (If all interviewers will be interviewing for the same position, or for the same set of positions, only one form should be submitted and only one employer code number will be assigned; therefore, each interviewer would then receive a separate computer schedule and separate table number.) More than one employer code will be required if some interviewers will not interview for all positions. Thus, if there are two disjoint sets of positions, two forms are required and two employer codes will be assigned.

A coded strip at the bottom of the form summarizes the information on each form. All employers are required to complete the Summary Strip. This is used to prepare a computer-printed list of preregistered employers for distribution to the applicants at the meeting.

Nonpreregistered Applicants and Employers

Employers and applicants who wish to participate in the Register who have neither preregistered nor paid the Employment Register fee must first go to the Joint Mathematics Meetings registration desk, in order to complete their registration. **No provision will be made to handle cash transactions at the site of the Employment Register.** Registration for the Joint Meetings is required for participation in the Employment Register. It is also required that all participating employer interviewers register for the Joint Mathematics Meetings.

Please refer to the Preregistration/Housing Form for onsite registration fees.

The registration fee for employers covers the cost of a copy of the December Issue of *EIMS*. This publication contains printed copies of the résumés of applicants who preregistered prior to the deadline. **Please note: The Winter List of Applicants will no longer be prepared and, therefore, will not appear in *EIMS* or be distributed at the meeting as in previous years.**

After registration has been completed, applicants and employers should come to fill out the forms necessary to participate in the Employment Register. Employers' job listings and applicants' résumés will be posted at the meeting, so that applicants and employers may review them.

Nonparticipating Employers

Employers who do not plan to participate in the Employment Register, but wish to display job descriptions, may obtain special forms from Carole Kohanski, MSER, P. O. Box 6887, Providence, RI 02940. These job descriptions must be received in the Providence office by **November 16** along with the fee of $25 for this service.

Employers who attend the Joint Mathematics Meetings, but do not want to interview, can post job descriptions at the Employment Register. Postings will not be allowed in the Joint Meetings registration area. A fee of $25 will be charged and must be paid at the Joint Mathematics Meetings registration desk. Participants should be sure to inform the cashier that they would like to post a job description but are not planning to interview and obtain the proper receipt in order to receive the form necessary for posting at the Employment Register desk.

Applicants Not Planning to Attend

Applicants seeking professional positions in the mathematical sciences, who do not plan to attend the meeting in San Francisco and participate in the Employment Register, may submit résumés for publication in the December issue of *EIMS* if they use the MSER Form for Applicants at the back of this issue and **observe the deadline of November 16. (It is, of course, not necessary to preregister for the meeting or pay the Employment Register registration fee if one is not attending the meeting. Résumés will only appear in the December Issue of *Employment Information in the Mathematical Sciences* and will not be posted at the Employment Register if the participant is not attending the meeting.)**

Winter Lists of Employers

The Winter List of Employers consists of summaries of the position listings submitted by the employers who

preregistered for the meeting; it will be distributed to the applicants participating in the Register. Others may purchase the Winter List of Employers at the AMS Exhibit and Book Sale at the meeting or from the Providence office after the meeting. The price at the meeting is $6 each. Any copies remaining after the meeting will be available from the Providence office of the Society for $8 each.

Please note that this list will not be updated with on-site employers during or after the Employment Register has concluded.

December Issue of Employment Information in the Mathematical Sciences

For several years the periodical *EIMS* has published six issues per year listing open positions in academic, governmental and industrial organizations, primarily in North America, along with a few listings from countries in other parts of the world. *EIMS* is a joint project of the American Mathematical Society (publisher), the Mathematical Association of America, and the Society for Industrial and Applied Mathematics.

The December issue of *EIMS* contains résumés of persons seeking professional positions in the mathematical sciences. Résumés of applicants taking part in the Employment Register and those not attending will be included in the December 1990 issue provided they are received before the November 16 deadline and are in satisfactory condition. Other mathematical scientists who wish to be included may have their résumés printed if the same deadline is observed and if the copy supplied meets the same technical requirements described in the following section.

Copies of the December issue of *EIMS* will be distributed to the employers who participate in the Employment Register.

Additional copies of the December Issue of *EIMS* will be available for sale at the AMS Exhibit and Book Sale at the meeting. Prices at the meeting are $8 each for the December issue. Any copies remaining after the meeting will be available from the Providence office of the Society for $15 each.

Preparation of Applicants' Résumés for the December issue of EIMS

The December issue of *EIMS* will be printed using photographic reproductions of forms completed and submitted by applicants. For this reason, special care must be exercised by those who prepare the forms in order to assure that the results are of good quality, and will be clear and legible after they have been photographed, reduced in size, and printed.

Because an employer's first impressions of an applicant are likely to be based on the appearance of the printed form, applicants are strongly advised to study the suggestions given below, before the forms are filled out, so that the original copy will be neither marred nor damaged.

The forms **must be** carefully typed using a new black ribbon. The best results are obtained by using a modern typewriter with a carbon-coated polyethylene film ribbon, but satisfactory results may be obtained with a ribbon made of nylon or other woven fabric if suitable care is exercised. It is important that the keys be clean and make a sharp, clear impression, which must be a uniform dark black. Gray, blue, or other colors will not reproduce and should, therefore, not be used. Do not use an eraser, as it will cause smudges which reproduce when photographed. Use a correcting typewriter, or correction tape or fluid, if necessary.

Only an original copy of the form should be submitted, a photocopy or xerographic reproduction will not reproduce as well and may not be accepted for publication. It is therefore important to exercise care in order to assure that the results are satisfactory.

Submission of copy of good quality is entirely the responsibilty of the applicant. The Society (which will print this material) must be the final judge of what copy is capable of being reproduced adequately and therefore of what is acceptable for inclusion in the printed booklet. The Society will not correct or replace inadequate copy and cannot prepare original copy. In the event the quality of a résumé, submitted by an applicant participating in the Employment Register, does not meet the necessary conditions for inclusion in the December issue, the résumé will be returned if time allows; otherwise the résumé will be posted at the Employment Register in San Francisco, along with those of the other participants. **Forms received past the deadline of November 16 will be returned.**

List of Retired Mathematicians Available for Employment

The annual *List of Retired Mathematicians* will be included in the December and January issues of the publication *Employment Information in the Mathematical Sciences*. Retired mathematicians who are interested in being included in the list may send the following information to the Mathematical Sciences Employment Register, American Mathematical Society, P. O. Box 6887, Providence, Rhode Island 02940.

1. Full name
2. Mailing address
3. Highest degree, year, university
4. Most recent employment: institution
5. Type of position desired
6. Academic or industrial employment preferred
7. Date available for employment (month/year)
8. Geographic location preferred

The deadline for receipt of this information is **November 16**. Offprints of the list will be available from the Mathematical Sciences Employment Register at the above address.

American Mathematical Society Short Course Series

Introductory Survey Lectures on *Probabilistic Combinatorics and Its Applications*

San Francisco, California, January 14-15, 1991

The American Mathematical Society, in conjunction with its ninety-seventh Annual Meeting, will present a two day Short Course entitled "Probabilistic Combinatorics and Its Applications" on Monday and Tuesday, January 14-15, 1991, at San Francisco Hilton on Hilton Square. The program is under the direction of Béla Bollobás of the University of Cambridge.

Probabilistic methods have been applied with great success in various branches of mathematics for over half a century, but it is in applications to combinatorics that their power is most apparent. This is partly because combinatorics is a very down-to-earth branch of mathematics, so that the methods are not hidden behind the machinery of the subject, and also because the results produced tend to be very striking. In combinatorics it is often fairly easy to show by probabilistic means the existence of certain objects with desirable properties, while their explicit construction may be rather difficult.

The prime area for the use of probabilistic combinatorics is the theory of random graphs, which during the past three decades has matured into a rich subject. The traditional methods of probabilistic combinatorics have recently been augmented by many exciting new techniques, such as martingale inequalities, discrete isoperimetric inequalities, Fourier analysis on groups, eigenvalue techniques, branching processes and rapidly mixing Markov chains.

Monday, January 14:

BÉLA BOLLOBÁS, University of Cambridge, *Random Graphs I*

FAN R. K. CHUNG, Bellcore, *Constructing Random-like Graphs*

IMRE LEADER, University of Cambridge, *Discrete Isoperimetric Inequalities*

Tuesday, January 15:

BÉLA BOLLOBÁS, University of Cambridge, *Random Graphs Revisited*

UMESH VAZIRANI, University of California, Berkeley, *Rapidly Mixing Markov Chains*

ALAN M. FRIEZE, Carnegie Mellon University, *Computing the Volume of Convex Bodies*

PERSI W. DIACONIS, Harvard University, *Fourier Analysis*

Synopses of the talks and accompanying reading lists follow. Lecture notes will be mailed to those who preregister and will be available at the Short Course registration desk for those registering on site.

Advance registration fee: $55 ($25 student/unemployed). Onsite registration fee: $70 ($30 student/unemployed). Registration and housing information can be found in this issue of *Notices*, see the section on **how to preregister and get a room in the meetings section.**

The Short Course series is under the direction of the Short Course Subcommittee of the AMS-MAA Committee on Employment and Educational Policy (CEEP): Stefan A. Burr (chair), R. Peter DeLong, Lisl Novak Gaal, Robert P. Kurshan, Barbara L. Osofsky, Marjorie L. Stein, and James J. Tattersall.

Synopses and Reading Lists:

Random Graphs (Béla Bollobás). Consider a set V of n vertices. We form a graph on V by joining each pair of vertices with the same probability p, independently of each other. What we obtain is a random graph G_p. What does a "typical" random graph G_p look like? How does its structure change as p increases? In this introductory lecture we shall present some of the basic results concerning the structure of G_p and other random graphs, and give some applications. In particular, we present the basic results of Erdős and Rényi, the description of the emergence of the giant component due to Bollobás, and the recent refinements due to Luczak.

Among the applications, we start with the classical results of Erdős concerning the chromatic number, and go on to consider expansion properties, sorting, and union-find algorithms.

[1] P. Erdős, Graph theory and probability, *Canad. J. Math.* **11** (1959), 34–38.

[2] P. Erdős and A. Rényi, On the evolution of random graphs, *Publ. Math. Inst.*, Hungar. Acad. Sci. **5** (1960), 17–61.

[3] B. Bollobás, The evolution of random graphs, *Trans. Amer. Math. Soc.* **286** (1984), 257–274.

[4] B. Bollobás, *Random Graphs*, Academic Press, London et al., 1985, xiv + 447pp.

Constructing Random-Like Graphs (Fan Chung). Random graphs have many nice properties that are often useful in a variety of applications in combinatorics, computer science and communication networks. We will describe old and new methods (algebraic, combinatorial as well as number theoretic) for explicitly constructing graphs that behave in many ways like random graphs.

[1] A. Lubotzky, R. Phillips and P. Sarnak, Ramanujan graphs, *Combinatorica* **8** (1988), 261–277.

[2] F. Bien, Constructions of telephone networks by group representations, *Notices Amer. Math. Soc.* **36** (1989), 5–22.

[3] N. Alon and V. Milman, λ_1, Isoperimetric inequalities for graphs and superconcentrators, *J. Combinatorical Theory (B)* **38** (1985), 73–88.

[4] F. R. K. Chung, Diameters and eigenvalues, *J. Amer. Math. Soc.* **2** (1989), 187–196.

[5] N. Pippenger, Superconcentrators, *SIAM J. Comput.* **6** (1977), 198–304.

Discrete Isoperimetric Inequalities (Imre Leader). An isoperimetric inequality is a lower bound for the size of the 'boundary' of a set in terms of the size of the set. In the discrete setting, most isoperimetric inequalities relate the 'boundary' of a set S of vertices of a graph G to the number of vertices in S. A typical notion of boundary is the edge-boundary $\partial_e S$: the collection of edges between S and its complement. Given $|S|$ (and G), how small can $|\partial_e S|$ be?

In recent years, discrete isoperimetric inequalities have become important in probabilistic combinatorics. Many new methods have been discovered for attacking isoperimetric inequalities: martingale techniques, eigenvalue analysis, and purely combinatorial methods. The talk will concentrate on various new combinatorial ideas, which often give rise to sharp bounds. The talk will also introduce martingale techniques, and the 'concentration of measure' phenomenon.

[1] L. H. Harper, Optimal numberings and isoperimetric problems on graphs, *J. Comb. Theory* **1** (1966), 385–393.

[2] N. Alon and V. D. Milman, λ_1, isoperimetric inequlaities for graphs, and superconcentrators, *J. Comb. Theory* (B) **38** (1985), 73–88.

[3] B. Bollobás, Sharp concentration of measure phenomena in the theory of random graphs, in *Random Graphs '87* (M. Karonski, J. Jaworski and A. Rucinski, eds.), Wiley, 1990, pp. 1–15.

[4] B. Bollobás and I. Leader, Compressions and isoperimetric inequalities, *J. Comb. Theory* (A), to appear.

[5] B. Bollobás and I. Leader, Edge-isoperimetric inequalities in the grid, *Combinatorica*, to appear.

Random Graphs Revisted (Béla Bollobás). In recent years the emergence of new methods has resulted in the solution of several hitherto inaccessible problems. Using sophisticated methods involving Poisson convergence and generating functions, Flajolet, Knuth and Pittel extended theorems of Janson and Bollobás to obtain precise results about the first cycles in an evolving graph. The chromatic number of a random graph was pinned down by the use of martingales. Random subgraphs of the cube were studied with success using isoperimetric inequalities and the theory of branching processes.

The aim of this talk is to discuss several of these solutions, with emphasis on the use of martingales and isoperimetric inequalities, as introduced in the third lecture.

[1] E. Shamir and J. Spencer, Sharp concentration of the chromatic number of random graphs $G_{n,p}$, *Combinatorica* **7** (1987), 121–129.

[2] B. Bollobás, The chromatic number of random graphs, *Combinatorica* **8** (1988), 49–55.

[3] S. Janson, Poisson convergence and Poisson process with applications to random graphs, *Stochastic Processes and their Applications* **26** (1980) 1–30.

[4] B. Bollobás, Martingales, isoperimetric inequalities, and random graphs, *Coll. Math. Soc. J. Bolyai* **52** (1987) 113–139.

[5] P. Flajolet, D. E. Knuth and B. Pittel, The first cycles in an evolving graph, *Discrete Mathematics* **75** (1989), 167–215.

Rapidly Mixing Markov Chains (Umesh Vazirani). Over the past five years, powerful new methods have been developed for proving rapid mixing properties for general Markov Chains. The motivating force was the analysis of sophisticated randomized approximate counting algorithms which are based on being able to efficiently sample from the stationary distribution of some Markov Chain. Our talk will explore the new methods for proving rapid mixing as well as the connection to approximate counting algorithms.

[DLMV] P. Dagum, M. Luby, M. Mihail and U. Vazirani, "Polytopes, Permanents and Graphs with Large Factors," *Proceedings of the 29th Annual Symp. on Foundations of Computer Science*, 1988.

[Mi] M. Mihail, "Conductance and Convergence of Markov Chains—A Combinatorial Treatment of Expanders," *Proceedings of the 30th Annual Symp. on Foundations on Computer Science*, 1989.

[JS] M. Jerrum and A. Sinclair, "Conductance and the Rapidly Mixing Property for Markov Chains: the Approximation of the Permanent Resolved," *Proceedings of the 20th Annual Symp. on the Theory of Computing*, 1988.

Computing the Volume of Convex Bodies (A. M. Frieze). Mathematicians have been interested in computing volumes of bodies since ancient times and in some sense the problem gave rise to the concept of the integral.

In this paper we will focus on the problem of the computation of the volume of a convex body K in R^n. We will discuss this from the point of view of its computational complexity. We give results which indicate that deterministic algorithms for this problem are bound to have bad worst-case behavior, i.e. take too

long or give very poor estimates.

We then describe how using a random walk on a lattice of cubes that meet K we can quickly, i.e. in polynomial time, find an estimate of the volume of K which is as accurate as desired.

Some applications of this result will be discussed.

[1] I. Barany and Z. Furedi, "Computing the volume is difficult", *Proceedings of the 18th Annual ACM Symposium on Theory of Computing*, (1986) 442–447.

[2] M. E. Dyer, A. M. Frieze and R. Kannan, "A random polynomial time algorithm for approximating the volume of convex bodies", *Proceedings of the 21st Annual ACM Symposium on Theory of Computing*, (1989) 375–381.

[3] L. Lovasz and M. Simonovitz, "The mixing rate of Markov chains, an isoperimetric inequality and computing the volume", *Proceedings of the 30th Annual IEEE Symposium on Foundations of Computing*, (1990).

Fourier Analysis (Persi W. Diaconis). We will survey recent results dealing with applications of Fourier analysis on groups to a variety of problems in combinatorics, theoretical computer science, probability, and statistics. These will include such topics as: eigenvalues and isoperimetric inequalities, random walks on hypercubes and other groups, and the randomness of card shuffling.

[1] Group representations in probability and statistics, *Institute of Mathematical Statistics Lecture Notes* – Monograph Series, 11, Institute of Mathematical Statistics, Hayward, CA, 1988, vi + 198 pp.

Invited Speakers and Special Sessions

Invited Speakers at AMS Meetings

The individuals listed below have accepted invitations to address the Society at the times and places indicated. For some meetings, the list of speakers is incomplete.

San Francisco, CA, January 1991

Please see the first announcement of this meeting elsewhere in this issue.

South Bend, IN, March 1991

Leonid G. Makar-Limanov
Donald G. Saari
Stephen D. Smith
Deane Yang

Tampa, FL, March 1991

Josefina Alvarez
Ronald A. DeVore
Michel L. Lapidus
Donald St. P. Richards

Orono, ME, August 1991

H. W. Lenstra (Progress in Mathematics Lecture)
Richard M. Schoen (Progress in Mathematics Lecture)

Fargo, ND, October 1991

Ian D. Macdonald
Harald Upmeier
Henry C. Wente
Sylvia M. Wiegand

Baltimore, MD, January 1992

Michael E. Fisher (Gibbs Lecture)

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.

January 1991 Meeting in San Francisco, California

Associate Secretary: Andy R. Magid
Deadline for organizers: Expired
Deadline for consideration: Expired

Please see the first announcement of this meeting elsewhere in this issue.

March 1991 Meeting in South Bend, Indiana

Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: Expired
Deadline for consideration: December 13, 1990

Charalambos D. Aliprantis and Carl P. Simon, *Mathematical economics and dynamical systems*
Jonathan L. Alperin and Stephen D. Smith, *Simplicial complexes associated to finite groups and their representations*
Steven A. Buechler, *Model theory*
Frank X. Connolly, *Geometric topology*
William G. Dwyer and Anthony D. Elmendorf, *Algebraic topology*
Gail R. Letzter, Peter Malcolmson and Frank Okoh, *Noncommutative ring theory*
John E. McCarthy, *Hilbert spaces of analytic functions*
Mohsen Pourahmadi, *Probability and prediction theory*

March 1991 Meeting in Tampa, Florida

Southeastern Section
Associate Secretary: Joseph A. Cima
Deadline for organizers: Expired
Deadline for consideration: December 13, 1990

Josefina Alvarez, *Harmonic analysis and applications*
Ronald A. DeVore, Edward B. Saff and B. Shektman, *Approximation theory*

David A. Drake, Chat Yin Ho and Geoffrey R. Robinson, *Finite groups and related topics*
Paul E. Ehrlich and Stephen J. Summers, *Differential geometry and mathematical physics*
Paul M. Gauthier, *Several complex variables*
Ladnor D. Geissinger, William H. Graves and L. Senechal, *Microcomputers and workstations in mathematics: teaching and research*
Joseph Glover and Arunava Mukherjea, *Probability on algebraic and topological structures*
Michel L. Lapidus and Robert S. Strichartz, *Fractal and spectral geometry*
Sung J. Lee and Y. You, *Operator methods for control problems*
R. Kent Nagle and Mary E. Parrott, *Nonlinear boundary value problems*
John F. Pedersen, W. Edwin Clark, W. Richard Stark, Jospeh J. Liang and Gregory L. McColm, *Mathematical issues in biologically motivated computing*
Donald St. P. Richards, *Hypergeometric functions on domains of positivity, jack polynomials, and applications*

June 1991 Meeting in Portland, Oregon
Western Section
Associate Secretary: Lance W. Small
Deadline for organizers: Expired
Deadline for consideration: March 5, 1991

August 1991 Meeting in Orono, Maine
Associate Secretary: Joseph A. Cima
Deadline for organizers: November 15, 1990
Deadline for consideration: May 8, 1991

October 1991 Meeting in Philadelphia, Pennsylvania
Eastern Section
Associate Secretary: W. Wistar Comfort
Deadline for organizers: January 10, 1991
Deadline for consideration: July 11, 1991
Daniel B. Szyld, *Numerical linear algebra*

October 1991 Meeting in Fargo, North Dakota
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: January 25, 1991
Deadline for consideration: July 11, 1991
Joseph P. Brennan and Sylvia M. Wiegand, *Commutative algebra*
Dogan Comez, *Ergodic theory*
Kendall E. Nygard, *Operations research*
James H. Olsen and Mark Pavicic, *Mathematical foundations of computer graphics*
Warren E. Shreve, *Graph theory*
Vasant A. Ubhaya, *Approximation theory*
Harald Upmeier, *Multivariate operator theory in symmetric domains*

November 1991 Meeting in Santa Barbara, California
Western Section
Associate Secretary: Lance W. Small
Deadline for organizers: February 7, 1991
Deadline for consideration: August 20, 1991

January 1992 Meeting in Baltimore, Maryland
Associate Secretary: Lance W. Small
Deadline for organizers: April 8, 1991
Deadline for consideration: September 11, 1991

March 1992 Meeting in Tuscaloosa, Alabama
Southeast Section
Associate Secretary: Joseph A. Cima
Deadline for organizers: June 13, 1991
Deadline for consideration: To be announced

March 1992 Meeting in Springfield, Missouri
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: June 26, 1991
Deadline for consideration: To be announced

June 1992 Meeting in Cambridge, England
Associate Secretary: Robert M. Fossum
Deadline for organizers: September 28, 1991
Deadline for consideration: To be announced

January 1993 Meeting in San Antonio, Texas
Associate Secretary: W. Wistar Comfort
Deadline for organizers: April 13, 1992
Deadline for consideration: To be announced

August 1993 Meeting in Vancouver, British Columbia, Canada
Associate Secretary: Lance W. Small
Deadline for organizers: November 11, 1992
Deadline for consideration: To be announced

January 1994 Meeting in Cincinnati, Ohio
Associate Secretary: Joseph A. Cima
Deadline for organizers: April 5, 1993
Deadline for consideration: To be announced

January 1996 Meeting in Orlando, Florida
Associate Secretary: Lance W. Small
Deadline for organizers: April 12, 1995
Deadline for consideration: To be announced

Information for Organizers

Special Sessions at Annual and Summer Meetings are held under the supervision of the Program Committee for National Meetings (PCNM). They are administered by the Associate Secretary in charge of that meeting with staff assistance from the Meetings and Editorial Departments in the Society office in Providence.

According to the "Rules for Special Sessions" of the Society, Special Sessions are selected by the PCNM from a list of proposed Special Sessions in essentially the same manner as Invited Speakers are selected. The number of Special Sessions at a Summer or Annual Meeting

is limited. The algorithm that determines the number of Special Sessions allowed at a given meeting, while simple, is not repeated here, but can be found in "Rules for Special Sessions" on page 614 in the April 1988 issue of *Notices*.

Each Invited Speaker is invited to generate a Special Session, either by personally organizing one or by having a Special Session organized by others. Proposals to organize a Special Session are sometimes requested either by the PCNM or by the Associate Secretary. Other proposals to organize a Special Session may be submitted to the Associate Secretary in charge of that meeting (who is an *ex-officio* member of the committee and whose address may be found below). These proposals must be in the hands of the PCNM at least nine months prior to the meeting at which the Special Session is to be held in order that the committee may consider all the proposals for Special Sessions simultaneously. Proposals that are sent to the Providence office of the Society, to *Notices*, or directed to anyone other than the Associate Secretary will have to be forwarded and may not be received in time to be considered for acceptance.

It should be noted that Special Sessions must be announced in *Notices* in such a timely fashion that any member of the Society who so wishes may submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration. This deadline is usually three weeks before the deadline for abstracts for the meeting in question.

Special Sessions are very effective at Sectional Meetings and can usually be accommodated. The processing of proposals for Special Sessions for Sectional Meetings is handled in essentially the same manner as for Annual and Summer Meetings by the Section Program Committee. Again, no Special Session at a Sectional Meeting may be approved so late that its announcement appears past the deadline after which members can no longer send abstracts for consideration for presentation in that Special Session.

The Society reserves the right of first refusal for the publication of proceedings of any Special Session. These proceedings appear in the book series *Contemporary Mathematics*.

More precise details concerning proposals for and organizing of Special Sessions may be found in the "Rules for Special Sessions" or may be obtained from any Associate Secretary.

Proposals for Special Sessions to the Associate Secretaries

The programs of Sectional Meetings are arranged by the Associate Secretary for the section in question:

Western Section

Lance W. Small, Associate Secretary
Department of Mathematics
University of California, San Diego
La Jolla, CA 92093
Electronic mail: g_small@math.ams.com
(Telephone 619-534-3590)

Central Section

Andy R. Magid, Associate Secretary
Department of Mathematics
University of Oklahoma
601 Elm PHSC 423
Norman, OK 73019
Electronic mail: g_magid@math.ams.com
(Telephone 405-325-6711)

Eastern Section

W. Wistar Comfort, Associate Secretary
Department of Mathematics
Wesleyan University
Middletown, CT 06457
Electronic mail: g_comfort@math.ams.com
(Telephone 203-347-9411)

Southeastern Section

Joseph A. Cima, Associate Secretary
Department of Mathematics
University of North Carolina, Chapel Hill
Chapel Hill, NC 27599-3902
Electronic mail: g_cima@math.ams.com
(Telephone 919-962-1050)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

Information for Speakers

A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special Session has been scheduled. Contributors should know that there is a limitation in size of a single Special Session, so that it is sometimes true that all places are filled by invitation. Papers not accepted for a Special Session are considered as ten-minute contributed papers.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Editorial Department, American Mathematical Society, P. O. Box 6248, Providence, RI 02940) by the special deadline for Special Sessions, which is usually three weeks earlier than the deadline for contributed papers for the same meeting. The Council has decreed that no paper, whether invited or contributed, may be listed in the program of a meeting of the Society unless an abstract of the paper has been received in Providence prior to the deadline.

Electronic submission of abstracts is available to those who use the TEX typesetting system. Requests to obtain the package of files may be sent electronically via the Internet to **abs-request@math.ams.com.** Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Electronic Abstracts, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940, USA. When requesting the abstracts package, users should be sure to specify whether they want the plain TEX, $\mathcal{A}\mathcal{M}$S-TEX, or the LATEX package.

Number of Papers Presented
Joint Authorship

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

An individual may contribute only one abstract by title in any one issue of *Abstracts*, but joint authors are treated as a separate category. Thus, in addition to abstracts from two individual authors, one joint abstract by them may also be accepted for an issue.

Site Selection for Sectional Meetings

Sectional Meeting sites are recommended by the Associate Secretary for the Section and approved by the Committee of Associate Secretaries and Secretary. Recommendations are usually made eighteen to twenty-four months in advance. Host departments supply local information, ten to twelve rooms with overhead projectors for contributed paper sessions and special sessions, an auditorium with twin overhead projectors for invited addresses, and registration clerks. The Society partially reimburses for the rental of facilities and equipment, and for staffing the registration desk. Most host departments volunteer; to do so, or for more information, contact the Associate Secretary for the Section.

Winter Meeting of the Canadian Mathematical Society December 9 – 11, 1990

Tentative Program

The Canadian Mathematical Society (CMS) and the University of Waterloo cordially invite all mathematicians to the 1990 Winter Meeting of the Society. The Scientific Program will take place December 9 – 11, 1990, at the University of Waterloo, Waterloo, Ontario.

Scientific Program

Plenary Speakers

The names and affiliations of the speakers, and the days and times they will talk are as follows:

ANDREW M. GLEASON, Harvard University, Sunday 1:30 p.m. – 2:30 p.m.

PHILIP J. HANLON, University of Michigan, Ann Arbor, Tuesday 9:00 a.m. – 10:00 a.m.

NANCY J. KOPELL, Boston University, Tuesday 1:30 p.m. – 2:30 p.m.

STEPHEN LICHTENBAUM, Cornell University, Sunday 9:30 a.m. – 10:30 a.m.

STEPHEN W. SEMMES, Rice University, Monday 9:00 a.m. – 10:00 a.m.

DAN VOICULESCU, University of California, Berkeley, Sunday 3:00 p.m. – 4:00 p.m.

Coxeter-James Lecture

The Coxeter-James Lecture will be given by NASSIF GHOUSSOUB, University of British Columbia, on Monday, December 10, at 1:30 p.m. to 2:30 p.m.

Symposia

Special Sessions in five areas will take place with session organizers and invited (but tentative) participants as follows:

Session I: *Algebraic combinatorics*, IAN P. GOULDEN, University of Waterloo, organizer

CURTIS GREENE, Haverford College

D. JACKSON, University of Waterloo

GILBERT LABELLE, University of Quebec at Montreal

PIERRE LEROUX, University of Quebec at Montreal

DENNIS W. STANTON, University of Minnesota, Minneapolis

JOHN R. STEMBRIDGE, University of Michigan, Ann Arbor

DAVID WAGNER, University of Waterloo

DORON ZEILBERGER, Drexel University

Session II: *Nonlinear oscillations*, JACQUES BÉLAIR, University of Montreal, co-organizer

WILLIAM F. LANGFORD, University of Guelph, co-organizer

S. DOEDEL, Concordia University

PHILIP J. HOLMES, Cornell University

LEO B. JONKER, Queen's University

WILLIAM F. LANGFORD, University of Guelph

MICHAEL C. MACKEY, McGill University

HANS G. OTHMER, University of Utah

JOHN RINZEL, National Institutes of Health, Maryland

Session III: *Algebraic K-theory*, R. JARDINE, University of Western Ontario, organizer

HENRI GILLET, University of Illinois, Chicago

DANIEL R. GRAYSON, University of Illinois, Urbana

MAX KAROUBI, University of Paris VII

M. KOLSTER, McMaster University

M. LEVINE, Northeastern University

VICTOR P. SNAITH, McMaster University

ROBERT W. THOMASON, Johns Hopkins University

CHARLES A. WEIBEL, Rutgers University

Session IV: *Harmonic analysis*, ERIC T. SAWYER, McMaster University, organizer

SAGUN CHANILLO, Rutgers University

S. DRURY, McGill University

MICHAEL W. FRAZIER, Washington University, St. Louis

PENGFEI GUAN, McMaster University

Y. S. HAN, Wilfrid Laurier University

CARLOS E. KENIG, University of Chicago

C. SOGGE, University of California, Los Angeles

Session V: *Operator algebras*, KENNETH R. DAVIDSON, University of Waterloo, and I. PUTNAM, Dalhousie University, co-organizers

P. BAUM, Pennsylvania State University

MAN-DUEN CHOI, University of Toronto
RONALD G. DOUGLAS, SUNY at Stony Brook
D. HANDELMAN, University of Ottawa
N. HIGSON, Pennsylvania State University
J. PHILLIPS, University of Victoria
M. PIMSNER, Romania

Mathematics education sessions are planned, with a keynote address by Professor Gleason.

Contributed papers of 15 minutes' duration are invited.

An impromptu session on partial differential equations will be organized by Professors G. Duff, University of Toronto, and E. Kreyszig, Carleton University.

Hotel Accommodations

Rooms have been booked at the Valhalla Inn, downtown in the adjacent city of Kitchener. The rates are $71 for a singly occupied room and $81 for a doubly occupied room, plus 5% tax. Reservations may be made directly with the hotel (519-744-4141 or fax 519-578-6889).

Very close to the Valhalla Inn is the Walper Terrace Hotel (519-745-4321), a nicely refurbished old hotel.

For those arriving by car, the following hotels are also suitable:

Waterloo Inn, 475 King Street N, Waterloo, 519-884-0220

Holiday Inn, 30 Fairway Road S, Kitchener, 519-893-1211

Conestoga Inn, 1333 Weber Street E, Kitchener, 519-893-1234

Journey's End, 190 Weber Street N, Waterloo, 519-747-9400

Miscellaneous Information

Bus transportation between the Valhalla and the conference site on campus will be arranged.

Social events include a free lunch as well as an evening banquet on Sunday.

Preliminary activities will be held at the Valhalla Inn on December 7 and 8 as follows:

December 7, CMS Executive Meeting, 2:30 p.m.

December 8, CMS Executive Meeting (if necessary), 9:30 a.m.

December 8, Board of Directors Meeting, 2:30 p.m.

December 8, Evening Registration, 6:00 p.m. to 9:00 p.m.

December 8, Cash Bar Reception/Complimentary snacks, 7:00 p.m.

After that, the program will move to the campus of the University on Sunday morning.

Scientific Program Committee: C. RIEHM, chairman; J. BELAIR; K. DAVIDSON; I. GOULDEN; J. F. JARDINE; and E. SAWYER.

For further information contact:

C. Riehm, Chairman of the Scientific Committee, Department of Mathematics and Statistics, McMaster University, Hamilton, Ontario, L8S 4L8, Canada, 416-525-9140 extension 3415 or by electronic mail: riehm@mcmaster.ca.

F. Zorzitto, Local Organizer, Department of Pure Mathematics, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1, 519-885-1211 extension 3484 or by electronic mail: pure math@water.waterloo.edu.

Registration Fees

	Before 11/9	After 11/9
CMS/AMS/MAA members with grants	$125	$150
CMS/AMS/MAA members without grants	50	75
Non-members with grants	175	200
Non-members without grants	75	100
Grads/PDF's/Retired Faculty	25	50
One Day Fee	50	50
Banquet Tickets for accompanying persons	25	25

(The one day fee is intended for anyone who wishes to take part for only one day of the meeting. All fees except the one day fee include a ticket to the Sunday night banquet.)

Mathematical Sciences Meetings and Conferences

THIS SECTION contains announcements of meetings and conferences of interest to some segment of the mathematical public, including *ad hoc*, local, or regional meetings, and meetings or symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. (Information on meetings of the Society, and on meetings sponsored by the Society, will be found inside the front cover.)

AN ANNOUNCEMENT will be published in *Notices* if it contains a call for papers, and specifies the place, date, subject (when applicable), and the speakers; a second full announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in each issue until it has been held and a reference will be given in parentheses to the month, year, and page of the issue in which the complete information appeared. Asterisks (*) mark those announcements containing new or revised information.

IN GENERAL, announcements of meetings and conferences held in North America carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of *Notices*, care of the American Mathematical Society in Providence.

DEADLINES for entries in this section are listed on the inside front cover of each issue. In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence SIX MONTHS prior to the scheduled date of the meeting.

EFFECTIVE with the 1990 volume of *Notices*, the complete list of Mathematical Sciences Meetings and Conferences will be published only in the September issue. In all other issues, only meetings and conferences for the twelve-month period following the month of that issue will appear. As new information is received for meetings and conferences that will occur later than the twelve-month period, it will be announced at the end of the listing in the next possible issue. That information will not be repeated until the date of the meeting or conference falls within the twelve-month period.

1990. **IMACS International Workshop on Massively Parallel Methods in Computational Physics**, Boulder, Colorado. (Sep. 1989, p. 914)

1990. **IMACS Conference on Computer Aided Design**, Yugoslavia. (Sep. 1989, p. 914)

1990. **CWI-IMACS Symposia on Parallel Scientific Computing**, Amsterdam, The Netherlands. (Feb. 1990, p. 216)

1990. **Concentration Year on Stochastic Models, Statistical Methods, and Algorithms in Image Analysis**, Rome, Italy. (Apr. 1990, p. 491)

1990–1991. **Academic Year Devoted to Operator Theory and Complex Analysis**, Mittag-Leffler Institute, Djursholm, Sweden. (Dec. 1989, p. 1432)

October 1990

15–19. **Modeles pour L'Analyse des Donnees Multidimensionnelles**, Marseille, France. (Jan. 1990, p. 60)

15–19. **Tercer Congreso Nacional de Matemáticas**, San José, Costa Rica. (Feb. 1990, p. 225)

15–19. **IMA Workshop: Shocked Induced Transitions and Phase Structures in General Media**, University of Minnesota, Minneapolis, MN. (Sep. 1990, p. 931)

18–21. **Sixteenth Annual Convention of the American Mathematical Association of Two-Year Colleges**, Dallas, TX. (May/Jun. 1990, p. 609)

19. **International Meeting on Nonlinear Dynamics in Mathematics & Science**, University of Massachusetts at Amherst. (Sep. 1990, p. 931)

19–20. **Nineteenth Midwest Conference on Differential and Integral Equations**, Univ. of Missouri-Rolla, Rolla, MO. (Apr. 1990, p. 498)

19–20. **Twelfth Midwest Probability Colloquium**, Northwestern University, Evanston, IL. (May/Jun. 1990, p. 610)

19–20. **1990 Mathematical Sciences Department Chairs Colloquium**, Arlington, VA. (Jul./Aug. 1990, p. 739)

20–21. **Eastern Section**, University of Massachusetts at Amherst, Amherst, MA.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

21–27. **Mathematische Methoden In Der Robotik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

21–27. **Arithmetik der Körper**, Oberwolfach, Federal Republic of Germany. (Oct. 1989, p. 1098)

21–27. **International Functional Analysis Meeting on the Occasion of the Sixtieth Birthday of Professor M. Valdivia**, Peñiscola, Spain. (May/Jun. 1990, p. 610)

21–27. **Algebraic and Combinatorial Problems in Multivariate Approximation Theory**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 740)

22–24. **Thirty-first Annual Foundations of Computer Science**, St. Louis, MO. (Jul./Aug. 1990, p. 740)

22–25. **Fifth Jerusalem Conference on Information Technology (JCIT-5)**, Jerusalem, Israel. (Jan. 1990, p. 60)

22–26. **Journées de Probabilités**, Marseille, France. (Jul./Aug. 1990, p. 740)

23–26. **Visualization '90**, San Francisco, CA. (Sep. 1990, p. 931)

24–26. **Fifth Annual Conference of the Midwest College Learning Center Association - Breaking Barriers to Learning**, Milwaukee, WI. (Jul./Aug. 1990, p. 740)

26–27. **Seventh Auburn Miniconference on Real Analysis**, Auburn University, AL. (Sep. 1990, p. 931)

26–27. **Statistical Mechanics at the 45th Parallel: Fourth Annual Meeting**, Université de Montréal, Canada. (Feb. 1990, p. 226)

26–28. **Twenty-first U.S.L. Mathematics Conference (Algebra)**, University of Southwestern Louisianna, Lafayette, LA. (May/Jun. 1990, p. 610)

28–November 1. **North American Conference on Logic Programming 1990 (NACLP '90)**, Austin, TX. (Jul./Aug. 1990, p. 740)

28–November 3. **Mathematical Economics**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

29–November 2. **Trieste Conference on Integrable Systems**, Trieste, Italy. (Jan. 1990, p. 61)

29–November 2. **Algorithme Parallele et Architectures Nouvelles**, Marseille, France. (Jan. 1990, p. 61)

29–November 2. **The International Conference "D-Modules and Microlocal Geometry"**, Lisbon, Portugal. (Mar. 1990, p. 333)

29–November 16. **Workshop on Mathematical Ecology**, Trieste, Italy. (Jan. 1990, p. 61)

31–November 3. **Latinamerican Seminar on Applications of Mathematics and Computer Science to Biology**, La Habana, Cuba. (Feb. 1990, p. 226)

November 1990

2–3. **Central Section Meeting of the AMS**, University of North Texas, Denton, TX.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

2–3. **Fifth Annual Pi Mu Epsilon Regional Undergraduate Mathematics Conference**, St. Norbert College, DePere, WI. (Sep. 1990, p. 932)

4–10. **Wahrscheinlichkeitsmaße auf Gruppen**, Oberwolfach, Federal Republic of Germany. (Oct. 1989, p. 1098)

5–7. **Mathematiques Informatique**, Marseille, France. (Jul./Aug. 1990, p. 740)

5–8. **Second SIAM Confernce on Linear Algebra in Signals, Systems & Controls**, San Francisco, CA. (Jul./Aug. 1990, p. 740)

6–7. **1990 ACM Conference on Critical Issues**, Arlington, VA. (Apr. 1990, p. 498)

7–8. **Third Annual Conference on Mathematical Models for Psychotherapy Research**, Nathan Kline Institute for Psychiatric Research, New York. (Sep. 1990, p. 932)

9–11. **Third Annual Conference on Technology in Collegiate Mathematics**, The Ohio State Univ., Columbus, OH. (Mar. 1990, p. 333)

10. **Differential Geometry Day**, Eastern Illinois University, Charleston, IL. (Apr. 1990, p. 498)

10–11. **Far Western Section**, University of California, Irvine, CA.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

12–16. **Supercomputing '90**, New York, NY. (Sep. 1989, p. 920)

12–16. **Workshop on Representations of Reductive Groups over Finite Fields**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1990, p. 61)

12–16. **Supercomputing '90**, New York, NY. (Jul./Aug. 1990, p. 740)

12–16. **IMA Workshop on Microstructure and Phase Transition**, University if Minnesota, Minneapolis, MN. (Sep. 1990, p. 932)

16–17. **Tenth Annual Southeastern-Atlantic Regional Conference on Differential Equations**, Virginia Polytechnic Institute and State University, Blacksburg, VA. (May/Jun. 1990, p. 610)

18–24. **Komplexitätstheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

19–22. **Huygens' Principle 1690-1990, Theory and Applications**, Scheveningen, The Hague, The Netherlands. (May/Jun. 1990, p. 610)

21–23. **Colloque Franco-Belge de Statistique**, Marseille, France. (Jul./Aug. 1990, p. 740)

25–28. **Mathematics and its Applications**, University of Bahrain, State of Bahrain. (May/Jun. 1990, p. 610)

25–December 1. **Stochastische Approximation Und Optimierungsprobleme In Der Statistik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

25–December 1. **Lineare Modelle und Multivariate Statistische Verfahren**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 769)

26–30. **Seminaire Sud-Rhodanien de Geometrie Differentielle**, Marseille, France. (Jul./Aug. 1990, p. 741)

December 1990

* December 1990. **Structural Complexity and Cryptography**, Rutgers University, New Brunswick, NJ.

INFORMATION: E. Allender, 201-932-3629; email: allender@aramis.rutgers.edu.

2–8. **Multigrid Methods**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

3–5. **First International Symposium on Uncertainty and Analysis: Fuzzy Reasoning, Probabilistic Methods and Risk Management**, College Park, Maryland. (Oct. 1989, p. 1098)

3–7. **Sixteenth Australasian Conference on Combinatorial Mathematics and Combinatorial Computing**, Palmerston North, New Zealand. (Feb. 1990, p. 226)

3–7. **SINO-JAPANESE Joint Seminar on Nonlinear PDEs with Emphasis on Reaction-Diffusion Aspects.**, Taipei, Taiwan. (Jan. 1990, p. 61)

3–7. **Workshop on General Group Representation Theory**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1990, p. 61)

9–11. **Canadian Mathematical Society Winter Meeting**, University of Waterloo, Ontario. (Sep. 1990, p. 933)

9–14. **International Conference on Mathematical Theory of Control**, I.I.T. Bombay. (Sep. 1990, p. 933)

9–15. **Allgemeine Ungleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

11–12. **Integral Valued Polynomials Encounter**, CIRM, Marseille, France. (Jul./Aug. 1990, p. 741)

11–13. **Third Joint IFSA-EC and EURO-WG Workshop on Fuzzy Sets**, Visegrád, Hungary. (May/Jun. 1990, p. 611)

15–19. **Curves and Surfaces: An Algorithmic Viewpoint**, Kent State Univ., Kent,

OH. (Apr. 1990, p. 499)

16–22. **Mathematische Logik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

17–21. **Non-linear Dispersive Wave Systems**, Univ. of Central Florida, Orlando, FL. (Apr. 1990, p. 499)

17–21. **International Conference on Theory of Differential Equations and Applications to Oceanography**, Goa University, Bamboli, St. Cruz, India. (Sep. 1990, p. 933)

25–January 1. **Lineare Modelle Und Multivariate Statistische Verfahren**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

27–31. **Holiday Symposium on Recent Developments in Homotopy Theory**, New Mexico State Univ., Las Cruces, NM. (Jul./Aug. 1990, p. 741)

1991. **IMACS Symposium on Parallel and Distributed Computing in Engineering Systems**, Athens, Greece. (Jul./Aug. 1990, p. 741)

Spring 1991. **IMACS International Symposium on Iterative Methods in Linear Algebra**, Brussels Free Univ., Brussels, Belgium. (Mar. 1990, p. 334)

January 1991

* January 1991. **Circuit and Communication Complexity**, Rutgers University, New Brunswick, NJ.

INFORMATION: A. Yao, 609-258-5050; email: yao@princeton.edu.

6–12. **Automorphe Formen und Anwendungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

7–9. **SIAM Workshop on Automatic Differentiation of Algorithms: Theory, Implementation, and Application**, Breckenridge, CO. (Jul./Aug. 1990, p. 741)

7–10. **Sixth Caribbean Conference in Combinatorics and Computing**, University of the West Indies, St. Augustine, Trinidad. (Jan. 1990, p. 61)

* 7–11. **NATO Advanced Research Workshop on Asymptotics Beyond All Orders**, La Jolla, CA.

CHAIRMEN: M.D. Kruskal, Rutgers; H. Segur, Colorado.
INVITED SPEAKERS: C.J. Amick, Chicago; M. Berry, Bristol; J.G.B. Byatt-Smith, Edinburgh; J. Gollub, Haverford; V. Hakim, Paris; J.M. Hammersley, Oxford; H. Levine, San Diego; J.E. Marsden, Berkeley; R.E. Meyer, Wisconsin; Y. Pomeau, Paris; J. Scheurle, Hamburg; J.-M. VandenBroeck, Wisconsin.
INFORMATION: H. Segur, Program in Applied Mathematics, Univ. of Colorado, Boulder, CO 80309-0526; 303-492-0592; email: segur@boulder.colorado.edu.

13–19. **Combinatorical Optimization**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

14–15. **AMS Short Course on "Probabilistic Combinatorics and its Applications"**, San Francisco, CA.

INFORMATION: D. Plante, AMS, P.O. Box 6248, Providence, RI 02940.

16–19. **Joint Mathematics Meetings**, San Francisco, CA. (including the annual meetings of the AMS, AWM, MAA, and NAM)

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

20. **Informal Workshop on the Teaching of Calculus**, San Francisco, CA (Sep. 1990, p. 933)

20–26. **Spektraltheorie Singulärer Gewöhnlicher Differentialoperatoren**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

21–25. **IMA Workshop on Statistical Thermodynamics and Differential Geometry of Microstructured Material**, University of Minnesota, Minneapolis, MN. (Sep. 1990, p. 933)

27–February 2. **Harmonische Analyse und Darstellungstheorie Topologischer Gruppen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

28–30. **Second ACM-SIAM Symposium on Discrete Algorithms**, San Francisco, CA. (Jul./Aug. 1990, p. 741)

February 1991

3–9. **Konstruktive Methoden in der Komplexen Analysis**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

4–8. **Winter School on Infinite Dimensional Differential Geometry**, Wien, Austria. (Sep. 1990, p. 934)

10–16. **Endlichdimensionale Lie-Algebren**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

10–16. **Affine Differentialgeometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

* 11–15. **The Twenty-Second Southeastern International Conference on Combinatorics, Graph Theory and Computing**, Louisiana State University, Baton Rouge, LA.

INVITED SPEAKERS: R. Brualdi, P. Erdös, C. Godsil, W. Pulleyblank, R. Thomas.
INFORMATION: J.G. Oxley, Mathematics Dept., Louisiana State Univ., Baton Rouge, LA 70803.

17–23. **Experimentelle, Insbesondere Computergraphische Methoden in der Mathematik**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 742)

17–23. **Krein Spaces and Applications to Differential Operators**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 742)

* 18–23. **Ninth International Seminar on Model Optimization in Exploration Geophysics, with a Workshop on Geophysical Data Inversion in Archeological Site Investigation**, Berlin, Free University of Berlin, Mathematical Geophysics Group and Archeological Institute.

INFORMATION: A. Vogel, Inst. für Geophysikalische Wissenschaften, Mathematische Geophysik, Podbielskiallee 6o, 1000 Berlin 33, Germany.

24–March 2. **Medical Statistics: Statistical Models for Longitudinal Data**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

25–March 1. **IEEE Computer Society COMPCON Spring '91**, San Francisco, CA. (Jan. 1990, p. 62)

March 1991

* March 1991. **Computational Number Theory**, Rutgers University, New Brunswick, NJ.

INFORMATION: A. Odlyzko, 201-582-7286; email: amo@research.att.com.

3–9. **Partielle Differentialgleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

4–15. **Workshop on Mathematical Physics**

and Geometry, Trieste, Italy. (Sep. 1990, p. 934)

5–7. **Association for Computing Machinery 1991 Computer Science Conference**, San Antonio Convention Center, San Antonio, TX. (May/Jun. 1990, p. 611)

7–8. **Twenty-second ACM SIGCSE Technical Symposium on Education in the Computing Sciences**, San Antonio, TX. (May/Jun. 1990, p.612)

7–10. **International Conference on Differential Equations**, Cadi Ayyad University, Marrakech, Morocco. (May/Jun. 1990, p.612)

10–16. **Mathematische Stochastik**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

11–15. **NSF-CBMS Regional Research Conference on Nonlinear Dispersive Wave Systems**, University of Central Florida, Orlando, FL. (Jul/Aug. 1990, p. 742)

11–15. **IMA Workshop on Free Boundaries in Viscous Flows**, University of Minnesota, Minneapolis, MN. (Sep. 1990, p. 934)

13–15. **IMACS Workshop on Decision Support Systems and Qualitative Reasoning**, LAAS-Toulouse, France. (May/Jun. 1990, p. 612)

13–16. **Twenty-Second Annual Iranian Mathematics Conference**, Ferdowsi University of Mashhad, Iran. (Sep. 1990, p. 934)

14–16. **Sixth S.E.A. Meeting, Southeastern Approximation Theorists Annual Meeting**, Memphis State Univ., Memphis, TN. (Sep. 1990, p. 934)

16–17. **Central Section**, Indiana University, South Bend, IN.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

17–23. **Elementare und Analytische Zahlentheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

17–24. **Sixth International Conference on Geometry**, University of Haifa, Israel. (May/Jun. 1990, p. 612)

22–23. **Southeastern Section**, University of South Florida, Tampa, FL.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

22–24. **Fifth SIAM Conference on Parallel Processing for Scientific Computing**, Houston, TX. (Mar. 1990, p. 334)

24–30. **Gewöhnliche Differentialgleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

25–27. **Fifth SIAM Conference on Parallel Processing for Scientific Computing**, Houston, TX. (Jul./Aug. 1990, p. 742)

25–28. **International Conference on Mathematical Linguistics - ICML '91**, Barcelona, Spain. (Jul./Aug. 1990, p. 742)

31–April 6. **Arbeitsgemeinschaft mit Aktuellum Thema**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

April 1991

* 1–4. **Eighth International Conference on Mathematical and Computer Modeling**, University of Maryland, College Park, MD.

CONFERENCE THEMES: Engineering systems, computational sciences and technology, methodology, biomedical systems, resources, defense related problems, economic problems, environmental sciences, model validations.
CALL FOR PAPERS: Authors are invited to submit papers in three categories: 1. Full length papers; 2. Short reports; 3. Papers for poster sessions. Deadline for submission of abstracts: November 30, 1990.
INFORMATION: X.J.R. Avula, President, IAMCM, Univ. of Missouri, Rolla, Dept. of Engineering Mechanics, P.O. Box 1488, Rolla, MO 65401-0249.

2–4. **IMACS International Symposium on Iterative Methods in Linear Algebra**, Brussels Free Universities, Belgium. (May/Jun. 1990, p. 612)

7–13. **Algebraische Gruppen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

8–12. **Seventh International Conference on Data Engineering**, Kobe, Japan. (Apr. 1990, p. 500)

8–12. **NASECODE VII, The Seventh International Conference on the Numerical Analysis of Semiconductor Devices and Integrated Circuits**, Copper Mountain, Colorado. (May/Jun. 1990, p. 612)

10–12. **Fourth International Conference on Rewriting Techniques and Applications (RTA-91)**, Como, Italy. (Jul./Aug. 1990, p. 743)

* 11–13. **Twenty-Fifth Annual Spring Topology Conference**, California State University, Sacramento, CA.

INFORMATION: M. Marsh, Dept. of Math., California State Univ., Sacramento, CA 95819; 916-278-6534; email: najzaaa@calstate.bitnet.

11–16. **Assessment in Mathematics Education and Its Effects**, Calonge (Costa Brava), Spain. (Sep. 1990, p. 935)

14–20. **Brauer Groups and Representation Theory of Finite Groups**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

15–19. **IMA Workshop on Variational Problems**, University of Minnesota, Minneapolis, MN. (Sep. 1990, p. 935)

18–20. **Determinantal Ideals and Representation Theory**, University of Arkansas, Fayetteville, Arkansas. (Sep. 1990, p. 935)

21–27. **Numerical Linear Algebra**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 743)

23–26. **Mathematical and Numerical Aspects of Wave Propagation Phenomena**, Strasbourg, France. (Jul./Aug. 1990, p. 743)

* 26–28. **Similarity Solutions of Differential Equations**, University of Pittsburgh, PA.

CONFERENCE TOPICS: Lie group methods or generalizations, occurrence of similarity solutions in applicable situations, similarity solutions of particular equations, relation of similarity solutions to more general solutions.
ORGANIZERS: S.P. Hastings, H. Levine, J.B. McLeod.
INVITED SPEAKERS: M. Ablowitz, G. Bluman, P. Clarkson, A. Fokas, J.-S. Guo, R. Kohn, P. Olver, L.A. Peletier.
INFORMATION: S.P. Hastings, Dept. of Math. and Stat., Univ. of Pittsburgh, Pittsburgh, PA 15260.

28–May 4. **Deductive Systems**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

May 1991

May/June 1991. **IMACS Workshop on Decision Support Systems and Qualitative Reasoning**, Toulouse, France. (Mar. 1990, p. 334)

2–3. **Twenty-Second Annual Pittsburgh Conference on Modeling and Simulation**,

University of Pittsburgh, PA. (Sep. 1990, p. 935)

5–11. **Darstellungstheorie Endlich-Dimensionaler Algebren**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 743)

6–8. **Fifth SIAM International Symposium on Domain Decomposition Methods for Partial Differential Equations**, Norfolk, VA. (Jul./Aug. 1990, p. 743)

7–10. **IMACS Symposium on Modelling and Simulation of Control Systems**, Casablanca, Morocco. (Mar. 1990, p. 334)

7–14. **Singapore Number Theory Workshop**, National Univ. of Singapore, Kent Ridge, Singapore. (Jul./Aug. 1990, p. 743)

12–18. **Nichtlineare Evolutionsgleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

13–17. **Conference in Harmonic Analysis in Honor of E.M. Stein**, Princeton University, Princeton, NJ. (Mar. 1990, p. 334)

13–18. **IMA Workshop on Degenerate Diffusions**, University of Minnesota, Minneapolis, MN. (Sep. 1990, p. 935)

15–17. **Third IEEE Conference on Computer Workstations: Accomplishments and Challenges**, Falmouth (Cape Cod), MA. (Sep. 1990, p. 936)

17–20. **Conference/Workshop on Continuum Theory and Dynamical Systems**, University of Southwestern Louisianna, Lafayette, LA. (Sep. 1990, p. 936)

19–25. **Differentialgeometrie im Grossen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

20–24. **Eleventh International Conference on Distributed Computing Systems**, Arlington, TX. (Sep. 1990, p. 936)

22–24. **Second International Conference on Algebraic Methodology and Software Technology, (AMAST)**, Iowa City, IA. (Apr. 1990, p. 501)

26–31. **Signal Theory and Image Processing**, Cetraro, Italy. (Sep. 1990, p. 936)

26–June 1. **Optimalsteuerung und Variationsrechnung-Optimal Control**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

29–June 1. **Eighth Biennial Conference of the Association of Christians in the Mathematical Sciences**, Wheaton College, Wheaton, IL. (Jul./Aug. 1990, p. 743)

29–June 1. **Methods in Module Theory**, University of Colorado, Colorado Springs, CO. (Sep. 1990, p. 936)

June 1991

2–8. **Diskrete Geometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

3–7. **1991 Annual Meeting of the Statistical Society of Canada**, Toronto, Ontario, Canada. (Mar. 1990, p. 334)

9–10. **Special Session on Polymer Configurations: Nonlinear and Nonlocal Diffusion Problems**, University of Minnesota, Minneapolis, MN. (Sep. 1990, p. 937)

* 9–14. **Second International Conference on Fixed Point Theory and Applications**, Dalhousie University, Halifax, Nova Scotia, Canada.

CALL FOR PAPERS: Abstracts of contributed papers should be received by the organizers by March 15, 1991.
INFORMATION: Fixed Point Theory Conference, 1991, Dept. of Math., Stat., and Comp. Sci., Dalhousie Univ., Halifax, Nova Scotia, Canada B3H 3J5.

9–15. **Singuläre Störungsrechnung**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

10–14. **Bernoulli Society Twentieth Conference on Stochastic Processes and their Applications**, Nahariya, Israel. (Nov. 1989, p. 1254)

13–15. **Western Sectional Meeting**, Portland State University, Portland, Oregon.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

* 14–17. **Symposium on Lattice Theory and its Applications, in Honor of the 80th Birthday of Garrett Birkhoff**, Darmstadt, Federal Republic of Germany.

CHAIRMEN: K.A. Baker (Los Angeles), E.T. Schmidt (Budapest), R. Wille (Darmstadt).
INVITED SPEAKERS: G. Birkhoff (Cambridge), M.K. Bennett (Amherst), R. Freese (Honolulu), B. Ganter (Darmstadt), G. Grätzer (Winnipeg), R. Greechie (Manhattan), B. Jónsson (Nashville), K. Keimel (Darmstadt), J.B. Nation (Honolulu), I. Rival (Ottawa), D. Scott (Pittsburgh), J. Tuma (Prague).
INFORMATION: K.A. Baker, Dept. of Math., UCLA, Los Angeles, CA 90024-1555; kab@math.ucla.edu; 213-825-1947.

* 16–21. **Conference on Symbolic Dynamics and its Applications**, Yale University, New Haven, CT.

ORGANIZERS: E. Coven, S. Kakutani, B. Kitchens, B. Marcus, D. Ornstein, B. Weiss.
INFORMATION: B. Kitchens, Mathematical Sciences Dept., IBM T.J. Watson Research Center, P.O. Box 218, Yorktown Heights, NY 10598; email: kitch@ibm.com.

17–21. **1991 International Symposium on the Mathematical Theory of Networks and Systems (MTNS-91)**, International Conference Center Kobe, Kobe, Japan. (Nov. 1989, p. 1254)

17–21. **European Conference on Elliptic and Parabolic Problems**, Pont á Mousson, France. (May/Jun. 1990, p. 613)

23–29. **Mathematische Methoden des VLSI-Entwurfs und des Distributed Computing**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 744)

26–28. **Third IMACS International Symposium on Computational Acoustics**, Harvard University, Cambridge, MA. (Jul./Aug. 1990, p. 744)

30–July 6. **Elliptische Operatoren auf Singulären und Nichtkompakten Mannigfaltigkeiten**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

July 1991

* 1–5. **The Mathematics of Nonlinear Systems**, University of Bath, United Kingdom. (Please note addition of Invited Speakers from Jan. 1990, p. 62)

INVITED SPEAKERS: C.J. Amick, C. Atkinson, M. Benedicks, T.B. Benjamin, F. Brezzi, J.W. Cahn*, J. Carr, D.G. Crighton, A.M. Davie, O. Diekmann, S.K. Donaldson, W. Eckhaus, C.M. Elliott, C.L. Fefferman*, C. Foias*, L.E. Fraenkel, A. Friedman, J.D. Gibbon, P. Glendinning, J.K. Hale, A.D. Ioffe, R.D. James, R.V. Kohn, M.A. Krasnosel'skii, H.-O. Kreiss, M.D. Kruskal*, O.A. Ladyzhenskaya, P.D. Lax*, A.J. Libchaber*, J.-L. Lions*, P.-L.Lions*, R. MacKay, A.J. Majda*, J.E. Mars-

den, H. Matano, J.N. Mather*, J.B. McLeod, J.W. Milnor*, S. Müller, J.R. Ockendon, T. Palmer, O. Penrose, D. Preiss, D.A. Rand, P.G. Saffman, J.A. Scheinkman, Ya. G. Sinai*, A. Spence, M. Struwe, L. Tartar*, R. Temam, J.R. Willis, S. Wolfram*, V.E. Zakharov*, Z. Zhi-Fen. (Asterisk indicates plenary lectures.)

2–5. **European Control Conference**, Grenoble, France. (Jul./Aug. 1990, p. 744)

7–13. **Computational Number Theory**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 744)

8–12. **Second International Conference on Industrial and Applied Mathematics**, Washington, DC. (Apr. 1990, p. 501)

* 8–12. **NATO Advanced Research Workshop: Approximation by Solutions of Partial Differential Equations, Quadrature Formulae, and Related Topics**, Hanstholm, Denmark.

ORGANIZERS: M. Goldstein (Director), Arizona State Univ., U.S.; W. Haussmann, Univ. of Duisburg, West Germany; W.K. Hayman, Univ. of York, England; A. Jensen, Aalborg Univ., Denmark; L. Rogge, Univ. of Duisburg, West Germany.

CONFERENCE TOPICS: Approximation of solutions of partial differential equations on closed subsets of N-dimensional Euclidean space or Riemann surfaces by globally defined solutions; characterizing domains in N-dimensional Euclidean space such as balls, annuli, strips, cylinders, etc. by means of quadratic formulae; best L^1 and best L^∞ approximation.

INVITED SPEAKERS: A. Ancona, Paris; B. Fuglede, Copenhagen; M. Goldstein, Tempe; W.K. Hayman, York; W. Haussmann, Duisburg; A. Jensen, Aalborg; P.M. Gauthier, Montreal; T. Murai, Nagoya; J.L. Lewis, Lexington; L. Rogge, Duisburg; J. Verdera, Barcelona; L. Zalcman, Ramat Gan.

INFORMATION: M. Goldstein, Dept. of Math., Arizona State Univ., Tempe, AZ 85287.

* 8–12. **Thirty-Fifth Annual Conference of the Australian Mathematical Society**, Melbourne, Australia.

INFORMATION: J.H. Rubinstein, Math. Dept., Univ. of Melbourne, Parkville, Victoria 3052 Australia; email: rubin@mundoe.maths.mu.oz.au.

8–14. **ICOR '91 International Conference on Radicals**, Szekszárd, Hungary. (Apr. 1990, p. 502)

14–20. **Dynamische Systeme**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 502)

15–17. **Fifth IFAC/IMACS Symposium on Computer Aided Design in Control and Engineering Systems**, Swansea, UK. (Mar. 1990, p. 334)

15–18. **Sixth Annual IEEE Symposium on Logic in Computer Science**, Amsterdam, The Netherlands. (Sep. 1990, p. 937)

21–27. **Halbgruppentheorie**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 744)

22–26. **Thirteenth IMACS World Congress on Computation and Applied Mathematics**, Trinity College, Dublin University, Dublin, Ireland. (Apr. 1990, p. 502)

28–August 3. **Gruppen und Geometrien**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 502)

August 1991

3–7. **Interamerican Conference on Mathematics Education**, Univ. of Miami, Coral Gables, FL. (Apr. 1990, p. 502)

4–10. **Effiziente Algorithmen**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 744)

5–8. **ICMI-China Regional Conference on Mathematics Education**, Beijing, China. (Jul./Aug. 1990, p. 744)

5–9. **Fourteenth International Symposium on Mathematical Programming**, Amsterdam, The Netherlands. (Jul./Aug. 1990, p. 745)

8–11. **Joint Mathematics Meetings**, University of Maine, Orono, ME. (including the summer meetings of the AMS, AWM, MAA, and PME)

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

11–17. **European Young Statisticians Meeting**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 745)

14–16. **Short Conference on Uniform Mathematics and Applications (International Conference on Quasi-Uniformities and Related Structures)**, Bern, Switzerland. (Sep. 1990, p. 937)

18–24. **The Navier-Stokes Equations: Theory and Numerical Methods**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 745)

18–24. **The Third Conference of the Canadian Number Theory Association**, Queen's University, Kingston, Ontario. (Sep. 1990, p. 938)

18–September 4. **Twenty-first Summer Ecole de Calcul des Probabilités**, Saint Flour, France. (Jul./Aug. 1990, p. 745)

19–22. **1991 Joint Statistical Meetings**, Atlanta, GA. (Mar. 1988, p. 466)

19–September 6. **College on Singularity Theory**, Trieste, Italy. (Sep. 1990, p. 938)

21–25. **The International Conference on the Theory of Rings, Algebras, and Modules in Honor of A.I. Shirshov**, Barnaul, U.S.S.R. (Jul./Aug. 1990, p. 745)

25–31. **Klassifikation Komplex-Algebraischer Varietäten**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 745)

September 1991

1–7. **Topologie**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 745)

* 4–10. **IMA Tutorial**, University of Minnesota, Minneapolis, MN.

TUTORIAL LECTURES: These lectures will be given by the senior people in residence for the fall quarter: S. Friedland, V. Klee, J. Liu, J. Gilbert, A. Bjorck, A. George, R. Brualdi. It is expected that there will be three one-hour lectures each day with each speaker giving two lectures. These lectures will touch on most of the issues for the first quarter and some of those for the second quarter.

INFORMATION: Institute for Mathematics and Its Applications, University of Minnesota, 514 Vincent Hall, 206 Church St., S.E., Minneapolis, MN 55455; 612-624-6066.

* 7–9. **International Workshop on Software for Automatic Control Systems**, Irkutsk, USSR.

CONFERENCE TOPICS: Methods, algorithms & software for automatized modelling, analysis and synthesis of controlling systems; CAD of motion controlling systems; applied artificial intelligence systems for controlling

systems & their automatized design.
INFORMATION: V.M. Matrosov, Director of the Irkutsk Computing Center, Siberian Branch, USSR Academy of Sciences, Lermontov Str. 134, 664033 Irkutsk, USSR.

8–14. **Niedrigidimensionale Topologie**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 745)

8–14. **Knoten und Verschlingungen**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 745)

9–27. **School on Dynamical Systems**, Trieste, Italy. (Sep. 1990, p. 938)

10–13. **IFAC/IMACS Symposium on Fault Detection, Supervision and Safety for Technical Processes-SAFEPROCESS '91**, Baden-Baden, Federal Republic of Germany. (Apr. 1990, p. 502)

* 11–13. **IFAC/IFIP/IMACS Symposium on Robot Control (SYROCO '91)**, Vienna, Austria.

CONFERENCE TOPICS: Modelling and estimation techniques; control: design and implementation; programming and programming languages; sensors and sensory systems; kinematics; path-planning; machine intelligence; simulation methods; application of AI-techniques; autonomous robots; applications.
CALL FOR PAPERS: Deadline for submission of abstracts: October 15, 1990.
INFORMATION: Austrian Center for Productivity & Efficiency, OEPWZ, J. Hahnel, Rockhgasse 6, A-1014 Vienna, Austria; tel: 0222/638636/54 DW; Fax: 0222/6386 3636.

15–20. **DMV-Jahrestagung 1991**, Bielefeld, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

15–21. **Geometrie der Banachräume**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

16–19. **Fourth SIAM Conference on Applied Linear Algebra**, Univ. of Minnesota, Minneapolis, MN. (Apr. 1990, p. 502)

22–28. **Nonlinear and Random Vibrations**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

23–29. **Sixth Symposium on Classical Analysis**, Kazimierz Dolny, Poland. (Apr. 1990, p. 502)

24–27. **International Conference on Theoretical Aspects of Computer Software**, Tohoku Univ., Sendai, Japan. (Sep. 1990, p. 938)

25–27. **Ninth GAMM Conference on Numerical Methods in Fluid Mechanics**, Lausanne, Switzerland. (May/Jun. 1990, p. 613)

29–October 5. **Kombinatorik Geordneter Mengen**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

October 1991

6–12. **Arbeitsgemeinschaft mit Aktuellem Thema (wird in den Mitteilungen der DMV Heft 3/1991 bekanntgegeben)**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

7–11. **Workshop on Stochastic and Deterministic Models**, Trieste, Italy. (Sep. 1990, p. 938)

ORGANIZERS: F. Chersi, S. Invernizzi, A. Wedlin (Univ. degli di Trieste).
INFORMATION: International Centre for Theoretical Physics, I.C.T.P., P.O. Box 586, 34100 Trieste, Italy.

12–13. **Eastern Section**, Temple University, Philadelphia, PA.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

13–19. **Geometrie**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

* 14–18. **IMA Workshop on Sparse Matrix Computations: Graph Theory Issues and Algorithms**, University of Minnesota, Minneapolis, MN.

PURPOSE: The purpose of this workshop is to bring together people who work in sparse matrix computation with those who conduct research in applied graph theory and graph algorithms.
ORGANIZERS: A. George, J. Gilbert, J. Liu.
CONFERENCE TOPICS: Chordal graphs, elimination trees, the minimum degree algorithm, graph separator theory and algorithms, finding independent sets, graph matching, simulated annealing, clique trees, graph traversals in sparse matrix computation.
INFORMATION: Institute for Mathematics and Its Applications, University of Minnesota, 514 Vincent Hall, 206 Church St., S.E., Minneapolis, MN 55455; 612-624-6066.

November 1991

* 11–15. **IMA Workshop on Combinatorial and Graph-Theoretic Problems in Linear Algebra**, University of Minnesota, Minneapolis, MN.

PURPOSE: The purpose is to bring together the diverse group of people who work on problems in linear algebra and matrix theory in which combinatorial or graph-theoretic analysis is a major component.
ORGANIZERS: R. Brualdi, S. Friedland, V. Klee.
CONFERENCE TOPICS: The use of graph theory and general combinatorial ideas in matrix analysis, eigenvalue estimates for graphs and finite Markov chains, qualitative properties of matrices with applications to chemistry and economics, spectra of nonnegative integral matrices with application to symbolic dynamical systems, matrices with some generic entries with application to systems analysis and controllability, the use of linear algebraic ideas in the graph isomorphism problem, and issues of computational complexity as they pertain to the problems above.
INFORMATION: Institute for Mathematics and Its Applications, University of Minnesota, 514 Vincent Hall, 206 Church St., S.E., Minneapolis, MN 55455; 612-624-6066.

20–26. **C^*-Algebren**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1990, p. 746)

25–26. **Central Section**, North Dakota State University, Fargo, ND.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

December 1991

* 2–6. **Workshop on Statistical Methods in Imaging**, Mathematical Sciences Research Institute, Berkeley, CA.

PROGRAM: This is the first of two workshops planned as part of MSRI's 1991-1992 program on statistics.
ORGANIZER: B. Silverman.
INFORMATION: I. Kaplansky, Director, Mathematical Sciences Research Institute, 1000 Centennial Dr., Berkeley, CA 94720.

* 7–10. **Canadian Mathematical Society Winter Meeting**, Victoria, B.C., Canada.

PROGRAM COMMITTEE: K.Y. Lam, S. Boyer, D. Boyd, M. Ismail, R. Illner, P. Van Den Driessche, T. Lau, A. Pianzola.
INFORMATION: B. Miers, Dept. of Math., Univ. of Victoria, P.O. Box 1700, Victoria, B.C., V8W 2Y2; 604-721-7463; email: crmiers@uvvm.uvic.ca.

* **IMACS International Conference on Computational Physics**, University of Colorado, Boulder, CO.

INFORMATION: K.E. Gustafson, Chair, IMACS, Computational Physics, Univ. of Colorado, Boulder, CO 80309-0425; email: imacs@boulder.colorado.edu.

* Spring 1992. **International Conference on Finite Elements and Boundary Elements in Geophysics**, Monteray, CA.

INFORMATION: B. Neta, Dept. of Math., Code 53ND, Naval Postgraduate School, Monteray, CA 93943.

January 1992

* 13–17. **IMA Workshop on Linear Algebra, Markov Chains, and Queuing Models**, University of Minnesota, Minneapolis, MN.

PURPOSE: Three areas are important in the construction and numerical solution to problems of complex systems: linear algebra, Markov chains, and queuing network models. The object of this workshop is to bring together experts from these three areas to share their different points of view of the subject.
ORGANIZERS: J. McKenna, R.J. Plemmons, and G.W. Stewart.
CONFERENCE TOPICS: Iterative methods for large Markov chains; dealing with the exponential explosion of the state space in queuing networks; transient behavior; matrix geometric methods.
INFORMATION: Institute for Mathematics and Its Applications, University of Minnesota, 514 Vincent Hall, 206 Church St., S.E., Minneapolis, MN 55455; 612-624-6066.

February 1992

* 24–March 1. **IMA Workshop on Iterative Methods for Sparse and Structured Problems**, University of Minnesota, Minneapolis, MN.

PURPOSE: Important applications await techniques for solving large nonsymmetric systems of linear equations and eigenvalue problems. The purpose of this workshop is to bring together researchers in numerical anaylsis and various application areas to discuss where such problems arise and possible methods of solution. The last two days of this workshop will be a celebration dedicated to Gene Golub on the occasion of his sixtieth birthday (Feb. 29, 1992). This program for this part of the workshop is being arranged by J. D. Dongarra and P. van Dooren.
ORGANIZERS: G. Golub, A. Greenbaum, M. Luskin.
INFORMATION: Institute for Mathematics and Its Applications, University of Minnesota, 514 Vincent Hall, 206 Church St., S.E., Minneapolis, MN 55455; 612-624-6066.

March 1992

* 30–April 3. **Workshop on Statistical Methods in Molecular Biology**, Mathematical Sciences Research Institute, Berkeley, CA.

PROGRAM: This is the second of two workshops planned as part of MSRI's 1991-1992 program on statistics.
ORGANIZER: M. Waterman.
INFORMATION: I. Kaplansky, Director, Mathematical Sciences Research Institute, 1000 Centennial Dr., Berkeley, CA 94720.

April 1992

* 6–10. **IMA Workshop on Linear Algebra for Signal Processing**, University of Minnesota, Minneapolis, MN.

PURPOSE: Signal processing is making increasingly sophisticated use of linear algebra on both theoretical and algorithmic fronts. The purpose of this workshop is to bring signal processing engineers, computer engineers, and applied linear algebraists together for an exchange of problems, theories, and techniques.
ORGANIZERS: A. Bojanczyk and G. Cybenko.
CONFERENCE TOPICS: Updating SVD and eigendecompositions; adaptive filtering; structured matrix problems; wavelets and multirate signal processing; and linear algebra architectures (parallel/vector and other high performance machines/designs).
INFORMATION: Institute for Mathematics and Its Applications, University of Minnesota, 514 Vincent Hall, 206 Church St., S.E., Minneapolis, MN 55455; 612-624-6066.

June 1992

* June 1992. **IMACS Symposium on Numerical Computing and Mathematical Modelling**, Bangalore, India.

INFORMATION: S.K. Dey, Dept. of Math., Eastern Illinois Univ., Charleston, IL 61920.

* 1–5. **IMA Workshop on Linear Algebra for Control Theory**, University of Minnesota, Minneapolis, MN.

INFORMATION: During the past decade the interaction between control theory and linear algebra has been ever increasing, giving rise to new results in both areas. The purpose of this workshop is to further develop and nurture this cross-fertilization by bringing together control theorists and linear algebraists for an exchange of problems, ideas, and techniques.
ORGANIZER: P. Van Dooren.
CONFERENCE THEMES: Numerical linear algebra for control; canonical forms and invariants; ring-theoretic methods in linear control; matrix theory in control; H^∞ control.
INFORMATION: Institute for Mathematics and Its Applications, University of Minnesota, 514 Vincent Hall, 206 Church St., S.E., Minneapolis, MN 55455; 612-624-6066.

New AMS Publications

New Series

The Soviet Academy of Sciences has authorized a new book series, co-edited by V. I. Arnold, S. G. Gindikin, and V. Maslov, to be published only in English by the American Mathematical Society. *Advances in Soviet Mathematics* will contain collections of top-quality articles focused on an area of mathematical research having a strong research group in the Soviet Union. Each of the two to three volumes per year will have its own editor who is an outstanding mathematician connected with the research school represented by the volume. The appearance of this new series attests to the vitality and productivity of researchers in the Soviet Union and will help to disseminate their results to a wider segment of the international mathematical sciences community.

THEORY OF SINGULARITIES AND ITS APPLICATIONS

V. I. Arnold, Editor

(Advances in Soviet Mathematics, Volume 1)

The theory of singularities lies at the crossroads between those branches of mathematics which are the most abstract and those which are the most applied. Algebraic and differential geometry and topology, commutative algebra and group theory are as intimately connected to singularity theory as are dynamical systems theory, control theory, differential equations, quantum mechanical and quasi-classical asymptotics, optics, and functional analysis.

This collection of papers incorporates recent results of participants in the editor's ongoing seminar in singularity theory, held in the Mechanics and Mathematics Department of Moscow University for over twenty years. With its broad range of subject matter, this volume will appeal to a wide range of readers in various areas of the mathematical sciences. Among the topics covered are: construction of new knot invariants, stable cohomology of complementary spaces to diffusion diagrams, topological properties of spaces of Legendre maps, application of Weierstrass bifurcation points in projective curve flattenings, classification of singularities of projective surfaces with boundary, nonsmoothness of visible contours of smooth convex hypersurfaces, flag manifolds, hyperbolic partial differential systems, and control theory.

Contents

1980 *Mathematics Subject Classifications*: 35C45, 55Q70, 57R70, 55M20, 58F05, 14H35, 33A25, 15A03, 53A05, 57R50, 58F08, 32C40, 55P35, 57M25, 55T25, 35L55, 35A30, 35B99, 53A20, 32C25, 05C10, 14H15, 34C30, 58F14, 32B30, 58G15, 58A35, 58C27, 14M15, 46E25, 34H05, 93B07, 93B50; 14M15, 58A35, 32C05, 93B30
ISBN 0-8218-4100-9, LC 90-45636, ISSN 1051-8037
333 pages (softcover), October 1990
Individual member $75, List price $125,
Institutional member $100
To order, please specify ADVSOV/1N

ALGEBRAIC GEOMETRY FOR SCIENTISTS AND ENGINEERS

Shreeram S. Abhyankar

(Mathematical Surveys and Monographs, Volume 35)

This book, based on lectures presented in courses on algebraic geometry taught by the author at Purdue University, is intended for engineers and scientists (especially computer scientists), as well as graduate students and advanced undergraduates in mathematics. In addition to providing a concrete or algorithmic approach to algebraic geometry, the author also attempts to motivate and explain its link to more modern algebraic geometry based on abstract algebra. The book covers various topics in the theory of algebraic curves and surfaces, such as rational and polynomial parametrization, functions and differentials on a curve,

branches and valuations, and resolution of singularities. The emphasis is on presenting heuristic ideas and suggestive arguments rather than formal proofs. Readers will gain new insight into the subject of algebraic geometry in a way that should increase appreciation of modern treatments of the subject, as well as enhance its utility in applications in science and industry.

Contents

1980 *Mathematics Subject Classification*: 14-XX
ISBN 0-8218-1535-0, LC 90-815, ISSN 0076-5376
295 pages (hardcover), October 1990
Individual member $52, List price $87,
Institutional member $70
To order, please specify SURV/35N

COMBINATORIAL GROUP THEORY
Benjamin Fine, Anthony Gaglione and Francis C. Y. Tang, Editors

(Contemporary Mathematics, Volume 109)

The AMS Special Session on Combinatorial Group Theory—Infinite Groups, held at the University of Maryland in April 1988, was designed to draw together researchers in various areas of infinite group theory, especially combinatorial group theory, to share methods and results. The session reflected the vitality and interests in infinite group theory, with eighteen speakers presenting lectures covering a wide range of group-theoretic topics, from purely logical questions to geometric methods. The heightened interest in classical combinatorial group theory was reflected in the sheer volume of work presented during the session.

This book consists of eighteen papers presented during the session. Comprising a mix of pure research and exposition, the papers should be sufficiently understandable to the nonspecialist to convey a sense of the direction of this field. However, the volume will be of special interest to researchers in infinite group theory and combinatorial group theory, as well as to those interested in low-dimensional (especially three-manifold) topology.

Contents

1980 *Mathematics Subject Classifications*: 20-06, 20EXX, 20FXX
ISBN 0-8218-5116-0, LC 90-40475, ISSN 0271-4132
191 pages (softcover), October 1990
Individual member $22, List price $37,
Institutional member $30
To order, please specify CONM/109N

LIE ALGEBRAS AND RELATED TOPICS
Georgia Benkart and J. Marshall Osborn, Editors

(Contemporary Mathematics, Volume 110)

The 1984 classification of the finite-dimensional restricted simple Lie algebras over an algebraically closed field of characteristic $p > 7$ provided the impetus for a Special Year of Lie Algebras, held at the University of Wisconsin, Madison, during 1987-88. Work done during the Special Year and afterward put researchers much closer toward a solution of the long-standing problem of determining the finite-dimensional simple Lie algebras over an algebraically closed field of characteristic $p > 7$.

This volume contains the proceedings of a conference on Lie algebras and related topics, held in May 1988 to mark the end of the Special Year. The conference featured lectures on Lie algebras of prime characteristic, algebraic groups, combinatorics and representation theory, and Kac-Moody and Virasoro algebras. Many facets of recent research on Lie theory are reflected in the papers presented here, testifying to the richness and diversity of this topic.

Contents

of representations of semisimple Lie algebras; **J. Schue**, *Enveloping algebras and division rings for Lie p-algebras*; **P. E. Singer**, *Serre relations*; **L. Solomon**, *The number of irreducible representations of a finite coxeter group*; **H. Strade**, *The role of p-envelopes in the theory of modular Lie algebras*; **V. R. Varea**, *On modular subalgebras in Lie algebras of prime characteristic*; **D. Witte**, *Cocompact subgroups of semisimple Lie groups*.

1980 *Mathematics Subject Classifications*: 17B50, 17B65, 17B35, 20G15, 22E46; 17B05, 17B10, 17B20, 17B25, 17B45, 17B67, 20C30, 58B25
ISBN 0-8218-5119-5, LC 90-44712, ISSN 0271-4132
313 pages (softcover), October 1990
Individual member $26, List price $44,
Institutional member $35
To order, please specify CONM/110N

FINITE GEOMETRIES AND COMBINATORIAL DESIGNS
Earl S. Kramer and Spyros S. Magliveras, Editors

(Contemporary Mathematics, Volume 111)

More than eighty participants from all over the world attended an AMS Special Session on Finite Geometries and Combinatorial Designs held in Lincoln, Nebraska in the fall of 1987. This volume contains the proceedings of that Special Session, in addition to several invited papers. Employing state-of-the-art combinatorial and geometric methods, the papers show significant advances in this area. Topics range over finite geometry, combinatorial designs, their automorphism groups, and related structures.

Requiring graduate-level background, this book is intended primarily for researchers in finite geometries and combinatorial designs. However, the interested nonspecialist will find that the book provides an excellent overview of current activity in these areas.

Contents

B. Alspach, K. Heinrich, and B. Mohar, *A note on Hamilton cycles in block-intersection graphs*; **B. A. Anderson**, *All dicyclic groups of order at least twelve have symmetric sequencings*; **F.E. Bennett**, *Concerning pairwise balanced designs with prime power block sizes*; **A. A. Bruen and U. Ott**, *On the p-rank of incidence matrices and a question of E.S. Lander*; **M. J. de Resmini**, *On the Dempwolff plane*; **J. F. Dillon**, *Difference sets in 2-groups*; **J. H. Dinitz and D. R. Stinson**, *On the existence of Room squares with subsquares*; **D. A. Drake**, *A bound for blocking sets in finite projective planes*; **J. W. P. Hirschfeld and J. A. Thas**, *Sets with more than one representation as an algebraic curve of degree three*; **N. L. Johnson**, *Flocks and partial flocks of quadric sets*; **P. B. Kleidman**, *The finite flag-transitive linear spaces with an exceptional automorphism group*; **D. L. Kreher and S. P. Radziszowski**, *Constructing* 6-(14,7,4) *designs*; **A. Pasini**, *On the classification of finite c_n-geometries with thick lines*; **V. Pless**, *Cyclic codes and cyclic configurations*; **J. J. Seidel**, *Designs and approximation*; **J. A. Thas**, *Flocks, maximal exterior sets, and inversive planes*; **V. D. Tonchev**, *Self-orthogonal designs*; **T. van Trung**, *Nonembeddable quasi-residual designs*; **W. D. Wallis**, *Finite planes and clique partitions*; **M. A. Wertheimer**, *Oval designs in quadrics*; **C. Y. Ho**, *On the order of a finite projective plane and its collineation group*; **P. C. van Oorschot and S. A. Vanstone**, *Some geometric aspects of root finding in $GF(q^m)$* ; **J. Siemons**, *Automorphism groups as linear groups*.

1980 *Mathematics Subject Classifications*: 05BXX, 51EXX
ISBN 0-8218-5118-7, LC 90-45302, ISSN 0271-4132
312 pages (softcover), October 1990
Individual member $32, List price $53,
Institutional member $42
To order, please specify CONM/111N

ALGEBRAIC IDEAS IN ERGODIC THEORY
Klaus Schmidt

(CBMS Regional Conference Series, Number 76
Supported by the National Science Foundation)

This book is based on a series of ten lectures sponsored by the Conference Board on the Mathematical Sciences and presented by the author at the University of Washington in Seattle in July 1989. The main theme of the lectures, the influence of algebraic ideas on the development of ergodic theory, was so extensive that the author chose to restrict himself to two specific topics.

The first topic is the influence of operator algebras on dynamics. The author concentrates on ergodic equivalence relations, their properties, and their classification, presenting occasional glimpses of the operator-algebraic context from which many of the ideas and techniques arose. In addition, he provides a large number of examples showing that equivalence relations provide a natural setting for many classical constructions and classification problems.

The second topic in the book is higher dimensional Markov shifts, a difficult field of research with no indication yet of a satisfactory general theory. After discussing some elementary examples of such shifts and the suprising difficulties these examples present, the author makes the assumption that the Markov shift carries a group structure. In that context, many of the difficulties can be resolved, and one has the beginnings of a successful analysis which exhibits an intriguing interplay between commutative algebra and dynamics.

Contents

Operator algebras and dynamical systems; *Cohomology of equivalence relations*; *Rokhlin's lemma and asymptotic invariance*; *Dimension*; *Markov shifts in higher dimensions*; *Markov shifts and Markov groups*; *The dynamics of abelian Markov groups*.

1980 *Mathematics Subject Classifications*: 28D05, 28D15, 28D20, 54C70
ISBN 0-8218-0727-7, LC 90-877, ISSN 0160-7642
92 pages (softcover), October 1990
All individuals $18, List price $30
To order, please specify CBMS/76N

SEX ALLOCATION AND SEX CHANGE: EXPERIMENTS AND MODELS
Marc Mangel, Editor

(Lectures on Mathematics in the Life Sciences, Volume 22)

The seven articles in this volume are based on lectures presented at the annual symposium, Some Mathematical Questions in Biology, held in conjunction with the American Institute of Biological Sciences meeting in Toronto, Ontario in August 1989. Sexual selection, sex determination, and sex allocation have been at the center of evolutionary ecology

since its inception and have played an important role in the development of many concepts. As this volume demonstrates, many key questions remain to be investigated through a combination of empirical and theoretical work. In addition, questions of sex provide a natural mechanism for crossing the great taxonomic divide by allowing plant and animal researchers to focus on similar kinds of questions using a wide variety of organisms.

Contents

1980 *Mathematics Subject Classifications*: 92A05, 92A06, 92A10, 92A12, 92A17
ISBN 0-8218-1172-X, LC 90-45411, ISSN 0075-8523
205 pages (softcover), October 1990
Individual member $25, List price $41,
Institutional member $33
To order, please specify LLSCI/22N

ASSISTANTSHIPS AND GRADUATE FELLOWSHIPS IN THE MATHEMATICAL SCIENCES, 1990–1991, UPDATED EDITION

This is the 1990 updated edition of *Assistantships and Graduate Fellowships*, the centralized resource for information about support for graduate study in the mathematical sciences. For students considering master's or doctoral studies, or for department chairs planning graduate programs, *A&GF* provides current information on the availability of fellowships, teaching assistantships, and stipends for study and travel. Information on thesis and foreign language requirements is included, as well as addresses for information on fellowships from the federal government and other sources.

Contributing information to *A&GF* are over 450 departments of mathematics, applied mathematics, statistics, computer science, and other mathematics-related disciplines spanning more than 300 educational institutions. A timely and informative publication, *A&GF* is a must for every mathematical sciences department.

1980 *Mathematics Subject Classification*: 00
ISBN 0-8218-0159-7, ISSN 1040-7650
156 pages (softcover), October 1990
Individual member $9, List price $15,
Institutional member $9
To order, please specify ASSTR/90N

OPTIMAL CONTROL AND DIFFERENTIAL GAMES
L. S. Pontryagin, Editor

(Proceedings of the Steklov Institute, Volume 185)

This collection of twenty-two papers, devoted to questions of optimal control theory and differential games, provides an excellent overview of current trends of research in the area of control systems. The papers encompass numerous optimization methods, necessary and sufficient conditions for optimality, extremal problems in differential games, and problems on multivalued mappings. The editor's survey paper considers differential games of pursuit and evasion, and his joint paper with Mishchenko solves a differential game of pursuit without discrimination of the evader.

Contents

1980 *Mathematics Subject Classifications*: 28B20, 34A55, 34A60, 34C35, 34H05, 35J05, 35L05, 35R35, 49A10, 49A40, 49B10, 49B27, 49B34, 49B99, 49D29, 49D30, 49E10, 49E15, 52A20, 54C08, 54C60, 58F25, 58F99, 90D25, 90D26, 93C05, 93C15; 34A60, 35J25, 35P25, 35R25, 49A10, 49B10, 49D29, 49D30, 49D35, 49D45, 49E15, 52A99, 54C60, 57M10, 57N05, 58F15, 70H20, 90D10, 90D25, 90D26, 90D42, 93C99.
ISBN 0-8218-3134-8, LC 90-42913, ISSN 0081-5438
278 pages (hardcover), October 1990
Individual member $80, List price $133,
Institutional member $106
To order, please specify STEKLO/185N

AMS Reports and Communications

The Council Meeting in Columbus

The Council of the American Mathematical Society met at 2:00 p.m. on Tuesday, 07 August 1990, in the Olentangy Room B of the Ramada Inn, Columbus, Ohio. President Browder presided. There were 21 members present.

The Council was able to conduct the business of a rather lengthy agenda in almost record time.

The first item of business was to pass the following resolution:

> The Council of the AMS extends its congratulations to the Mathematical Association of America on the occasion of its 75th Anniversary. Its long history of energetic and dedicated endeavor in the field of mathematical education has greatly contributed to the welfare of our subject and our nation. It notes the long history of fruitful cooperation between our two organizations and looks forward to even closer relations in the future.

It handled a number of routine matters such as appointments to editorial committees and nominations for the upcoming election.

Regarding editorial committees, the Council received two reports from its Editorial Boards Committee (EBC), the committee that is responsible for, among other things, suggesting appointments to these editorial committees. The first report was a request from the Council to endorse a policy regarding associate editors. The policy, as adopted by the Council, reads:

> When it is appropriate for editors to form a panel of associate editors they will do so in consultation with the Editorial Boards Committee, which has the authority to ratify the selections.
> While editors are often chosen from a panel of associate editors, the pool of candidates for an editorship is not limited to that panel.

The second report concerned rebuttals to reviews of books in the *Bulletin of the American Mathematical Society*. The EBC had been asked to formulate a policy. After having sent one formulation to the Council in January 1990, which was returned to the committee, the EBC submitted the following policy statement, which was adopted by the Council:

> Controversial reviews are acceptable for the *Bulletin of the American Mathematical Society*.
> Corrections and rebuttals should appear in print. Corrections to erroneous statements of fact in a *Bulletin* book review should appear in the *Bulletin*. Rebuttals should, as a matter of policy, appear in the Letters section of *Notices*.
> In case an author of a book under review is still not satisfied, the appeal should be referred to the EBC. The Council should be involved, if necessary, only as a final board of appeal.

The Council accepted the recommendations of the EBC for appointments to various editorial committees as follows:

> Frank Quinn to the *Bulletin* Editorial Committee as editor in charge of Research Announcements.
> Barry Mazur, Richard Melrose, and Wilfried Schmid to the *Journal of the American Mathematical Society* Editorial Committee.
> Avner Ash, Sun-Yang Alice Chang, Ralph L. Cohen, Jerry L. Kazdan, and David J. Saltman to the *Transactions* and *Memoirs* Editorial Committee.
> Hans Weinberger to the *Mathematical Reviews* Editorial Committee.
> Bhama Srinivasan to the *Mathematical Surveys and Monographs* Editorial Committee.
> Ted Gamelin, Charles Pugh, Peter Li to the *Proceedings* Editorial Committee. In addition, the Council appointed Irwin Kra as Managing Editor of the *Proceedings*.
> Frank W. J. Olver to the *Mathematics of Computation* Editorial Committee.

The Council acted on recommendations from its Nominating Committee for election and appointments to two committees. It elected Amassa Fauntleroy, Carolyn Gordon, and Ridgway Scott to the *Notices* Editorial Committee for four year terms beginning on 1 January 1991. It appointed William Abikoff and Diane Meuser to the Committee to Monitor Problems in Communication for three year terms.

Also the Council completed the slate of candidates for the upcoming election by nominating Frank Gilfeather, Edward B. Saff, and Steven H. Weintraub for election as members-at-large of the Council.

While considering the administrative aspects of the Society, the Council agreed to a procedure for selecting candidate(s) for Treasurer and Associate Treasurer. This is necessary because the current Associate Treasurer, Steve Armentrout, has indicated his desire to step down from the position after serving out his next term. Also the current Treasurer, Franklin P. Peterson, has indicated a desire to step down in the near future. The Council agreed that a committee consisting of two members from the Board of Trustees,

one from the Executive Committee, one elected from the Nominating Committee, and one elected from the Council would serve as a search committee that would recommend candidates to the Council. The time table has been established so as to get a candidate in place to serve an apprentice year in the office.

The Council adopted several amendments to the Bylaws for approval by the members of the Society in the upcoming election. One concerned lengths of terms of office of members of editorial committees, another concerned how the working officers of the Society are elected. The recommended amendments to the Bylaws have been recorded in *Notices* (see the September 1990 *Notices*, pages 911-912) and will have been sent to all members of the Society by the time this report is printed, so they will not be repeated here.

The Council considered several policy and program matters. It considered and adopted, in principal, a policy on accepting gifts to the Society. It established a Committee on Education which will advise the various governing bodies of the Society on educational matters and serve as a liaison between the Society and other organizations on mathematics education matters. It established, in principal, a program to administer and make research awards in the under $5000 range to support travel and other costs for mathematical research. It established the Trjitzinsky Memorial Awards to support the education of needy mathematics students. These memorial awards were established by a generous bequest from the estate of Barbara G. Trjitzinsky, wife of the late Waldemar J. Trjitzinsky. It established the John von Neumann Symposium, which will be funded in part by the income from a generous bequest from the estate of Dr. Carrol V. Newsom. This will be a quadrennial symposium that will focus on fundamental concepts in the forefont of mathematics. It agreed that the Society could, if asked, submit a proposal to administer a National Security Agency Review Panel that would screen applications for research grants made to the National Security Agency.

The Council heard a report from Edward A. Connors, the new Director of the Office of Governmental and Public Affairs. It welcomed and heard from the President of the Mathematical Association of America (MAA), Lida Barrett, and her successor, President-Elect of MAA, Deborah Haimo.

The Council considered several resolutions. It suggested that the President write, on behalf of the Council, concerning an immigration matter. And it passed the following resolution:

> The Council of the American Mathematical Society notes with pleasure the action by the City University of New York recognizing the achievements and distinction of its former faculty member, Lee Lorch, by its award to him of an honorary degree. By this action, the University has acknowledged the injustice of its treatment of Lorch in firing him for political reasons in 1949.
>
> The Council suggests to The University of Michigan that it acknowledge the injustice of its treatment of Chandler Davis and his dismissal in 1954. The damage done to Professors Davis and Lorch and others like them cannot be undone, but formal recognition of these past injustices will help to strengthen freedom of inquiry in or academic institutions.

Finally, the Council agreed that correspondence and other material that its committees garner should be deposited in the Society archives on a regular basis and it agreed that changes in published scientific programs at Society meetings should be minimal and made only after approval by the cognizant secretary.

The Council adjourned at 6:15 p.m.

Robert M. Fossum
Secretary
Urbana, Illinois

The Business Meeting in Columbus

The Business Meeting of 10 August 1990 began about 12:00 noon and followed immediately upon the award of the 1990 Wiener Prize and the 1990 Steele Prizes. President Browder presided.

The Secretary began his report by reading the resolution that had been adopted by the Council at its meeting on 07 August:

The Council of the AMS extends its congratulations to the Mathematical Association of America on the occasion of its 75th Anniversary. Its long history of energetic and dedicated endeavor in the field of mathematical education has greatly contributed to the welfare of our subject and our nation. It notes the long history of fruitful cooperation between our two organizations and looks forward to even closer relations in the future.

The Secretary then asked for and received permission to record the other actions of the recent Council meetings and other business of the Society in a future issue of *Notices* (see the report of the Council meeting in this section of *Notices*.)

The only business on the agenda being the report of the Secretary, the President then asked for a motion to adjourn. The meeting adjourned shortly after 12:00 noon.

Robert M. Fossum
Secretary
Urbana, Illinois

Miscellaneous

Personals

Richard H. Herman, professor and head of The Pennsylvania State University's department of mathematics, was named dean of the College of Computer, Mathematical and Physical Sciences at the University of Maryland.

Simon A. Levin, the Charles A. Alexander Professor of Biological Sciences at Cornell University, received an Honorary Doctoral Degree from Eastern Michigan University, Ypsilanti and delivered the Commencement address at that university on April 21, 1990.

Mervin E. Muller, of Ohio State University, has been named chairman of the Scientific and Technical Information Board (STIB) of the National Research Council (NRC), which was formerly known as the Numerical Data Advisory Board of the NRC.

Joan Wick Pelletier, of York University, has been appointed Associate Vice-President (Research) at that institution.

Andrew Rosalsky, of the University of Florida, Gainesville, has been promoted to Professor of Statistics at that university.

Deaths

Isabella A. Adjaero, of the University of Nigeria Nsukka, died on July 11, 1990, at the age of 48. She was a member of the Society for 13 years.

Lawrence D. Gould, of the North Carolina School of Science and Mathematics, died on May 9, 1990, at the age of 58. He was a member of the Society for 30 years.

Louis F. Tolle, Professor Emeritus of St. John's University, died on July 18, 1990, at the age of 82. He was a member of the Society for 48 years.

David V. Widder, Retired Professor of Harvard University, died on July 8, 1990, at the age of 92. He was a member of the Society for 66 years.

Visiting Mathematicians

Supplementary List

Mathematicians visiting other institutions during the 1989-1990 and 1990-1991 academic years have been listed in recent issues of *Notices*: September 1990, p. 959; July/August 1990, p. 758; May/June 1990, p. 621; April 1990, p. 508; March 1990, p. 342; February 1990, p. 231; and December 1989, p. 1450.

Sen Hu (People's Republic of China), Northwestern University, Dynamical Systems, 9/90 - 8/92.

Vladimir Kalashnikov (USSR), University of California, Santa Barbara, Stability Problems, 9/90 - 12/90.

Michael Kapranov (USSR), Cornell University, Sheaf Theory, 9/90 - 6/91.

Carlengelo Liverani (Italy), Cornell University, Dynamical Systems, 9/90 - 1/90.

Michal Misiurewicz (Poland), Northwestern University, Dynamical Systems, 9/90 - 8/91

Anis Mukhopadhyay (India), University of California, Santa Barbara, Applied Statistics, 7/89 - 6/91.

Talluri Rao (India), University of California, Santa Barbara, Applied Statistics, 7/89 - 6/91.

Jan Rosinski (Poland), Cornell University, Probability, 8/90 - 12/90.

Peter G. Trotter (Australia), Marquette University, Semigroup Theory, 1/91 - 5/91.

Jerzy Wojciechowski (Poland), West Virginia University, Combinatorics/Graph Theory, 8/90 - 5/91.

Andrei Zelevinski (USSR), Cornell University, Lie Algebras, 9/90 - 6/91.

Günter Ziegler (Germany), Cornell University, Combinatorics, Spring 1991.

Krystyna Zieman (Poland), Northwestern University, Dynamical Systems, 9/90 - 8/91.

New Members of the AMS

ORDINARY MEMBERS

Feras Hameed Al-Alwan, Univ of Baghdad, Jadiriya, Iraq
Sadoon Almusawe, Univ of Birmingham, England
Jesús Antonio Alvarez López, Lugo, Spain
Isam S Ayoubi, King Fahd Univ, Dhahran, Saudi Arabia
Ronald J Beattie, Mount Allison Univ, Sackville, New Brunswick Canada
Jerry E Bolick, Lenoir-Rhyne College, Hickory, NC
Valentin E Brimkov, Bulgarian Academy of Sciences, Sofia
Mikolaj Buslowicz, Bialystok, Poland
Martin Cadek, Czechoslovakia Academy of Science, Brno
Philip R Carlson, New Brighton, MN
Chin-Loon Chai, Singapore
Jor-Ting Chan, National Univ of Singapore, Kent Ridge
Athanasios Chatzitheodoridis, Korydallos, Greece
Xiao Peng Cheng, South China Univ of Technology, Guangzhou
Yi Cheng, Univ of Science & Technology of China, Hefei
Joan Countryman, Philadelphia, PA
Valery Covachev, Bulgarian Academy of Science, Sofia
Thomas L Curtright, Univ of Miami, Coral Gables, FL
Ljiljana Cvetkovic, Institute of Mathematics, Novi Sad, Yugoslavia
Lynn K Davis, Raymond Walters College, Cincinnati, OH
Gerald Jerry Diaz, Colorado Springs
Daryl L Ezzo, Centerville, IN
Abdulrahim Muhammad Farhat, Albuquerque, NM
Dmitry G Fleischman, Moscow, USSR
Antonio Gómez Tato, Colegio Univ de Lugo, Spain
Michael R Gadberry, Phillips Univ, Enid, OK
Guo Zhu Gao, China Textile Univ, Shanghai
Ronald S Gentle, Carleton Univ, Ottawa, Ontario Canada
Vladimir Ya Gershkovich, Leningrad, USSR
Viktor L Ginzburg, Berkeley, CA
Ewa Graczynska, Polish Academy of Sciences, Wroclaw
Sat N Gupta, Univ of Southern Maine, Portland
Verner T Hansen, Jefferson City, TN
Arthur D Harris Jr, Chatsworth, CA
Shirley S Harrison, Marion Military Institute, AL
Gerald L Hefley, Research Triangle Park, NC
Mohamed Atef A A Helal, Cairo Univ, Giza, Egypt
Isamu Hosouchi, Nagasaki Univ, Japan
R M Hovstad, Oslo, Norway
Rebecca Carol Jackson, Swarthmore College, PA
Gerhard Jaeschke, Eberbach, Federal Republic of Germany
Zheng Da Jin, Dalian Maritime Univ, People's Republic of China
Judith E Johnson, Wilberforce, OH
Ivor Jones, Clwyo, Wales
Ahmed K A Khalifa, King Saud Univ, Riyadh, Saudi Arabia
Michal Kisielewicz, Zielona Gora, Poland
Vera V Kovacevic-Vujcic, Mathematical Institute, Belgrade, Yugoslavia
Chu Jen Lai, Taichung, Taiwan
S Lajos, Univ for Economics, Budapest, Hungary
A Stephen Lee, Flagstaff, AZ
Benedict J Leimkuhler, Helsinki Univ of Technology, Espoo, Finland
Adrian S Lewis, Univ of Waterloo, Ontario Canada
De Li Li, Jilin Univ, Changchun, People's Republic of China
Xin Li, Univ of Central Florida, Orlando, FL
Aleksandar Lipkovski, Tubingen, Federal Republic of Germany
Stefano Luzzatto, Marlboro College, VT
Fu Ming Ma, Jilin Univ, Changchun, People's Republic of China
Petr Mandl, Charles Univ, Prague, Czechoslovakia
V M Marchenko, Minsk, USSR
Gerard A Maugin, Univ Pierre et Marie Curie, Paris, France
Dimitry B Maxutov, Clearwater, FL
Sergei Mazanik, Byelorussian State Univ, Minsk, USSR
Walter J Meyer, Garden City, NY
Philip J Moody, Ohio Univ, Athens
Donald L Muench, Saint John Fisher College, Rochester, NY
Robert P Orr, Memphis, TN
Gary W Ostedt, MacMillan Publishers, New York, NY
Margarita Otero, Mathematical Institute, Oxford, England
Lee Jonathan Parnell, Asbury College, Wilmore, KY
Garuta Pasc, Polytechnic Institute of Timisoara, Romania
Daniel E Perez, Westland, MI
Huu Tiep Pham, Moscow State Univ, USSR
Donald E Purcell, Palatine, IL
Sajeel Rashid, Troy, NY
Peter Ratener, Redmond, WA
Cleon L Rogers, Sunnyvale, CA
Janet B Roll, Ada, OH
B Ya Ryabko, Novosibirsk Institute of Communication, USSR
Karen V Sagatelyan, Erevan State Univ, USSR
Kazuhiro Sakai, Chiba-ken, Japan
Andrei V Sarychev, USSR Academy of Sciences, Moscow
Carsten Schütt, Oklahoma State Univ, Stillwater
Florence C Sehl, East Greenwich, RI
John Matthew Selisky, Chicago, IL
Qi Man Shao, Hangzhou Univ, People's Republic of China
A V Shokurov, Moscow, USSR
Kerry Dale Smith, Greenwood, IN
Trudy A Smith, Shelbyville, IN
Boris Solomyak, Stony Brook, NY
Joan M Spetich, Baldwin-Wallace College, Berea, OH
C Contee Stansbury, Harvard Univ, Cambridge, MA
Plamen D Stefanov, Bulgarian Academy of Science, Sofia
Kevin W Streeter, Wichita, KS
Timo E Suhonen, Jyvaskyla, Finland
Djurdjica Takači, Univ of Novi Sad, Yugoslavia
Jean-Claude Thomas, Villeneuve d'Ascq, France
Corneliu Ursescu, Univ Al Cuza Iasi, Romania
Laura R Van Zoest, Peoria, IL
Peter John Vassiliou, Univ of Canberra, Australia
Lie Heng Wang, Academia Sinica, Beijing, People's Republic of China
Xiang Chen Wang, Jilin Univ, Changchun, People's Republic of China
Thomas B Ward, Univ of Maryland, College Park
Abdul-Majid A Wazwaz, Loves Park, IL
Jun Jie Wei, Northeast Normal Univ, Changchun, People's Republic of China
Catherine Westbrook Williams, Knoxville, TN
DeLana W Williams, Birmingham-Southern College, AL
Hongyuan Zha, Stanford Univ, CA
Jingzhong Zhang, Chengdu, People's Republic of China
Wu Zhang, Peking Univ, Beijing, People's Republic of China

Michel van den Bergh, Univ of Antwerp, Wilrijk, Belgium

RECIPROCITY MEMBERS

Allahabad Mathematical Society
Himadri Kumar Mukerjee

Australian Mathematical Society
Johann Linhart
G N Newsam

Dansk Matematisk Forening
Niels Gronbaek

Deutsche Mathematiker-Vereinigung e. V.
Detlef Berntzen
Bernd Günther
Klaus Pommerening
Alexander Pott
Rudolf Rupp
Norbert Weck

Edinburgh Mathematical Society
John H McCabe

Irish Mathematical Society
Patrick Fitzpatrick

Korean Mathematical Society
Jin Suk Pak
Jooseok Song

London Mathematical Society
Robert James Baston
D Bruce Christianson
John Cremona
James Howie
Christopher M Williams

Mathematical Society of Japan
Yasuko Chikuse
Shihoko Ishii
Yoshifumi Ito
Saichi Izumino
Tadato Matsuzawa
Ochiai Mitsuyuki
Chie Nara
Kamiya Noriaki
Takeo Ohsawa
Mutsuo Oka
Kunio Sakamoto
Kazuhiro Sasano
Hiroshige Shiga
Masataka Tomari
Osanobu Yamada
Noriaki Yamawaki

Société Mathématique Suisse
Lars-Erik Persson

Société Mathématique de Belgique
Herman Roelants

Société Mathématique de France
Robert Cauty
Michel Lazarus
Jean-Pierre Soublin

Société de Mathématiques Appliquées et Industrielles
Carlo Mamone Capria

Sociedade Brasileira de Matemática
Valmecir Bayer
Jorge Mujica
Marcio L B de Carvalho

Societat Catalana de Matemàtiques
Pere Mumbrú Rodriguez

Svenska Matematikersamfundet
Jan Gustavsson
Bo T Kagstrom
Bo Stenström

Unione Matematica Italiana
Elsa L Abbena
Marco Gaviano
Stefano Pallottino
Tommaso Ruggeri

Wiskundig Genootschap
H Broer
Roelof Koekoek
Jan Kuper
Hemmie Nico Jan Poulisse

Österreichische Mathematische Gesellschaft
Gustov Feichtinger

NOMINEE MEMBERS

College of William & Mary
H Rosie Hilbawi

Michigan State University
Chih-Ching Ouyang

Ohio State University, Columbus
Manabendra Nath Das
Dihua Jiang

SUNY at Albany
Lisa M Benacquista

United States Naval Academy
Marc David Lucas

University of Arizona
James A Powell

University of Illinois at Chicago
Zaiqing Xi

University of Lowell
Hsing-Me Chen

University of New Brunswick, Fredericton
Yongyi Bi
Chunhui Li

University of Texas at Arlington
Hie-Choon Chung

University of Waterloo
Yuqing Chen
Patricia Ann Newcombe

University of Winnipeg
Andrew D Bendor-Samuel

Postdoctoral Positions
Research or Research/Teaching 1990–1991

Postdoctoral positions, either research or a combination of research and teaching available through academic departments for 1990–1991 are listed below. An asterisk is used to indicate that the information was not yet available.

Alabama

Univ of Alabama at Birmingham
- Mathematics 1

California

California State Univ, Long Beach
- Mathematics 2

San Diego State Univ
- Mathematical Sciences 5

Univ of California, Berkeley
- Mathematics 6

Univ of California, Los Angeles
- Mathematics 10

Univ of Southern California
- Mathematics 2

Colorado

Colorado School of Mines
- Mathematical and Computer Sciences 1

Colorado State Univ
- Statistics 2

Univ of Colorado, Boulder
- Applied Mathematics 2

Univ of Colorado at Denver
- Mathematics 1

Connecticut

Yale Univ
- Computer Science 5
- Mathematics 5

Florida

Florida Inst of Tech
- Applied Mathematics 2

Univ of Central Florida
- Mathematics 4

Georgia

Georgia Inst of Tech
- Mathematics 4

Univ of Georgia
- Mathematics 1
- Mathematics Education 3

Illinois

Univ of Illinois, Urbana
- Computer Science 1
- Statistics 1

Western Illinois Univ
- Mathematics 1

Indiana

Purdue Univ
- Mathematics 5
- Statistics 2

Maryland

Johns Hopkins Univ
- Mathematical Sciences 2

Univ of Maryland, College Park
- Computer Science 2-3

Massachusetts

Boston Univ
- Computer Science 3
- Mathematics 1

Massachusetts Inst of Tech
- Mathematics 6

Univ of Massachusetts, Amherst
- Computer and Information Science 1-5

Michigan

Michigan State Univ
- Mathematics 2

Univ of Michigan
- Industrial and Operations Engineering 1
- Mathematics 8

Western Michigan Univ
- Mathematics and Statistics 1

Missouri

Washington Univ
- Mathematics 8

Nebraska

Univ of Nebraska, Lincoln
- Computer Science and Engineering 2
- Mathematics 1

New York

Clarkson Univ
- Mathematics and Computer Science 2

Columbia Univ
- Applied Physics 3

New York Univ, Courant
- Mathematics 20

Rensselaer Polytech Inst
- Mathematical Sciences 2

State Univ of New York at Albany
- Computer Science 1

State Univ of New York at Stony Brook
- Applied Mathematics and Statistics 4

Syracuse Univ
- Mathematics 1

Univ of Rochester
- Computer Science 1
- Statistics 1

North Carolina

North Carolina State Univ
- Mathematics 2
- Operations Research 1
- Statistics 4

Univ of North Carolina, Chapel Hill
- Biostatistics 3

Univ of North Carolina, Charlotte
- Mathematics 1

Ohio

Bowling Green State Univ
  Mathematics and Statistics 2
Case Western Reserve Univ
  Mathematics 6
Ohio State Univ
  Mathematics 15
Univ of Cincinnati
  Mathematical Sciences 1
Univ of Toledo
  Mathematics 1

Oklahoma

Oklahoma State Univ
  Mathematics 3
Univ of Oklahoma
  Biostatistics and Epidemiology 3
  Mathematics 2

Oregon

Oregon State Univ
  Mathematics 1
  Statistics 2

Pennsylvania

Carnegie Mellon Univ
  Statistics 3
Pennsylvania State Univ
  Mathematics 2
Temple Univ
  Mathematics 5
Univ of Pittsburgh
  Biostatistics 1

Rhode Island

Brown Univ
  Applied Mathematics 9

South Carolina

Univ of South Carolina
  Mathematics 2

Tennessee

Memphis State Univ
  Mathematical Sciences 3

Texas

Rice Univ
  Mathematical Sciences 3
Univ of Houston
  Mathematics 6

Utah

Univ of Utah
  Mathematics 4

Virginia

Univ of Virginia
  Mathematics 2
Virginia Polytech Inst and State Univ
  Computer Science 2
  Mathematics 1

Washington

Univ of Washington
  Applied Mathematics 2
  Biostatistics 2
  Mathematics 3

West Virginia

West Virginia Univ
  Mathematics 2

Wisconsin

Univ of Wisconsin, Madison
  Mathematics 4

Wyoming

Univ of Wyoming
  Mathematics 1

Canada

Concordia Univ
  Computer Science 3
Dalhousie Univ
  Mathematics, Statistics and Computer Science 5
McGill Univ
  Mathematics and Statistics varies
Memorial Univ of Newfoundland
  Computer Science 1-2
  Mathematics and Statistics 1
Queen's Univ
  Mathematics and Statistics 1-5
Simon Fraser Univ
  Mathematics and Statistics 4-5
Univ of Alberta
  Mathematics 5
Univ of British Columbia
  Statistics 2
Univ of Calgary
  Mathematics and Statistics 3
Univ of Manitoba
  Mathematics and Astronomy 2
Univ of Ottawa
  Computer Science 2
Univ of Saskatchewan
  Mathematics 1
Univ of Toronto
  Computer Science 9
  Industrial Engineering 1
Univ of Victoria
  Mathematics and Statistics 1
Univ of Western Ontario
  Mathematics 1

Stipends for Study and Travel

Beginning with this volume, the Stipends for Study and Travel will appear in the October issue rather than the December issue.

- Information from the December 1989 issue not yet confirmed. The dates have been updated for the coming year.

Graduate Support

American Association for the Advancement of Science. *Summer Fellowship.* Provides support for up to twenty outstanding graduate students in the natural and social sciences and engineering as intern reporters, researchers, and production assistants in the mass media for 10 weeks during the summer. (Exceptional undergraduate or postdoctoral students will also be considered.) Fellows will work for radio and television stations, newspapers and magazines and will have their travel expenses and stipends paid by the AAAS. Fellows will have the opportunity to: observe and participate in the process by which events and ideas become news; improve their communication skills by teaming to describe complex technical subjects in a manner understandable by the public; and increase their understanding of editorial decision-making and the manner in which information is effectively disseminated. Each fellow will: attend an orientation and evaluation session in Washington, DC; begin the internship in mid-June; and submit an interim and final report to AAAS to help evaluate the program. Interested students should write for more information and application procedures to: Manager, Mass Media Science and Engineering Fellows Program, American Association for the Advancement of Science, 1333 H Street, N.W., Washington, DC 20005. Application deadline will be about February 1.

American Association of University Women (AAUW) Educational Foundation. *American Fellowships.* Postdoctoral and dissertation fellowships for women who are citizens or permanent residents of the U.S. Applicants for the postdoctoral fellowships must hold a doctoral degree by the application deadline, November 15, 1990. The Founders Fellowship provides $25,000 for a senior scholar in any field; the other fellowships provide $20,000, and some have disciplinary restrictions. The dissertation fellowships provide stipends of $12,500, for the final year of writing the dissertation. An applicant must have completed all coursework, passed all examinations, and have had the dissertation proposal or plan approved by the application deadline. For more information, contact: AAUW Educational Foundation, 1111 16th Street, NW, Washington, DC 20036; telephone: (202)785-7700.

American Association of University Women (AAUW) Educational Foundation. *Career Development Grants* (formerly project RENEW). These grants are intended to support women who are continuing their self-development through higher education. Funding is provided to women who are preparing themselves to re-enter the work force, change careers, or advance a current career. Special consideration is given to AAUW members who submit qualified applications. Preference is given to applicants pursuing non-traditional coursework. These grants are one-time only awards. Minority women are encouraged to apply. Candidate eligibility: These grants are open to women who: are U.S. citizens or permanent residents; hold a baccalaureate degree; have received last degree on or before June 30, 1986; plan to pursue coursework at a fully accredited two or four year college or university, or at a technical school that is licensed, accredited, or approved by the Federal Veterans Administration; and, enroll in courses that are pre-requisites for professional employment plans. Funds are provided for tuition, fees, books, transportation (to/from/at school), and dependence care. Funds are not available for the final year of terminal degree professional programs (i.e., MBA, JD, MD, etc.). Ph.D. candidates may apply only for funding for coursework; not for dissertation research or writing. Candidates who fulfill eligibility requirements of other fellowship programs offered by the AAUW Educational Foundation *will not be considered* for funding from this grant and therefore, must apply to the appropriate program. Award Range: $1,000 - $5,000. AAUW Educational Foundation, 1111 16th Street, NW, Washington, DC 20036; telephone: (202)785-7700.

American Association of University Women (AAUW) Educational Foundation. *Eleanor Roosevelt Fund Teacher Enrichment Sabbatical Fellowship.* Created as the first programmatic component of the Eleanor Roosevelt Fund for Women and Girls, the purpose is two-fold. First, it recognizes and rewards good teachers and second, it enables teachers to improve their ability to teach girls. Candidate eligibilty: This program is open to full-time female classroom teachers who: are U.S. citizens or permanent residents; teach at U.S. public schools in grades K-12; have at least 5 consecutive years full-time teaching experience; plan to continue teaching for the next five years; and, can demonstrate commitment to educational opportunities for women and girls through work in the classroom, the school district and the community. Award range: $1,000 - $10,000. The amount of the award depends on the period of study undertaken. Teachers are not required to have sabbaticals from the school district. Coursework and/or research can be conducted during the summer or part-time. AAUW Educational Foundation, 1111 16th Street, NW, Washington, DC 20036; telephone: (202)785-7700.

American Association of University Women (AAUW) Educational Foundation. *Selected Professions Fellowships.* These are awarded to women who are citizens or permanent residents of the U.S. in designated fields. For 1991-1992, a focus is placed on science and technology, engineering and architecture fields to address the continuing low participation of women in these areas. The fields of law, medicine and the MBA program are open to minority women only. Fellowships for master's degree candidates, including those enrolled in one-year programs, are available for the final year of study in computer/information science and mathematics/statistics. The fellowships, which range from $5,000 to $9,500, are for full-time study. The deadline is December 15, 1990. For more information, contact: AAUW Educational Foundation, 1111 16th Street, NW, Washington, DC 20036; telephone: (202)785-7700.

American Society for Engineering Education. *ONR Graduate Fellowship Program.* About 50 36-month fellowships will be granted by the Office of Naval Research to support study and research leading to a doctoral degree in one of the following fields: electrical engineering, computer science, naval architecture and ocean engineering, materials science, applied physics, aerospace/mechanical engineering, oceanography, mathematics, biological/biomedical sciences, and cognitive/neural sciences. Applicants must be citizens of the U.S. (of any age) who will receive their baccalaureate degree in 1991, or who have not attended graduate school since receiving their baccalaureate degree. The fellowships, tenable at U.S. institutions offering doctoral degrees in the designated science and engineering disciplines, offer a stipend of $15,000 per 12-month year. In addition, ONR will provide the affiliated institution, on behalf of each Fellow, full tuition and fees, and will provide $2,000 per year to the Fellow's department. The application deadline is January 17, 1991. Application materials are available from the American Society for Engineering Education (ASEE), Eleven Dupont Circle, Suite 200, Washington, DC 20036 (202-745-3616 or 202-293-7080).

Argonne National Laboratory. See listing in the Postdoctoral Support section for information.

Associated Western Universities (AWU). AWU is a contractor for the U.S. Department of Energy, providing fellowships for teaching faculty members and to student participants who desire to become involved in an energy or energy-related research project at one of the cooperative laboratories or centers in the western U.S. For information telephone or write to Associated Western Universities, Inc., 4190 South Highland Drive, Suite 211, Salt Lake City, Utah 84124 (801-278-0799).

Bunting-Cobb Graduate Residential Fellowships for Women. Women graduate students enrolled in math, science, or engineering programs at Rutgers University's Graduate School on its New Brunswick campus have a special opportunity. Douglass College, the largest women's college in the nation, offers the Bunting-Cobb Graduate Residential Fellowship program. The Fellowship includes a stipend of $2,000 for new graduate students as well as room and board in the Bunting-Cobb Math and Science Hall. The Fellowship is renewable; second-year students receive a stipend of $4,000 plus room and board. Bunting-Cobb Fellows serve as mentors to the undergraduates in the residence hall. The hall is equipped with a microcomputer room and a resource library. For information about the Bunting-Cobb Fellowship, please contact Dr. Ellen F. Mappen, Director, Douglass Project for Rutgers Women in Math, Science, and Engineering at 201-932-9197. For information about graduate study at Rutgers, please contact Beverly Tarter at 201-932-7711.

- **California State Graduate Fellowships.** The state offers fellowships of up to $6,490 to cover tuition and fees only, for residents of California who attend accredited graduate or professional schools located in California. Write to California Student Aid Commission, Graduate Fellowship Program, P.O. Box 945627, Sacramento, California 94245-0627. The application deadline for 1991-1992 awards is March 2, 1991.

Center for Naval Analyses (CNA). *Summer Employment.* CNA, operated under contract with the Hudson Institute,

is engaged in a broad spectrum of operations research and systems analysis studies for the U.S. Navy, Marine Corps, and other government agencies. Opportunities are available for graduate students in operations research, economics, engineering, mathematics, physics, and statistics. Assignments include analysis related to force level planning, manpower, logistics, and operational effectiveness. U.S. citizenship required. Submit resume to Mr. Paul M. Moke, Employment Manager, Center for Naval Analyses, 4401 Ford Avenue, P.O. Box 16268, Alexandria, Virginia 22302-0268.

Committee on Institutional Cooperation. *CIC Minorities Fellowships in the Sciences, Mathematics and Engineering.* Fellowships are offered to American Indians, Black Americans, Mexican Americans and Puerto Ricans for graduate study leading to the Ph.D. The fellowships provide full tuition plus an annual stipend of at least $9,000 for each of four years. They may be used at any of these thirteen CIC universities: University of Chicago, University of Illinois, University of Illinois-Chicago, Indiana University, University of Iowa, University of Michigan, Michigan State University, University of Minnesota, Northwestern University, Ohio State University, Purdue University, University of Wisconsin-Madison or University of Wisconsin-Milwaukee. The deadline for applications for the 1991-1992 academic year is January 4, 1991. Detailed information about the program can be obtained by writing to the CIC Minorities Fellowships Program, 114 Kirkwood Hall, Indiana University, Bloomington, Indiana 47405 or by calling toll-free 1-800-457-4420.

Fellowships in Mathematics and Molecular Biology. The Program in Mathematics and Biology has graduate and postdoctoral fellowship support available. Current topics in the Program include geometry, topology, and sequence analysis of DNA, molecular dynamics, and mapping functions and algorithms for DNA and protien structure prediction. Other areas will be considered. Fellowships can be held at any University or College in the United States. Application deadline is January 1, 1991. Women and minorities are encouraged to apply. Funding can begin February 1, 1991. Apply to Dr. Sylvia J. Spengler/Dr. Nicholas R. Cozzarelli, Program in Mathematics and Molecular Biology, 214A Stanley Hall, University of California, Berkeley, CA 94720; E-mail SylviaJ@Violet.Berkeley.edu or SylviaJ@ucbviole.bitnet.

Florida Endowment Fund. *The McKnight Doctoral Fellowship Program.* McKnight Doctoral Fellowship provides up to $5,000 in tuition and fees plus an annual stipend of $11,000 to 25 African-American citizens to pursue Ph.D. degrees at participating Florida universities. Applicants must hold or be receiving a bachelor's degree from a regionally accredited college or university. Contingent upon successful academic progress, the maximum length of the award is four years. The Florida Endowment Fund provides the first three years and the student's university continues funding at the same level of support for a fourth year. Fifth year funding is available at many of the participating institutions. Detailed information and application packets can be obtained by writing or calling: The Florida Endowment Fund for Higher Education, 201 E. Kennedy Boulevard, Suite #1525, Tampa, FL 33602; 813-221-2772. The deadline for applications for Fall 1991 is: January 15, 1991.

Georgia Institute of Technology. *President's Fellowships.* These stipends of $4,000 for twelve months, plus waiver of all tuition and fees, are awarded to a selected number of highly qualified U.S. nationals who intend to pursue doctoral degrees. The awards are highly competitive; selection is based on academic criteria and evidence of scholarship. Participants are expected to maintain high academic standing. The Fellowships are intended to supplement other forms of support and can be extended for three additional years based on academic performance and research potential. *Graduate Research/Teaching Assistantships.* Usually awarded at a one-third time basis at a salary of $9,628 per twelve months, plus waiver of all tuition and fees. Appointments are based primarily on scholarship and ability to contribute to ongoing programs of the school. Prospective students who consider themselves highly qualified for an award should include with their application for admission a letter describing in as much detail as possible their qualifications and needs. Write to the Dean, College of Computing, Georgia Institute of Technology, Atlanta, Georgia 30332-0280.

Daniel and Florence Guggenheim Foundation. Fellowships for U.S. and Canadian residents interested in jet propulsion, energy conversion, fluid mechanics and flight structures. For information on flight structures, write to the Department of Civil Engineering and Engineering Mechanics, Columbia University. For information on applied physics and materials science; dynamics and control systems; energy conversion, propulsion, and combustion; energy and environmental policy; flight science and technology; and fluid mechanics, and computational and experimental fluid mechanics, write to the Director of Graduate Studies, Department of Mechanical and Aerospace Engineering, Princeton University, Princeton, New Jersey 08544.

Fannie and John Hertz Foundation Fellowships. The stipend is $15,000, plus $8,000 cost-of-education allowance per nine month year. Offered on the basis of academic (A– undergraduate GPA) and research performance, recommendations, and personal technical in-

terview, for the support of personal and institutional expenses during graduate education directed toward the Ph.D. degree in applied physical sciences. Tenable at the Department of Applied Science of the Davis Campus, and at all campuses of the University of California; California Institute of Technology; Carnegie-Mellon University; The University of Chicago; Cornell University; Courant Institute of Mathematical Sciences, New York University; Georgia Institute of Technology; Harvard University; Johns Hopkins University; University of Illinois at Urbana-Champaign; Massachusetts Institute of Technology; Polytechnic Institute of New York; Princeton University; Rensselaer Polytechnic Institute; Rice University; University of Rochester; Stanford University; University of Texas at Austin; Texas A& M University; Vanderbilt University; University of Washington, Seattle; University of Wisconsin, Madison and Yale University, New Haven, Connecticut. Application deadline is November 1. Applicants should write to the Office of the Graduate Dean at these institutions, or write directly to the Hertz Foundation, Box 5032, Livermore, California 94551-5032.

Hughes Aircraft Company Fellowships. Masters and Doctoral Fellowships are awarded on a competitive basis to qualified individuals in Engineering and Science for study at selected universities in the fields of electrical, mechanical, aerospace or systems engineering, computer science, mathematics, or physics. Most are awarded on a work-study basis. U.S. citizenship is required. G.P.A. must be at least 3.0/4.0. Write to the Hughes Aircraft Company, Corporate Fellowship Office, Technical Education Center, P.O. Box 45066, Bldg. C1/B168, Los Angeles, California 90045-0066.

Hubert H. Humphrey Doctoral Fellowships. Awards are made by the U.S. Arms Control and Disarmament Agency (ACDA) to stimulate interest in the study of arms control in universities around the country by supporting unclassified doctoral dissertation research in the field. Applicants must be U.S. citizens or nationals and must have completed all requirements for the doctorate, except the dissertation, at a U.S. college or university. (Law students are also eligible.) The stipend will be $5,000 for a 12-month period, plus applicable tuition and fees of up to $3,400 for one year. Application deadline is March 15, for the 12-month award period beginning in either September or the following January. For application materials write: Hubert H. Humphrey Fellowship Program, U.S. Arms Control and Disarmament Agency, Washington, DC 20451.

- **Kosciuszko Foundation.** Scholarships and grants for Americans of Polish background. Application deadline is January 15. For information write to Scholarship and Exchange Programs, the Kosciuszko Foundation, 15 East 65th Street, New York, New York 10021.

Laboratory Graduate Participation. Supports full-time thesis and dissertation research at participating DOE research facilities for M.A. and Ph.D. candidates majoring in the life, physical, and social sciences; mathematics; and engineering. Applicants must be U.S. citizens who have completed all requirements for the degree except thesis or dissertation research. The annual stipend is $12,000–$14,400 plus tuition and fees and additional allowances for dependents. Additional information and application materials may be obtained from Science/Engineering Education Division, Oak Ridge Associated Universities, P.O. Box 117, Oak Ridge, Tennessee 37831-0117.

National Research Council. *Ford Foundation Predoctoral and Dissertation Fellowships for Minorities.* Predoctoral and dissertation fellowships consisting of annual stipends of $11,500 and $18,000 respectively are available to minorities enrolled in research-based doctoral programs in mathematics, engineering, and other fields. The predoctoral awards also include an allowance to the awardee's university in lieu of tuition and fees. Students interested in the 1991 doctoral fellowships may obtain application materials from the Fellowship Office, National Research Council, 2101 Constitution Avenue, N.W., Washington, DC 20418. The deadline for applications is November 9, 1990. Students interested in the 1992 predoctoral and dissertation fellowship should contact The Fellowship Office at the above address in September 1991.

National Science Foundation. *Graduate Fellowships.* Three-year awards available to citizens or nationals of the U.S. for full-time study leading to master's or doctoral degrees in science (including mathematics). Awards made only to students who have completed less than one year of graduate study in science or engineering. Stipends of $13,500 proposed for 1991–1992 for a 12-month tenure. No dependency allowances. Education allowance paid to fellowship institution. Application deadline November 9. Further information and application materials may be obtained from the Fellowship Office, National Research Council, 2101 Constitution Avenue, Washington, DC 20418.

National Science Foundation. *Minority Graduate Fellowships.* Awarded for study or work leading to the master's or doctoral degrees, these fellowships are granted for periods of three years. They are open to U.S. citizens or nationals who are members of an ethnic minority group underrepresented in the advanced levels of the U.S. science personnel pool, i.e., American Indian, Native Alaskan (Eskimo or Aleut), Black, Hispanic, or Native Pacific Islander (Polynesian or Micronesian). The

stipend is $13,500 proposed for 1991–1992 for 12-month tenures. No dependency allowances. Education allowance paid to fellowship institution. The deadline for applications is November 9. Application materials may be obtained from the Fellowship Office, National Research Council, 2101 Constitution Avenue, Washington, DC 20418.

Office of Naval Research. *Graduate Fellowship Program.* ONR will award up to 50 thirty-six month fellowships for study and research at U.S. institutions offering doctoral degrees in specified engineering science and engineering disciplines. Participants must be U.S. citizens and receive a baccalaureate degree in 1990. Fellows selected in 1990 will receive $15,000 for the first year of tenure. ONR will pay the institution full tuition and fees and provide $2,000 to the Fellow's department. ONR Fellowships awarded in this tenth year of the program will be for study and research in ten major disciplines: Electrical Engineering, Computer Science, Naval Architecture and Ocean Engineering, Materials Science, Applied Physics, Aerospace/Mechanical Engineering, Biological/Biomedical Sciences, Cognitive/Neural Sciences, Mathematics, and Oceanography. Deadline for applications is January 17, 1991. Application materials may be obtained from the American Society for Engineering Education (ASEE), 11 Dupont Circle, Suite 200, Washington, DC 20036 (202-745-3616 or 202-293-7080).

Purdue University. *Purdue University Fellowships, Black Fellowships and Ethnic Minorities Fellowships.* The stipend is up to $12,000 for twelve months with tuition and fees remitted except for $135 per semester and $67.50 for summer session. Fellowships are renewable upon satisfactory performance in coursework. Fellows may hold additional University employment up to one-quarter time, as teaching or research assistants. *Teaching Fellowships:* The stipend is $15,000 for twelve months with tuition and fees remitted except for $135 per semester and $67.50 for summer session. Fellows usually teach four hours per week and fellowships are renewable upon satisfactory performance in coursework. For application forms and information, write to Graduate Office, Department of Mathematics, Mathematical Sciences Building, Purdue University, West Lafayette, IN 47907.

Sigma Delta Epsilon, Graduate Women in Science. Awards of $1,500 - $4,000 for one year, nonrenewable, are available on a competitive basis to those who hold a degree from a recognized institution of higher learning in all the natural sciences (physical, environmental, mathematical, computer and life sciences), are currently involved in research or have an approved research proposal. Appointments will be made irrespective of race, nationality, creed or age. Applications from women are especially encouraged. Application deadline is December 1. Announcement of awards will be made by the following July 1. Further information and application forms may be obtained from Sigma Delta Epsilon, Graduate Women in Science, Inc., P.O. Box 4748, Ithaca, NY 14852.

Zonta International. *Amelia Earhart Fellowship Awards.* Established in honor of Amelia Earhart, Zonta member from 1928-1937, the Fellowships recognize excellence and encourage and support women in science and engineering. 40 $6,000 grants to women for graduate study in aerospace-related science or engineering are awarded annually. Qualifications for the Fellowships are: a graduate degree preparatory for advanced study and research in a qualifying area of science or engineering; a superior academic record and evidence of potential; and an acceptance by an institution offering fully accredited graduate courses and degrees in aerospace-related sciences and engineering. Deadline for applications is December 31, 1990. For more information: Zonta International, 557 W. Randolph St., Chicago, IL 60606-2284; (312)930-5848.

Postdoctoral Support

Air Force Office of Scientific Research. *Research Contracts and Grants.* Mathematicians and computer scientists are encouraged to submit proposals through their organizations for research support. Research areas include mathematics of dynamics and control, mathematics of computation, mathematics of physical, chemical or biological systems, mathematics of communication and signal processing, mathematical optimization, applied analysis, finite mathematics, probability and statistics, general computer science, and artificial intelligence. Research proposals should be forwarded to the Director of Mathematical and Information Sciences, Air Force Office of Scientific Research, Bolling AFB, Washington, DC 20332-6448.

American Association for the Advancement of Science. *1991-1992 Congressional Science and Engineering Fellowships.* Fellows spend one year working as special legislative assistants on the staffs of members of Congress or congressional committees, beginning in September 1991. The program includes an orientation on congressional and executive branch operations and a year-long seminar program on issues involving science and public policy. To provide a unique public policy learning experience, to demonstrate the value of such science-government interaction, and to make practical contributions to the more effective use of scientific and technical knowledge in government. A prospective fellow must demonstrate exceptional competence in some area of science or engineering; have a good scientific and technical background;

and have a strong interest and some experience in applying personal knowledge toward the solution of societal problems. Candidates should be postdoctoral to mid-career scientists or engineers. AAAS will sponsor two Fellows. The stipend is $38,000 plus an allowance for relocation and travel expenses. Deadline for receipt of applications by AAAS is January 15, 1991. American Association for the Advancement of Science, 1333 H. St., NW, Washington, DC 20005; 202-326-6600.

American Association for the Advancement of Science. *Science, Engineering and Diplomacy Fellowships.* One-year fellowships are available for work as staff officers in the State Department and in the Agency for International Development. The Fellow must demonstrate exceptional competence in some area of science or engineering, be flexible, and have a strong interest or some experience in applying knowledge toward the solution of problems in the area of foreign affairs. A secret security clearance must be obtained after selection. Salaries are at the GS12 level depending upon education and experience. Deadline for receipt of applications is January 15. For application materials and more specific information on assignment possibilities write to Science, Engineering and Diplomacy Fellows Program, AAAS, 1333 H Street, N.W., Washington, DC 20005.

American Association for the Advancement of Science. *Summer Environmental Science and Engineering Fellows Program.* Fellows will spend ten weeks working as special research consultants with the Office of Research and Development (ORD) of the U.S. Environmental Protection Agency (EPA) in Washington, DC. Fellows will undertake a detailed, future-oriented research project of mutual interest to the Fellow and one of EPA's research or program offices and prepare a report at the completion of the summer's work. The program includes a week-long orientation to EPA and relevant congressional and executive branch operations, as well as a weekly seminar program on environmental issues and science, technology and public policy. The purpose of the fellowship program is to assist ORD in identifying and assessing the significance of long-range environmental problems and opportunities. Prospective fellows must be postdoctoral to mid-career professionals, show exceptional competence in a relevant professional area, have a broad professional background, and have a strong interest and some experience in applying scientific or other professional knowledge toward the identification and assessment of future environmental problems. Persons may apply from any physical, biological, or behavioral science field, any field of engineering, or any other relevant professional field. Applicants must be residents of the U.S. The stipend is $850 per week plus nominal relocation and travel expenses. The deadline for receipt of applications is March 1, 1991. American Association for the Advancement of Science, 1333 H. St., NW, Washington, DC 20005; 202-326-6600.

American Association of University Women (AAUW) Educational Foundation. *American Fellowships.* See the listing in the Graduate Support section for information.

American Association of University Women (AAUW) Educational Foundation. *Career Development Grants.* See the listing in the Graduate Support section for information.

American Mathematical Society Centennial Fellowships. *Postdoctoral Fellowships.* These fellowships are intended to provide enhanced research opportunities to mathematicians who are several years past the Ph.D., who have a strong research record, but who have not had extensive postdoctoral research support in the past. Applicants should have received the Ph.D. degree between January 1, 1979, and December 31, 1984, and should not have had the equivalent of more than two years of full-time postdoctoral support.The stipend for fellowships awarded in 1991–1992 has been set by the Trustees of the Society at $38,000 for nine months. In addition, there will be an expense allowance of $1,200. Applicants must be citizens or permanent residents of a country in North America. The fellowship may be combined with other stipends and/or part-time teaching; this option can be used to extend the award to cover a period of up to two years. For further information about the acceptability of such arrangements, individuals should contact the Secretary of the Society.The number of fellowships to be awarded is small and depends on the amount of money contributed to the program. The Trustees have arranged a matching program from general funds in such fashion that funds for at least one fellowship are guaranteed. Because of the generosity of the AMS membership it was possible to award three fellowships a year for the past three years (1988–1989, 1989–1990, 1990–1991). The deadline for receipt of applications is **December 1, 1990**. Awards will be announced in February 1991, or earlier if possible. For application forms, write to the Executive Director, American Mathematical Society, P.O. Box 6248, Providence, RI 02940. (It should be noted that completed application and reference forms should NOT be sent to this address, but to the address given on the forms.)

American Philosophical Society. Postdoctoral research grants of up to $4,000 (averaging $2,000) for candidates with Ph.D. or equivalent to aid specific research projects. Grants contribute toward travel expenses, food and lodging, photoduplication, and some other research

costs. Tenable abroad and in U.S. The Committee on Research meets by end of February, April, June, October, and December. Respective *deadlines* for application and all supporting material are December 1, February 1, April 1, August 1, and October 1. For application forms, please briefly describe your project and proposed budget in a letter to: Committee on Research, American Philosophical Society, 104 South Fifth Street, Philadelphia, Pennsylvania 19106.

American Society for Engineering Education. *NASA-ASEE Summer Faculty Fellowships.* Programs in science and engineering research in collaboration with the National Aeronautics and Space Administration research centers; for U.S. citizens who are faculty or research members (with at least two years experience) of institutions of higher education. Stipends will be $900/week for ten weeks, plus trave allowance. Application deadline is February 1. For published announcement write to NASA-ASEE Summer Faculty Fellowships, American Society for Engineering Education, Suite 200, Eleven Dupont Circle, N.W., Washington, DC 20036; (202)745-3616/(202)293-7080.

American Society for Engineering Education. *Navy-ASEE Summer Faculty Research Programs.* Programs in math, science and engineering research at the laboratories and R&D centers of the Navy; for U.S. citizens who are faculty or research members of institutions of higher education. Stipends will be given at various levels, plus travel and relocation allowances. Application deadline is January 16. For a program announcement write to American Society for Engineering Education, Suite 200, Eleven Dupont Circle, N.W., Washington, DC 20036.

Argonne National Laboratory. The Mathematics and Computer Science (MCS) Division of Argonne National Laboratory offers visiting positions to mathematicians and computer scientists interested in advanced scientific computing. The division's research programs cover differential equations, optimization, automated reasoning, logic programming, and software engineering. The division operates Argonne's Advanced Computing Research Facility, which comprises a variety of advanced-computer architectures. Visiting positions of various durations are available for graduate students, postdocs, and faculty. Interested candidates should submit their resume to Nancy L. Griparis, Employment and Placement, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL 60439.

Australian Institute of Nuclear Science and Engineering. *Research Fellowships.* Fellowships are intended for scientists and engineers who have qualifications equivalent to the Ph.D. Stipends are in the range of $30,140 to $36,638 per annum (Australian currency), and the Institute may contribute to travel costs to and from Australia. A research project within the field of nuclear science and engineering of interest to the Institute must be proposed in the nomination after agreement between the candidate and the nominating organization. Further information can be obtained from the Scientific Secretary,Australian Institute of Nuclear Science and Engineering, Private Mail Bag No. 1, Post Office, Menai N.S.W. 2234, Australia. Candidates must be nominated by an Australian university, the ANSTO, or the Commonwealth Scientific and Industrial Research Organization. Closing dates are February 28 and August 31 each year, and all nominations received after one closing date will be considered together after the next closing date.

Bowling Green State University. *Visiting Lecturership.* Applications are invited for an anticipated Visiting Lecturership in the Mathematics and Statistics Department for the 1991-1992 academic year. Applicants should have a recent Ph.D. in mathematics or statistics with research interests that supplement those of the departmental faculty. The appointee is expected to participate in seminar activities and teach up to six hours per week for a compensation of $20,000 plus usual fringe benefits for the academic year. Interested persons should send a vita, an **official** copy of graduate transcripts and arrange for three letters of reference to: Hassoon S. Al-Amiri, Chair, Department of Mathematics and Statistics, Bowling Green State University, Bowling Green, Ohio 43403. Applications accepted until positions are filled. Bowling Green State University is an Equal Opportunity/Affirmative Action Employer. Women and minorities are encouraged to apply.

The Bunting Institute of Radcliffe College. *Science Scholar Fellowships.* The Bunting Institute provides fellowships to postdoctoral scientists to work on projects that will make a contribution to their fields and advance their careers. Open to women scientists, who are U.S. citizens or permanent residents,in the fields: astronomy, biochemistry, ecology, geology, physics, chemistry, engineering, computer science, mathematics, cognitive and neural science, and biological science. Office and laboratory space; stipend $27,600 plus research expenses; one-year appointment; access to Harvard/Radcliffe libraries and facilities. Deadline for applications is October 15, 1990 (postmarked). Write or call for application and information to: Science Scholar Fellowship Program, The Bunting Institute of Radcliffe College, 34 Concord Avenue, Cambridge, Massachusetts 02138 (617-495-8212).

California Institute of Technology. *Harry Bateman Research Instructorships.* Offered by Mathematics at the California Institute of Technology. Open to men and

women (of any age) who have recently received their doctorate in mathematics. Appointments are for one year and are renewable for one additional year. The annual salary will be $36,000. Duties include teaching one course for the full academic year. Please send applications by January 1 if possible. Inquiries or requests for application forms should be addressed to Professor D. B. Wales, Professor and Executive Officer for Mathematics, 253-37 Sloan Laboratory, Pasadena, California 91125. Caltech is an Affirmative Action/Equal Opportunity Employer. Women and minorities are encouraged to apply.

Cornell University. Possible *H. C. Wang Assistant Professorship.* During one of the years, the holder of a Wang Assistant Professorship will have a teaching load of two courses in the first semester and one in the second; otherwise, it will be two courses per semester. Salary $32,000. The Assistant Professorship is nonrenewable after a three-year term. Applications and letters of reference should be addressed to Recruiting Committee, Department of Mathematics, White Hall, Cornell University, Ithaca, New York 14853-7901.

Courant Institute. *Instructorships in Mathematics.* Open to mathematicians (of any age) who are recent recipients of doctoral degrees and who show strong promise in research. The teaching duty will consist of one course each term. Appointments are for two years. The academic salary for nine months will be at least $34,000. In addition, the Courant Institute may be able to offer support for research in residence during two summer months. (When longer term faculty positions are available, applicants for Instructorships will also be considered for them.) Inquiries and requests for application forms should be addressed to the Committee on Instructorships and Visiting Memberships, Courant Institute of Mathematical Sciences, New York University, 251 Mercer Street, New York, New York 10012. Applications should be filed no later than December 15, 1990. N.Y.U. is an Equal Opportunity/Affirmative Action Employer.

Courant Institute. *Postdoctoral Visiting Memberships.* The Courant Institute of Mathematical Sciences of New York University offers postdoctoral Visiting Memberships to mathematicians, scientists and engineers who are interested in its program of training and research in a broad range of pure and applied mathematics. Applications must be received by December 15, 1990. Inquiries and requests for application forms should be addressed to the Committee on Instructorships and Visiting Memberships, Courant Institute of Mathematical Sciences, New York University, 251 Mercer Street, New York, New York 10012. N.Y.U. is an Equal Opportunity/Affirmative Action Employer.

Dartmouth College. *John Wesley Young Research Instructorships.* Two instructorships are normally awarded by Dartmouth College each year. Teaching duties are one course for two quarters and two courses for one quarter (or two courses for two quarters) and are of a varied and nonroutine nature. The academic-year salary of $32,500 is supplemented by a two-month resident research stipend of $7,150, for a total of $39,650. Appointments are for two years and are not renewable. Applicants should write to Department of Mathematics and Computer Science, Dartmouth College, Hanover, New Hampshire 03755 (Attention: Recruiting). Applicants are advised to apply promptly, and no later than January 15, 1991.

Fellowships in Mathematics and Molecular Biology. See listing in the Graduate Support section for information.

Fulbright Scholar Program. The Fulbright Scholar Program include 300 grants in research and 700 grants in university lecturing for periods ranging from three months to a full academic year. There are openings in over 100 countries with some opportunity for multicountry research. Fulbright awards are granted in virtually all disciplines. Scholars in all academic ranks, retired faculty and independent scholars are eligible to apply. Benefits include round-trip travel; maintenance allowance to cover living costs of grantee and family; and other supplemental allowances. Basic eligibility requirements are U.S. citizenship; Ph.D. or comparable professional qualifications; university or college teaching experience; and, for selected assignments, proficiency in a foreign language. Application deadlines vary. For more information and applications, call or write Council for International Exchange of Scholars, 3400 International Drive, N.W., Suite M-500, Washington, DC 20008-3097; (202)686-7866.

John Simon Guggenheim Memorial Foundation Fellowships. Fellowships are on an advanced professional level. U.S. or Canadian citizenship or permanent residence is required. Fellowships are also offered to citizens or permanent residents of Latin America and the Caribbean. Application deadline: October 1 for the U.S. and Canada competition; December 1 for the Latin American and Caribbean competition. Approximately 170 awards are made, averaging approximately $26,300 in 1990. For more information write to John Simon Guggenheim Memorial Foundation, 90 Park Avenue, New York, New York 10016.

Harvard University. *Benjamin Peirce Lectureships.* Rank of Assistant Professor. The appointments are for three years with a starting salary of approximately $37,100 (for the nine-month academic year) which can be augmented

by teaching in the summer school or by working on a research contract if funds are available. The teaching commitment is six hours per week of lectures including a half course on any topic of the lecturer's choice. Application forms may be obtained by writing to: Benjamin Peirce Lectureships, Department of Mathematics, Harvard University, One Oxford Street, Cambridge, Massachusetts 02138. Applications must be filed by January 1, 1991. Harvard is an Equal Opportunity/Affirmative Action Employer, and particularly encourages applications from women and minority candidates.

IBM Thomas J. Watson Research Center. *Mathematical Sciences Department Postdoctoral Research Fellowships.* These fellowships provide an opportunity for scientists of outstanding ability to pursue their own research interests in pure or applied mathematics while interacting closely with Department members in an atmosphere in which basic research is combined with exposure to technical problems arising in a mathematically oriented industry. Candidates (of any age) must have no more than five years of postdoctoral professional experience when the fellowship commences. Fellowships have a period of one year, extendable to two years depending on mutual interest in continuation. The stipend will be generally in the range of $54,000 to $60,000 per year, depending on experience. To apply, submit the following *by December 15, 1990*: résumé; thesis summary; thesis or reprints of publications based on thesis, if available; bibliography with reprints of principal papers; research proposal containing an abstract of approximately 200 words for the period of the fellowship; and three or more letters of reference, including one from your thesis adviser. The letters of reference should arrive separately, but must be received by the above date. Résumé must list applicant's visa status. Direct all material to Committee on Postdoctoral Fellowships, Department of Mathematical Sciences, IBM Research Center, Post Office Box 218, Yorktown Heights, New York 10598. Applicants will be notified individually as soon as the Committee has reached a decision on the application. The Research Center is located in Westchester County about thirty miles north of New York City.

Indiana University, Bloomington. *Václav Hlavatý Research Assistant Professorships.* This position is intended for mathematicians with recent doctorates who show definite promise in research and teaching. Inquiries and requests for application forms should be addressed to Allan Edmonds, Chairman, Department of Mathematics, Indiana University, Bloomington, Indiana 47405. Preference will be given to applications received before January 1, 1991. Indiana University is an Equal Opportunity/Affirmative Action Employer.

Institute for Advanced Study Memberships. The School of Mathematics will grant a limited number of memberships, some with financial support, for research in mathematics at the Institute during the academic year 1991-1992. Candidates must have given evidence of ability in research comparable at least with that expected for the Ph.D. degree. Application blanks may be obtained from The School of Mathematics, Institute for Advanced Study, Princeton, New Jersey 08540, and should be returned (whether or not funds are expected from some other source) by December 1, 1990. An Equal Opportunity/Affirmative Action Employer.

Institute for Mathematics and its Applications (IMA). *Postdoctoral Memberships.* The IMA will award up to 15 12-month research memberships with starting date approximately September 1, 1991. The postdoctoral terms will include the academic year program on Applied Linear Algebra, September 1991 to June 1992. All requirements for a doctorate should be completed by September 1, 1991. Applicants must show evidence of mathematical excellence, but they do not need to be specialists in the field. The following materials must be submitted: (1) personal statement of scientific interest, research plans, and reasons for wishing to participate in the program. (This is an essential part of the application.); (2) Curriculum vitae and a list of publications; (3) Three letters of recommendation, to be sent directly to the IMA. All material should arrive by January 15, 1991. *Senior memberships* are also available. Preference will be given to supplementary support for persons with sabbatical leaves, fellowships, or other stipends. *All correspondence* should be sent to: Visiting Membership Committee, Institute for Mathematics and its Applications, University of Minnesota, 514 Vincent Hall, 206 Church Street S.E., Minneapolis, MN 55455-0436 U.S.A. The University of Minnesota is an equal opportunity educator and employer and specifically invites and encourages applications from women and minorities.

Institute for Mathematics and its Applications (IMA). *Postdoctorates in Industrial Mathematics.* The IMA will award up to 8 one-to-two year positions in Industrial Mathematics, effective September 1, 1991. These appointments are in addition to the regular IMA postdoctoral program and are funded jointly by the NSF and by Honeywell, Inc. and 3M. They are designed to prepare mathematicians for research careers involving industrial interaction. Applicants should have received their Ph.D. in Mathematics or Applied Mathematics by September 1, 1991. Familiarity with pde and/or numerical anlysis is desired, but no knowledge in engineering is required. Postdoctorates will spend 50% effort in the IMA program and 50% effort working with scientists from Honeywell or 3M on one of the following topics:

(A) Signal processing and computational ocean acoustics (Honeywell); (B) Diffractive optics; Maxwell equations in periodic structure (Honeywell); (C) Computational fluid mechanics - viscous free-surface flows (3M); (D) Scattering of electromagnetic waves from complex objects (3M); (E) Magneto-optic recording media; the writing process (3M). The following materials must be submitted: (1) Personal statement of scientific interest, research plans and reasons for wishing to participate in the program. (This is an essential part of the application.) (2) Curriculum vitae and a list of publications. (3) Three letters of recommendation, to be sent directly to the IMA. All material should arrive by January 15, 1991. *All correspondence* should be sent to: Industrial Mathematics Postdoctorate Membership Committee, Institute for Mathematics and its Applications, University of Minnesota, 514 Vincent Hall, 206 Church Street S.E., Minneapolis, MN 55455-0436 U.S.A. The University of Minnesota is an equal opportunity educator and employer and specifically invites and encourages applications from women and minorities.

Los Alamos National Laboratory. Research opportunities in computer science, natural sciences, engineering, applied mathematics, and physics. Postdoctoral appointments are available for two years, subject to renewal for a third year. Los Alamos National Laboratory is an Equal Opportunity Employer. Write to Ronnie Cohen, Mail Stop P-290, Los Alamos National Laboratory, Los Alamos, New Mexico 87545.

Los Alamos National Laboratory. *J. Robert Oppenheimer Research Fellowship.* Candidates must be recipients of a doctorate in the physical sciences, natural sciences, mathematics or engineering, and must show clear and definite promise of becoming outstanding leaders in scientific research. Two- to three-year appointments; salary: $55,000/year; application deadline: mid-November each year. For additional information write to Ronnie Cohen, Mail Stop P-290, Los Alamos National Laboratory, Los Alamos, New Mexico 87545. An Affirmative Action/Equal Opportunity Employer.

Massachusetts Institute of Technology. *C. L. E. Moore Instructorships in Mathematics.* Offered by the Department of Mathematics at the Massachusetts Institute of Technology. Open to mathematicians with doctorates who show definite promise in research. The base salary will be at least $32,450, and the teaching load is six hours per week in one semester and three hours per week in the other. Appointments are for one year and are renewable for one additional year. Applicants please send (a) a vita; (b) a description of the research in your thesis and other work you have done (1-3 pages); and (c) the research which you plan for next year. Application should be sent, by December 31 if possible, to the Department of Mathematics, Room 2-263, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139. M.I.T. is an Equal Opportunity Employer.

Mathematical Sciences Research Institute. The Institute will award about 20 yearlong research fellowships with starting date September 1991 for new and recent Ph.D.s. The stipend will be at least $30,000. The year 1991-1992 features statistics, Lie groups and ergodic theory, but some awards will be made in other areas, so applications from candidates in all fields are welcome. Formal application forms are not used, but a sheet giving suggestions on how to apply is available on request. Write to the Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley, California 94720. Files must be complete by November 30, 1990.

The Michigan Society of Fellows. *Horace H. Rackham School of Graduate Studies, The University of Michigan.* The Michigan Society of Fellows was founded in 1970 through grants from the Ford Foundation and Horace H. Rackham Graduate School for the purpose of promoting academic and creative excellence in the arts, sciences and professions. The objective of the program is to support individuals selected for outstanding achievement, professional promise, and interdisciplinary interests. We invite applications from qualified candidates for 4 three-year postdoctoral fellowships at The University of Michigan. Candidates should be near the beginning of their professional careers, not more than three years beyond completion of their degrees. The Ph.D. degree or comparable professional degree, received prior to appointment, is required. Fellows are appointed as Assistant Professors/Postdoctoral Scholars with departmental affiliations. They spend the equivalent of one academic year teaching; the balance of time is devoted to their own scholarly research and creative work. Applications will be screened by faculty in relevant University of Michigan departments. Final selections will be made by the Senior Fellows of the Society. Four new Fellows will be selected for three-year terms beginning September 1991. The initial stipend will be $24,000. Completed applications are due October 15, 1990. Please send requests for application materials to Michigan Society of Fellows, 3030 Rackham Building, The University of Michigan, Ann Arbor, Michigan 48109-1070 (313-763-1259).

Michigan State University. *MSU Postdoctoral Research Positions in Mathematics.* One or more two-year positions will be available for new or recent Ph.D.s who show strong promise in research and teaching. These positions will begin in the Fall of 1991, with a starting salary of at least $33,000. Teaching duties will be kept to a

minimum to maximize research time and interaction with faculty. The teaching load is three quarter courses per year, and it may be possible to arrange these courses in a 2-1-0 or like manner to leave a quarter entirely free for research. NSF postdoctoral fellowships or other awards may be held concurrently for a further reduction in teaching load. An applicant should send a vita as well as a brief statement of research interests and should arrange to have sent three letters of recommendation commenting on the applicant's research and teaching abilities. All application materials should be addressed to The Chairperson, Department of Mathematics, Michigan State University, East Lansing, MI 48824. The deadline for applications is January 15, 1991. MSU is an Equal Opportunity/Affirmative Action Employer.

National Center for Atmospheric Research. *Advanced Study Program.* Postdoctoral Fellowships are offered for highly qualified atmospheric scientists, and scientists from related disciplines, who wish to continue basic research in the atmospheric sciences. Appointments are for a one-year period with a possible extension for an additional year. Stipends are $29,400 for recent recipients of the Ph.D. and are adjusted annually in June. The application deadline is January 10, 1991. Inquiries should be sent to Barbara McDonald, Advanced Study Program, NCAR, P.O. Box 3000, Boulder, Colorado 80307-3000.

National Institute of Standards and Technology (NIST) and American Society for Engineering Education (ASEE). *NIST/ASEE Engineering Postdoctoral Research Fellowships.* NIST/ASEE will award postdoctoral fellowships at the NIST Laboratories in Gaithersburg, Maryland and Boulder, Colorado. Although primarily focused on engineering, the program does sponsor fellowships in several mathematical and computer science areas: applied mathematics and scientific computing, computer and telecommunications systems, manufacturing engineering (data modeling and data interfaces), fire safety research (computer modeling and applied mathematics). The stipend will range from $36,000 to $42,000 depending on experience and field of study. Travel and transportation of goods to NIST will be paid. The normal term of appointments will be two years. Applicants must be citizens or permanent residents of the United States with a Ph.D., Sc.D. or other earned doctoral degree recognized in U.S. academic circles as equivalent to the Ph.D. (Degree must have been awarded within 7 years of date of application or acceptable evidence of having completed all formal academic requirements for one of these degrees before appointment.) Application deadline dates are January 1, April 1, July 1, October 1. For more information: NIST/ASEE Postdoctoral Fellowship Program, American Society for Engineering Education, Eleven Dupont Circle, N.W., Suite 200, Washington, DC 20036. (202)745-3616/(202)293-7080.

National Research Council. *Ford Foundation Postdoctoral Fellowships for Minorities.* Administered by the National Research Council, these fellowships are sponsored by the Ford Foundation. Applicants must be U.S. citizens who are members of one of the designated minority groups: American Indians and Alaskan Natives (Eskimo or Aleut), Black Americans, Mexican Americans/Chicanos, Native Pacific Islanders (Micronesians and Polynesians), or Puerto Ricans, who are engaged in college or university teaching, and hold a doctoral degree. Tenure of the one-year fellowship provides postdoctoral research experience at an appropriate nonprofit institution of the Fellow's choice. The deadline for the submission of applications is January 11, 1991. Further information and application materials may be obtained from the Fellowship Office, National Research Council, 2101 Constitution Avenue, N.W., Washington, DC 20418; 202-334-2872.

National Research Council. *Research Associateship Programs.* These programs provide scientists and engineers opportunities for postdoctoral research, free from administrative duties, in a variety of scientific disciplines and fields of specialization. The programs are conducted in cooperation with thirty selected federal organizations with one hundred laboratories at approximately sixty geographic locations in the United States. Many programs are open to senior investigators as well as recent Ph.D.'s. Most are also open to foreign nationals as well as U.S. citizens. Applications for these competitive awards will be received by the National Research Council until January 15, 1991, (December 15, 1990 for NASA awards). Appointments will be made in the spring. In some programs additional deadlines are April 15 and August 15 with awards announced in July and November respectively. Annual stipends range from $27,150 to $42,000, depending on laboratory of application. Further information and application materials can be obtained from Associateship Programs (GR430/M1), National Research Council, 2101 Constitution Avenue, N.W., Washington, DC 20418; 202-334-2872.

National Science Foundation. *Career Advancement Awards.* The goal of these awards is to support activities that can expand a promising applicants research career potential. All women who are eligible to receive standard NSF research grants can apply for Career Advancement Awards. It is expected that applicants will have had prior research support, federal or otherwise. Awards are limited to a maximum of $50,000 for a period of 12 months with an additional $10,000 for equipment, if needed. Up to 10% of these funds may be used to defray administrative expenses in lieu of direct costs. These awards are

not renewable. Proposals must be received by December 1 of each year. Ten copies of the proposal should be submitted to NSF disciplinary programs through standard institutional channels. For more information write to: Women's Program, Human Resources Development, National Science Foundation, Washington, DC 20550; 202-357-7456.

National Science Foundation. *Computer Science Research.* Grants support research concerned with such topics as theoretical foundations of computer science, software systems science, software engineering, numeric and symbolic computation, and computer systems architecture, which includes graphics. Guidelines on eligibility and proposal preparation are available in "Grants for Scientific and Engineering Research." For this brochure and additional information write: Division of Computer and Computational Research, National Science Foundation, 1800 G Street, N.W., Washington, DC 20550.

National Science Foundation. *Mathematical Sciences Postdoctoral Research Fellowships.* (With Research Instructorship Option). The format of the 1991 Fellowship program has not been significantly changed from that of 1990. The stipend portion of the awards will consist of support for two nine-month academic years and six summer months, for a total of 24 months of support. The awardee will have two options for the academic years' stipend: 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 as one academic year full-time and two academic years half-time (the Research Instructorship Option). The stipend will be paid at the rate of $2,750 per full-time month or $1,375 per half-time month, for a total of $66,000 for the eighteen academic months and six summer months. Deadline for applications is November 15, 1990; awards will be announced on or about February 15, 1991. For further details write to Special Projects Program, Room 339, Division of Mathematical Sciences, National Science Foundation, 1800 G Street, N.W., Washington, DC 20550.

National Science Foundation. *Postdoctoral Fellowships in Japan.* In an effort to strengthen ties between U.S. and Japanese researchers in science and engineering, the National Science Foundation (NSF) established in 1988 a "Japan Initiative ". The initiative includes a number of programs designed to increase the number of American researchers who can operate with ease in Japan's research community and follow developments in the Japanese research literature. As part of the program, the NSF coordinates two postdoctoral fellowship programs. The first, sponsored by the Japan Society for the Promotion of Science, will award 25 fellowships to conduct research in Japanese university laboratories or at other institutions affiliated with the Japanese Ministry of Education, Sciences, and Culture. The 12-month research visits are open to U.S. citizens or nationals not more than 35 years of age. The program provides airfare for the awardee, a monthly stipend, a modest housing allowance, medical insurance, and a language-training allowance. Through the second program, sponsored by the Science and Technology Agency of Japan, approximately 35 young American researchers will have the opportunity to collaborate with Japanese colleagues at nonacademic research facilities in Japan. The awards may be held for 6 - 24 months and provide a monthly stipend, travel, housing, medical insurance, and research-related expenses. The Research Development Corporation of Japan will provide language training for the participants at Tsukuba Science City. To be eligible, applicants must be no more than 35 years of age. The deadline for both programs is November 1. For more information, request NSF publications 88-52 and 88-98 from Forms and Publications Unit, Room 232, National Science Foundation, Washington, DC 20550, or electronically through either Bitnet (pubs@NSF) or Internet (pubs@note.nsf.gov). Include the publication numbers, your name, and a complete mailing address.

National Science Foundation. *Research Planning Grants for Women.* These awards are made to help increase the number of new women investigators participating in NSF's Research Programs and to assist those who have not previously developed a successful independent proposal for federally funded research to develop a more competitive NSF disciplinary research proposal. The grantee is expected to submit a full research proposal to NSF subsequent to the completion of the research planning grant. The grants are limited to $18,000 up to 18 months. Up to 10% of these funds may be used to defray administrative expenses in lieu of direct costs. Eligibility is limited to women who have not served as principle or coprinciple investigators on independent federal research awards or to women whose careers have been interrupted for at least two of the past five years. For more information write to: Women's Program, Human Resources Development, National Science Foundation, Washington, DC 20550; 202-357-7456.

National Science Foundation. *Visiting Professorships for Women(VPW).* This program enables women scientists and engineers experienced in independent research to undertake advanced research at a university or research institution. In addition to research, the visiting professor undertakes lecturing, counseling, and other interactive activities. These may be done at the graduate or un-

dergraduate level, be directed to the community at large, or involve some combination of such activities. Applicants must hold a doctorate (or have equivalent experience) in a field of research supported by NSF, and have independent research experience. The usual award is for twelve months for a full- or part-time professorship. Awards for one academic semester will be considered, as will proposals for periods of up to 24 months. The amount of the award will be determined by the work to be performed; past VPW awards have ranged from approximately $30,000 to $235,000. Proposals must be submitted by November 15 of each year. For more information contact the VPW Program Director at (202)357-7734 or write to obtain a Visiting Professorship Program announcement (NSF 90-42) to: Program Director, Visiting Professorships for Women, National Science Foundation, Washington, DC 20550.

OTA Congressional Fellowship Program. The Office of Technology Assessment is seeking qualified candidates from academia, private industry, and the public sector for its Congressional Fellowship Program. Up to six Fellows will be selected for a 1-year appointment in Washington, DC beginning in September 1991. The program is open to men and women of all disciplines who have demonstrated exceptional competency in the physical or biological sciences, engineering, law, economics, environmental and social sciences, or public policy. Candidates must have completed research and training at the doctoral level, or have equivalent experience. Salaries will range from $28,000–$55,000 per year, based on the Fellow's current salary and/or training and experience. In some instances a Fellow may accept a salary supplement from his or her parent institution. Applications and letters of reference must be postmarked by January 31,1991. For application information contact Congressional Fellowships, Personnel Office, Office of Technology Assessment, 600 Pennsylvania Ave., S.E., Washington, DC 20003; (202)224-8713.

President's Commission on White House Fellowships. The White House Fellowships offer outstanding Americans early in their careers the opportunity to serve for one year, September through August, as special assistants to Cabinet Officers, to the Vice-President, or to members of the President's senior staff. The Fellowships are open to all U.S. citizens, with the exception of civilian employees of the Federal Government. Applications for the 1991-1992 Fellowships may be obtained from The President's Commission on White House Fellowships, 712 Jackson Place, N.W., Washington, DC 20503. Telephone (202)395-4522. The application deadline is December 15, 1990.

Purdue University. *Research Assistant Professorship.* These positions are intended for recent Ph.D.'s who can benefit from and contribute to an active research environment. Appointments are for the two academic years 1991–1993, and are nonrenewable. The normal teaching load is two courses per semester; there will be a one course reduction during the spring semester of 1992. Advanced courses are encouraged; the Department presently has 180 graduate students. The beginning academic year salary will be $36,000. In addition, a stipend of $7,200 will be available for research in residence during the summer of 1992. Candidates are expected to have a Ph.D. degree in mathematics prior to September 1991. Selection will be based primarily on outstanding research potential in an area where some interaction with present faculty seems likely. Applications, including a vita, brief description of research interests, and three letters of recommendation, one of which addresses teaching, should be sent to Joseph Lipman, Head, Department of Mathematics, Purdue University, West Lafayette, Indiana 47907. The deadline for applications is January 11, 1991. Purdue University is an Equal Opportunity/Affirmative Action Employer.

Rice University. *Griffith Conrad Evans Instructorships.* Postdoctoral appointments for two to three years for promising research mathematicians with research interests in common with the active research areas at Rice. Applications received by December 31, 1990 will receive thorough consideration. Rice University is an Equal Opportunity/Affirmative Action Employer. Inquiries and applications should be addressed to Chairman, Evans Committee, Department of Mathematics, Rice University, Box 1892, Houston, Texas 77251.

Rutgers, The State University of New Jersey. Department of Mathematics, New Brunswick, NJ, anticipates the following open positions beginning September 1991. *Hill Assistant Professorships.* These are three-year nonrenewable positions. Candidates should have recently received the Ph.D., show outstanding promise in research ability in pure or applied mathematics, and have concern for teaching. Normal course load approx. 6 hours per semester but one course teaching reduction provided in two of the three years, resources permitting. Send resume and at least three letters of recommendation to Search Committee, Department of Mathematics, Rutgers University, New Brunswick, NJ 08903 as soon as possible. Indicate position desired and give # of your area of specialty according to AMS Mathematics Subject Classification. Rutgers University is an Equal Opportunity/Affirmative Action Employer.

Sigma Delta Epsilon, Graduate Women in Science. See the listing in the Graduate Support section for information.

Sloan Foundation. *Research Fellowships.* Unrestricted grants made to selected university scientists in the physical sciences, mathematics, applied mathematics, economics, and in neuroscience. Candidates must be members of the regular faculty, though not necessarily in a tenured position, at a recognized college or university in the United States or Canada. Candidates do not apply but are nominated by their department chairmen or other scientists. For information write to the Sloan Research Fellowships, Alfred P. Sloan Foundation, 630 Fifth Avenue, New York, New York 10111.

U.S. Department of Energy (DOE). *Special University-Laboratory Cooperation.* Participants engage in laboratory-approved projects in a program designed to increase the interactions and flow of information between universities and DOE laboratories. Included is research in applied mathematics and computer science. Inquiries should be addressed to the Director at any of the following organizations: Associated Western Universities, 4190 South Highland Drive, Suite 211, Salt Lake City, UT 84124. Argonne Division of Education Programs, 9700 South Cass Avenue, Argonne, Illinois 60439; Brookhaven National Laboratory, Upton, New York 11973; Northwest College and University Association for Science (NORCUS), 390 Hanford St., Richland, Washington 99352-1620; Oak Ridge Associated Universities, P.O. Box 117, Oak Ridge, Tennessee 37831-0117.

U.S. Department of Health and Human Services, National Institutes of Health, supports postdoctoral training in specified areas of biomedical and behavioral research. Applicant must have earned an appropriate degree and arranged for appointment to an institution and acceptance by a sponsor who will supervise the training research experience. U.S. citizenship or lawful admittance to the U.S. for permanent residence is required. Announcements and application kits available from Office of Grants Inquiries, Division of Research Grants, National Institutes of Health, Bethesda, Maryland 20892. An enclosed self-addressed gummed mailing label will expedite handling.

University of California. *President's Fellowship Program.* The University of California offers postdoctoral fellowships to enhance the competitiveness of outstanding minority and women scholars for academic appointments at major research universities such as the University of California. Awards are for one academic year with the possibility of renewal for a second year pending demonstration of satisfactory progress. Stipends are $25,000–$29,000 plus health benefits and up to $4,000 for research expenses. Applicants must be U.S. citizens or permanent residents, and hold a Ph.D. degree from an accredited University. Preference is given to minority and women candidates historically underrepresented in higher education. Applications are encouraged from African-Americans, American Indians, Asian Americans, Filipinos, Mexican-Americans and Latinos, and from white women in Physical Sciences, Mathematics and Engineering. Further information and application materials may be obtained from: University of California, 300 Lakeside Drive, 18th Floor, Oakland, CA 94612-3550; 415-987-9500. Application and information materials will be available in the Fall. The application deadline is December 14, 1990. An Equal Opportunity, Affirmative Action Employer.

University of California, Los Angeles. *Earle Raymond Hedrick Assistant Professorships in Mathematics.* The Department of Mathematics, University of California, Los Angeles, announces the availability of two appointments for the year 1991-1992. These awards will be made to mathematicians with recent Ph.D.'s who show strong promise in research. The appointment will be for three years, at an annual salary of $38,500 in the first year. The teaching load will be three hours per week for two quarters and six hours per week for one quarter. One course may be an advanced course in the candidate's research area. Requests for application forms should be sent to Alfred W. Hales, Chair, Department of Mathematics, University of California, 405 Hilgard Avenue, Los Angeles, California 90024-1555, Attn: Staff Search. Preference will be given to applications completed by January 1, 1991. UCLA is an Equal Opportunity/Affirmative Action Employer.

University of California, San Diego. *S. E. Warschawski Assistant Professorship.* The S. E. Warschawski Assistant Professorship is a special two-year position. The nine-month salary is $38,000. Candidates (of any age) should possess a recent Ph.D. degree (received no earlier than 1988) in mathematics or expect to receive one prior to July 1991. All areas of specialization will be considered. Selection will be based primarily on demonstrated research achievement. Teaching experience is desirable. To apply, please submit your placement file including at least three letters of reference, vitae and publications to the "Faculty Search Committee", Department of Mathematics, C-012, University of California, San Diego, La Jolla, California 92093. All applications received by January 4, 1991, will receive thorough consideration. All supporting material must be received no later than January 11, 1991. In compliance with the Immigration Reform and Control Act of 1986, individuals offered employment by the University of California will be required to show documentation to prove identity and authorization to work in the United States before hiring can occur. UCSD is an equal opportunity/affirmative action employer.

University of Chicago. *Assistant Professorships and Leonard Eugene Dickson Instructorships in Mathematics.* The Dickson Instructorships are intended for new or recent Ph.D.'s. Appointment is for two years with an annual salary of at least $35,000. The Assistant Professorships are intended for people with two or more years of postdoctoral experience. Appointment is for three years with an annual salary of at least $38,000. Application deadline is January 1, 1991. Further information and application forms may be obtained from the Appointments Secretary, Department of Mathematics, University of Chicago, 5734 S. University Avenue, Chicago, Illinois 60637.

University of Cincinnati. *Charles Phelps Taft Postdoctoral Fellowships.* These fellowships are intended to afford scholars who have demonstrated unusual ability for creative research the opportunity to enhance their education through additional study and research. Applicants must have been awarded the Ph.D. degree during the past five years or have completed all degree requirements by September 1 of the year in which the tenure will begin. Applications must include a research plan and the name of a University of Cincinnati faculty member, if known, with whom the applicant would like to study. Ten departments, including the Department of Mathematical Sciences, compete for three awards. Tenure is for one academic year and involves no teaching duties; however, teaching is allowed for additional compensation. Inquiries should be sent to the University Dean for Graduate Education and Research, Mail Location 627, University of Cincinnati, Cincinnati, Ohio 45221. The deadline for the complete application is February 1.

University of Illinois at Urbana-Champaign. *The Chancellor's Postdoctoral Fellowship Program.* Purpose: To train more underrepresented minorities for research careers. Awards: One year (possibly a second year) to promising applicants in all academic fields. Stipends: $25,000-$30,000, some transportation costs, health coverage funds, and some research-related expenses. Eligibility: U.S. citizens or permanent residents; appropriate terminal degree in hand or before appointment begins; preference to high achievers in disciplines of limited postdoctoral opportunities. Application: Curriculum vitae; statement of proposed research; sample publications/dissertation chapters; letters of reference from three evaluators. Deadline: Application and letters by December 1, 1990; announcement of awards before March 25, 1991.

University of Massachusetts. *Sabbatical Lectureships.* Available, subject to funding, in the Department of Mathematics and Statistics, these lectureships are open to faculty members of colleges or universities without a Ph.D. program in mathematics and/or statistics, who wish to spend their sabbatical leaves at the University of Massachusetts. Applicants should generally have a master's degree, will be required to teach one course per semester, and will be expected to enroll in one or two courses and a seminar. Stipends are available; tuition will be waived. For further information, write to Professor M. K. Bennett, Director, Sabbatical Lectureship Program, Department of Mathematics and Statistics, University of Massachusetts, Amherst, Massachusetts 01003.

University of Michigan, Ann Arbor. *T. H. Hildebrandt Research Assistant Professorships.* Designed to provide mathematicians with favorable circumstances for the development of their research talents. Preference is given to persons of any age having their Ph.D. less than two years. Teaching load averages one and one-half courses per semester. The stipend for the academic year 1991-1992 will be competitive and determined later; there is a good possibility of additional income during the summer. Appointment is for three years. NSF postdoctoral fellowships may be held simultaneously with a further reduction in teaching load. Applicants should submit completed application form and request at least three letters of recommendation. Letters should contain comments on applicant's mathematical promise, teaching ability, and personality. First preference will be given to applications completed, and supported by three or more letters, prior to January 4. Appointments will be announced by the middle of February. Applications should be made to J. B. Rauch, Chairman, Department of Mathematics, University of Michigan, Ann Arbor, Michigan 48109-1003. Affirmative Action Employer.

University of Pennsylvania. *Hans Rademacher Instructorship.* This post-doctoral position has been instituted in the Mathematics Department in honor of Hans Rademacher, a member of the department from 1934 to 1962. Appointment will be for two years, beginning July 1, 1991. Applicants should have received a Ph.D. in mathematics before start of the appointment, but no earlier than 1989, and are expected to show promise of significant accomplishment. The position carries a reduced academic year teaching load of one course each semester. Salary will be at least $33,000 and there is an additional discretionary research fund of $1,500. A letter of application, vitae and publications, and three letters of recommendation should be received by January 1, 1991. Write to: Personnel Committee, Department of Mathematics, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6395. The University of Pennsylvania is an Equal Opportunity/Affirmative Action Employer.

University of Pittsburgh. *Andrew Mellon Postdoctoral Fellowships.* Intended to support the research and foster the

professional development of scholars who give promise of achieving distinction in their fields. Applicants should submit a completed application form, a research proposal, three to ten pages long, a list of publications, and three letters of recommendation by January 15. The Fellows are expected to be in Pittsburgh throughout the period of their appointment and to be engaged in research and writing during this period; they have no other formal responsibilities. Preference will be given to applicants who have completed all doctoral degree requirements by January 15. A basic stipend of $21,000 for eleven months, plus supplements: traveling expenses, up to $200, from the Fellow's home to Pittsburgh and return and incidental costs of research. Nine-month appointments are available for a stipend of $17,200 plus supplements. Applications may be obtained from the Director of Graduate Programs, Faculty of Arts and Sciences, University of Pittsburgh, Pittsburgh, Pennsylvania 15260.

University of Texas at Austin. *R H Bing Faculty Fellowships.* Two Fellowships will be available at The University of Texas at Austin with terms beginning September 1, 1991. Each Fellow will hold an Instructorship in the Mathematics Department, with a teaching load of two courses in the fall and one course in the spring. The beginning salary will be $34,500 with a travel supplement of $1,000 per year. The Fellowships are not renewable after three years. Applicants must show outstanding promise in research, and preference will be given to those having doctorates conferred in 1990 or 1991. There are no restrictions on applicants' fields of interest. To apply, send a vita and have three letters of recommendation submitted by January 1, 1991, to R H Bing Faculty Fellowships, Department of Mathematics, The University of Texas, Austin, Texas 78712.

University of Utah. *Instructorship in Mathematics.* Two or more nonrenewable three-year instructorships are offered. Persons of any age receiving Ph.D. degrees in 1990 or 1991 are eligible. Applicants will be selected on the basis of ability and potential in teaching and research. Starting salary this academic year is $31,500; cost of living increases are contingent on action by the State Legislature. Duties consist of teaching five courses during the three quarter academic year. *C.R. Wylie Instructorship.* The term of this instructorship is one year, but it may be renewed for up to three years. It will be awarded either to an incoming Instructor or to one of the Instructors already in residence on the basis of ability and potential in teaching and research. The stipend is $35,500. Duties consist of teaching four courses during the three quarter academic year. Please send application to Instructorship Committee, Department of Mathematics, University of Utah, Salt Lake City, Utah 84112. Applications will be accepted until January 31, 1991, or until the positions are filled.

University of Wisconsin, Madison. *Van Vleck Assistant Professorship in Mathematics.* Applications are invited from outstanding mathematicians (of any age) who are recent recipients of a doctorate. People are sought who will interact well with members of the department, who care about teaching, and who can contribute to the research and instructional programs. The regular teaching load is two courses per semester, with at least one in the applicant's specialty every other year. There is a high probability of additional income through research or teaching during summers between consecutive years of appointment. The salary will be dependent on experience and will be at least $33,000 per academic year. All positions are for specified two or three-year terms. Deadline for applications is December 31, 1990. Application forms may be obtained from Hiring Committee, 223 Van Vleck Hall, Department of Mathematics, University of Wisconsin-Madison, 480 Lincoln Drive, Madison, Wisconsin 53706. Women and minorities are encouraged to apply.

Yale University. *Josiah Willard Gibbs Instructorships/ Assistant Professorships.* Offered to men and women with the doctorate who show definite promise in research in pure mathematics. Applications from women and members of minority groups are welcome. Appointments are for two/three years. The 1990-1991 salary is $35,000/$36,000, an increase is expected for 1991-1992. The teaching load is kept light to allow ample time for research. This will consist of two one-semester courses of undergraduate and another semester course of your choice. If desired, part of the teaching duties may consist of a one-semester course at the graduate level in the general area of the instructor's research. Inquiries and applications should be addressed to the Gibbs Committee, Department of Mathematics, Yale University, Box 2155 Yale Station, New Haven, Connecticut 06520. Deadline for applications and supporting materials is January 1, 1991.

Travel and Study Abroad

The African-American Institute. Seeks to further African development and to strengthen understanding between the United States and Africa. For information about the several programs write the African-American Institute program representatives in twenty-two African countries, relevant African ministries or universities, or the Division of Education, African-American Institute, 833 United Nations Plaza, New York, New York 10017.

American-Scandinavian Foundation. Grants and Fellowships for study or research in Scandinavia (Denmark, Finland, Iceland, Norway, and Sweden). Applicants must be U.S. citizens or permanent residents and have completed their undergraduate education by the time the overseas project is to begin. Necessary language competence, financial need, and merit in pursuing the study program in Scandinavia are considered in making these awards. The deadline for completed applications is November 1. Write to the Exchange Division, The American-Scandinavian Foundation, 725 Park Avenue, New York, New York 10021.

Centro de Investigación y de Estudios Avanzados del IPN. *Solomon Lefschetz Research Instructorships.* Offered to young mathematicians with doctorates who show definite promise in research. Appointments are for one year, with possibility of renewal. Salary equivalent to that of Assistant Professor in the Mathematics Department. An allowance for moving expenses. Teaching duties generally include one course per semester; knowledge of Spanish is desirable. Deadline for applications is February 28 but late applications may be considered. Inquiries should be addressed to: Solomon Lefschetz Instructorships, Mathematics Department, Centro de Investigación del IPN, Apartado Postal 14-740, 07000, México, D.F., México, Phone (905) 7-54-44-66, Telex 017-72826 PPTME, Fax (905) 7-54-87-07; Bitnet CINVES@UNAMVM1.

Winston Churchill Foundation. A scholarship program for graduate work in engineering, mathematics and science at Churchill College, Cambridge University. Tuition and living allowance worth $17,000. Application forms are available from representatives on campuses of colleges and universities participating in the program. For further information write to The Winston Churchill Foundation, P.O. Box 1240, Gracie Station, New York, New York 10028.

Lady Davis Fellowship Trust. Fellowships for study and/or research at graduate or postdoctoral levels at the Hebrew University of Jerusalem and the Technion-Israel Institute of Technology, Haifa. Lady Davis Fellows will be selected on the basis of demonstrated excellence in their studies, promise of distinction in their chosen fields of specialization and qualities of mind, intellect, and character. The Fellowships are tenable for a period of one year. They may be renewed for a second year and in special circumstances extended for a third year. They are intended to defray travel and tuition fees and to meet reasonable living expenses. Deadline for completed applications is December 1, 1990. Application forms can be obtained from the Lady Davis Fellowship Trust, P.O. Box 1255, Jerusalem, Israel.

Lady Davis Visiting Professorships. Lady Davis Visiting Professorships, for periods from one semester to a full academic year, are intended for candidates with the rank of Full or Associate Professor at their own institution. Such Visiting Professors are appointed after consultation with the appropriate Faculties of the Hebrew University of Jerusalem or the Technion-Israel Institute of Technology, Haifa. The grant includes a professorial salary and cost of travel. Deadline for completed applications is December 1, 1990. Application forms can be obtained from the Lady Davis Fellowship Trust, P.O. Box 1255, Jerusalem, Israel.

Fulbright-Hays Program. *Fulbright and Other Grants for Graduate Study Abroad.* For graduate study or research in any field in which the project can be profitably undertaken abroad. Applicant must be a U.S. citizen, hold a B.A. degree or the equivalent, and have language proficiency sufficient to carry out the proposed study and to communicate with the host country. If an applicant is already enrolled in a U.S. university, he must apply directly to the Fulbright Program Adviser on his campus. Unenrolled students may apply to the Institute of International Education. Further details may be obtained from the U.S. Student Programs Division, Institute of International Education, 809 United Nations Plaza, New York, New York 10017, (212)984-5330.

Alexander von Humboldt Foundation. *Research Fellowships.* Provides postdoctoral scholars with the opportunity of carrying out research at a university or other research institute within the Federal Republic of Germany incl. Berlin (West). Scholars of all nationalities and disciplines may apply. Selection is based exclusively on academic merit. Applicants must have completed their academic studies, have evidence of a degree equivalent to the doctorate (Ph.D., C.Sc., etc.), have scholarly publications, and for research in the humanities, have adequate knowledge of German. Period of fellowship: 6 to 12 months (extension possible up to 24 months). Applications may be obtained from and returned directly to the Alexander von Humboldt-Stiftung, Jean-Paul-Strasse 12, D-5300 Bonn 2, Federal Republic of Germany. Additional scholarships for a German language course are available.

Indo-American Fellowship Program. Approximately 12 grants to be awarded to U.S. citizens for advanced research in India, for six- to ten-month periods during the academic year. In addition to a basic grant there are travel, dependent and research allowances. Also up to nine shorter grants (two- to three-months) for research and/or professional activity. Applications are encouraged from non-Indian specialists and for projects which include collaboration with Indian colleagues. Deadline

for applications June 15 each year. For details write the Council for International Exchange of Scholars, Attention: Indo-American Fellowships Program, 3400 International Drive, N.W., Suite M-500, Washington, DC 20008-3097.

International Research and Exchanges Board (IREX). IREX administers academic exchange programs, open to advanced graduate students, postdoctoral scholars, and faculty members in all fields of study who are United States citizens, and who are affiliated with a North American college or university. Exchange agreements are in effect with Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, the Mongolian People's Republic, Poland, Romania, Yugoslavia, and the USSR. Placements are made for one to ten months at universities or academy institutes. For more detailed information, write to the International Research & Exchanges Board, 126 Alexander Street, Princeton, NJ 08540-7102 (609-683-9500).

Italian National Research Council Fellowships for Foreign Citizens. The Italian National Research Council announces some fellowships (maximum period one year) for foreign mathematicians. The stipend is 2,200,000 Italian lire per month, plus travel expenses to and from the country of residence. Prospective applicants may write for details to: Carlo M. Scoppola, C.N.R., via Santa Marta 13A, 50139 Firenze, Italy. In their letter they should include information concerning their curriculum, their research program, and the names of the Italian mathematicians they would like to work with.

Japan Society for the Promotion of Science (JSPS). The JSPS Fellowship for Research in Japan was established in 1959 to promote international cooperation and mutual understanding in scientific research, and is operated under a Japanese government subsidy. The program presupposes existing contact between scientists in Japan and their fellow scientists overseas, a condition considered auspicious for future scientific cooperation and exchange. The JSPS sponsors three types of Research Fellowship Programs for the invitation of foreign researchers by Japanese scientists. *Type I Short-Term Program*: To invite senior scientists for discussion and observation, as well as attending seminars and giving lectures, etc. Duration 14-90 days. *Type II Long-Term Program (Senior)*: To invite senior scientists for cooperative research work with scientists at Japanese universities or research institutes. Duration 6-10 months. *Type III Long-Term Program (Junior)*: To invite postdoctoral researchers for cooperative research work at Japanese universities or research institutes. Duration 6-12 months. Enquiries should be addressed to: Head, Exchange of Persons Division, Japan Society for the Promotion of Science, Yamato Bldg, 5-3-1 Kojimachi, Chiyoda-ku, Tokyo 102, Japan.

- **Kosciuszko Foundation.** *Graduate and Postgraduate Exchange with Poland.* Open to U.S. citizens. Candidates must have at least a master's degree and a knowledge of the Polish language. Apply by November 15 for the following academic year. Write to Scholarship and Exchange Programs, Kosciuszko Foundation, 15 East 65th Street, New York, New York 10021.

Marshall Scholarships. Offered by the British Government to U.S. graduates; tenable at any university in the United Kingdom. Recipients of awards are required to take a degree at their British university. Fields unrestricted. Deadline: October 15; to commence the following September; Age Limit: 25 years. Apply through British Consulates-General in the following regions (1) Northeast: Federal Reserve Plaza, 25th Floor, 600 Atlantic Avenue, Boston, Massachusetts 02106; (2) Mideast: British Embassy Cultural Dept.,3100 Massachusetts Avenue, N.W., Washington, DC 20008; (3) South: Marquis One Tower, Suite 2700, 245 Peachtree Center Avenue, Atlanta, Georgia 30303; (4) Midwest: 33 North Dearborn Street, Chicago, Illinois 60602; (5) Pacific: 1 Sansome Street, San Francisco, California 94104.

National Academy of Sciences (NAS). *Individual Exchange and Project Development Visits.* The NAS invites applications from American scientists who wish to make visits to the USSR, Bulgaria, Czechoslovakia, Hungary, Poland, Romania, and Yugoslavia. The program of individual exchanges will support one- to 12-month research visits during calendar year 1992. The program of two-week project development visits will support two cycles of visits: April through August 1991 and August through December 1991. Applicants for the project development visits need to demonstrate that a joint proposal for collaborative research will be prepared during their visit for submission to the National Science Foundation for funding. There is special emphasis on young investigators in each program.

Applicants must be U.S. citizens and have doctoral degrees or their equivalent six months prior to the requested beginning date of their visit in physics; chemistry; mathematics and computer sciences; earth, atmospheric, and oceanographic sciences; agricultural, forestry, fishery, and plant sciences; biological sciences; environmental sciences; engineering; archaeology and anthropology; geography; psychology; science and technology policy; or the history and philosophy of science. Projects in the economic and social sciences that involve development of new analytical methodologies will be considered on a case-by-case basis. Necessary expenses will be met by the NAS and the foreign academy, in-

cluding reimbursement for long-term visitors for salary lost up to a predetermined maximum and expenses for family members accompanying the scientist for more than six months.

Requests for applications for the first round of the project development visits should reach the National Academy of Sciences no later than November 15, 1990. **Applications for this program must be postmarked no later than November 30, 1990.** Requests for applications for the individual exchange program should reach the National Academy of Sciences no later than February 15, 1991. **Applications for this program must be postmarked by February 28, 1991.** Requests for applications for the second round of the project development visits should reach the National Academy of Sciences no later than February 15, 1991. **Applications for this program must be postmarked by February 28, 1991.** Address application requests to: Soviet and East European Affairs, National Academy of Sciences, 2101 Constitution Ave., N.W., (HA-166), Washington, DC 20418; 202-334-3884.

National Science Foundation. Travel awards for U.S. citizens who are either predoctoral students or individuals who have held a doctoral degree for three years or less as of the starting date of the Institute, to attend North Atlantic Treaty Organization (NATO) Advanced Study Institutes in Europe. Applications are made to the appropriate NATO Institute Director who nominates eligible candidates. Information may be obtained by writing to the Advanced Institute Travel Awards Program, Division of Research Career Development, National Science Foundation, Washington, DC 20550; (202-357-7536).

Natural Sciences and Engineering Research Council of Canada. *Visiting Fellowships.* The Government of Canada offers Fellowships on behalf of the following Canadian Government Departments and Agencies: Agriculture Canada; Communications Canada–Communications Research Centre; National Defence; Energy, Mines and Resources Canada; Environment Canada–Atmospheric Environment Service, Environmental Conservation Service–Inland Waters Directorate, Lands Directorate, Fisheries and Oceans and Surveys; Foresty Canada; Health and Welfare Canada–Health Protection Branch, Food Directorate, Environmental Health Directorate, Drugs Directorate, Laboratory Centre for Disease Control; National Research Council Canada; Atomic Energy of Canada Limited. The annual value of the fellowships is $32,626 effective May 1, 1990, subject to Canadian income tax. The initial appointment is for one year, with a possibility of renewal for a second year. The applicant should hold a recent doctoral degree (within the last five years) or its equivalent, plus appropriate research experience. The closing date for applications is November 15 each year. Write to the Visiting Fellowships Office, Natural Sciences and Engineering Research Council of Canada, 200 Kent Street, Ottawa, Ontario, Canada K1A 1H5.

North Atlantic Treaty Organization. The NATO Science Committee has a Programme of Grants for Collaborative Research which provides financial aid for research projects aimed at stimulating, encouraging, and facilitating scientific research in collaboration between scientists working in different member countries of the Alliance, thus promoting the flow of ideas and of experimental and theoretical methods across frontiers. Projects are supported for a limited period usually not exceeding five years, covering mainly travel and living expenses abroad for principal investigators visiting partner laboratories or for staff members collaborating on specific projects with laboratories abroad. Deadlines for applications are 31 March, 15 August and 30 November. Application forms and details of the awards together with information about the Science Committee's other programmes can be obtained from: Scientific Affairs Division, NATO, 1110 Brussels, Belgium.

- **North Atlantic Treaty Organization.** *Postdoctoral Fellowships.* Awarded for twelve-month periods, for scientific study or work at appropriate nonprofit institutions in NATO countries, other than the U.S., or neighboring countries that cooperate with NATO. This program is for citizens or nationals of the U.S. Fellows receive a stipend of $24,000 for twelve-month tenure, plus dependency and travel allowances. Application deadline is November 4, 1990. Applications will available in late August 1990. For information and application material, write to NATO Program, Division of Research Career Development, Room 630, National Science Foundation, Washington, DC 20550.

Research Fellowships in India. The Council for International Exchange of Scholars has announced the availability of twelve long-term (6-10 months) and nine short-term (2-3 months) awards for research in India during 1991–1992. These grants are available in all academic disciplines except clinical medicine. The purpose of the program is to open new channels of communication between academic and professional groups in the U.S. and India and to encourage a wider range of research activity between the two countries than currently exists. Scholars and professionals with limited or no prior experience in India are especially encouraged to apply. Applicants must be U.S. citizens at the postdoctoral or equivalent level. The terms of the fellowships include $1500 per month, of which $350 per month is payable in dollars and the balance in rupees, and an allowance for books, study and travel in India, and

international travel for the grantee. Long term grantees receive additional allowances, including funds for dependents. The program is sponsored by the Indo-U.S. Subcommission on Education and Culture and is funded by the United States Information Agency, the National Science Foundation, the Smithsonian Institution, and the Government of India. The application deadline is June 15, 1991. Application forms and further information are available from: Council for International Exchange of Scholars, Attn: Indo-American Fellowship Program, 3400 International Drive, Suite M-500, Washington, DC 20008-3097; 202-686-4013.

Royal Norwegian Council for Scientific and Industrial Research. *Postdoctoral Fellowships.* Fields: engineering and applied sciences. Studies can be carried out at the Universities of Oslo, Bergen, Trondheim or Tromsø, and at institutes for applied research in the same areas. English may be used at all institutes. Deadline each year is September 1 and March 1. Write to Royal Norwegian Council for Scientific and Industrial Research, P.O. Box 70, Tåsen, 0801 Oslo 8, Norway.

- **Social Sciences Research Council.** *International Dissertation Research Fellowship Program.* The program provides support to advanced doctoral candidates at U.S. universities for dissertation research in Africa; the Near and Middle East; East, South, and Southeast Asia; Western Europe; Latin America, and the Carribbean. Full information on this program may be obtained by writing to the Social Science Research Council, Fellowships and Grants, 605 Third Avenue, New York, New York 10158.

Weizmann Institute of Science. *Feinberg Graduate School Postdoctoral Fellowships.* The Fellowships are intended mainly for scientists who have recently obtained their Ph.D. degree. The Fellowships provide a 12-month stipend (with possible renewal for a second year), a small relocation allowance and a one-way air ticket. Round-trip airfare is provided if the Fellowship is extended for a second year. The annual stipend is adjusted periodically in accordance with living costs. Application forms and additional information may be obtained from the Feinberg Graduate School, The Weizmann Institute of Science, P.O. Box 26, Rehovot 76100, Israel. The review of applications is held twice a year, on January 1 and May 15.

Weizmann Institute of Science. *Openings for Scientists.* The Weizmann Institute of Science is now offering a limited number of temporary appointments to the position of Scientist. Candidates must have completed two years of post-doctoral work. Appointments will be made in all the areas of scientific research at the Institute: Biology, Chemistry, Biochemistry-Biophysics, Physics, Mathematics, and Science teaching. Appointments are for a period of one year, however, they may be extended for a period not to exceed 5 years from receipt of Ph.D. degree (or equivalent). Successful appointees will be eligible to apply for promotion to the position of Senior Scientist. Financial renumeration for a Scientist is at the level of Lecturer and includes all of the associated benefits. In addition, a relocation stipend is provided. Application forms and additional information may be obtained from The Feinberg Graduate School, The Weizmann Institute of Science, Rehovot, 76100 Israel. Applications are reviewed each year on January 1 and May 15.

Study in the U.S. for Foreign Nationals

Many of the programs in the Graduate Support and Postgraduate Support sections are also applicable to Foreign Nationals.

American-Scandinavian Foundation. Scandinavian scholars are awarded graduate fellowships to study in the U.S. For information write to the appropriate society in Scandinavia cooperating with The American-Scandinavian Foundation (Danmark-Amerika Fondet, Dronningens Tvaergade 44, DK-1302, Copenhagen K, Denmark; Suomi-Amerikka Yhdistysten Liitto, Mechelininkatu 10, SF-001 00 Helsinki, Finland; Íslenzk-Ameríska Félagid, P.O. Box 7051, Reykjavík, Iceland; Norge-Amerika Foreningen, Drammensveien 20C, 0255 Oslo 2, Norway; Sverige-Amerika Stiftelsen, Box 5280, S-102 46 Stockholm, Sweden), or to the Exchange Division, The American-Scandinavian Foundation, 75 Park Avenue, New York, New York 10021.

American Association of University Women (AAUW) Educational Foundation. *International Fellowships.* These are awarded to women of outstanding academic ability, who are not citizens or permanent residents of the U.S., for full-time graduate or post-graduate study in the U.S. Applicants must hold the equivalent of a U.S. bachelor's degree by December 1, 1990. Upon completion of studies, fellowship recipients must return to their home countries to pursue professional careers. Previous and current recipients of AAUW fellowships are not eligible. The fellowships provide $13,000 each. The deadline is December 1, 1990. For more information, contact: AAUW Educational Foundation, 1111 16th St., NW, Washington, DC 20036; telephone: (202)785-7700.

Fulbright Program. Grants under the Fulbright Act for study, research, teaching, and lecturing in the United States are available to nationals of many countries. Information regarding these opportunities may be secured

from the Cultural Affairs Officer of the United States Embassy or from the binational Educational Commission or Foundation if there is one in the inquirer's own country. The number of grants for each academic year will depend on funds available.

Institute of International Education. Grants for study, training and research in the U.S. Open to nationals of most countries. IIE develops and administers exchange programs for a number of organizations and corporations, and administers U.S. Government grants under the Fulbright and other educational exchange programs of the U.S. Information Service. Information regarding these opportunities may be secured from the Cultural Affairs Officer of the U.S. Embassy or from the Binational Commission or Foundation if there is one in the inquirer's own country.

Kennedy Scholarships. For citizens of the United Kingdom, these grants are for graduate study at Harvard University or the Massachusetts Institute of Technology. Application deadline is October 18. Write to Secretary, Kennedy Memorial Trust, 16 Great College Street, London SWIP 3RX, England.

- **Kosciuszko Foundation.** One-year grants to doctoral and postdoctoral students. Applicants must be Polish citizens and have excellent command of English. Apply by November 15 for the following academic year. Write to Scholarship and Exchange Programs, the Kosciuszko Foundation, 15 East 65th Street, New York, New York 10021.

Sources of Fellowship Information

Some of the publications listed below are available at school, or college and university libraries, or in the reference room of a good public library.

Academic Year Abroad. E. Marguerite Howard (ed.). Describes over 1800 study-abroad programs, both undergraduate and graduate, conducted during the academic year in countries around the world. Information on courses, costs, credits, housing, scholarships, and language of instruction. 1990/91. Annual. $29.95 (includes book rate postage and handling). 1990/91 edition available in June 1990. IIE Books, Institute of International Education, 809 United Nations Plaza, New York, New York 10017.

American Association of University Women Educational Foundation. Programs Office, 1111 16th St., N.W., Washington, DC 20036, or call 202-785-7700 and ask for the foundation.

Annual Register of Grant Support, 1991. National Register Publishing Co., 3004 Glenview Road, Wilmette, IL 60091. Directory of fellowships, grant support programs of government agencies, foundations, corporations and business and professional organizations. Annual. $141.00 plus $5.25 postage and handling.

Australian Study Opportunities 1989/1990. Sponsored by the International Development Program of Australian Universities and Colleges and the Ministry of Employment, Education, and Training, this definitive guide to Australian higher education provides institutional profiles, course offerings, and costs for all Australian postsecondary institutions, as well as an overview of study in Australia written especially for the overseas student. $18.95pb. IIE Books, Institute of International Education, 809 United Nations Plaza, New York, NY 10017.

Basic Facts on Foreign Study. A fact sheet on what to expect from a study-abroad program and where to find pertinent information; 1990, 32 pp.; single copies free, $35 per 100. IIE Books, Institute of International Education, 809 United Nations Plaza, New York, New York 10017.

Chronicle Student Aid Annual, 1989. Catalog No. 502A. $19.95 plus $2.00 postage and handling. (Price subject to change after January 1, 1991.) Revised annually. Chronicle Guidance Publications, Inc., Aurora Street, P.O. Box 1190, Moravia, New York 13118-1190. Provides information on about 1,975 financial aid programs available to undergraduate, graduate, and postgraduate students, including programs sponsored by private organizations and foundations, state and federal government sources, and national and international labor unions, both AFL-CIO affiliated and independent. A Cross Reference to Programs gives easy access to programs for which a student may be eligible. A bibliography leads users to names and sources of other financial aid publications.

CIEE Student Travel Catalog. $1 postage and handling. CIEE Publications, 205 East 42nd Street, New York, NY 10017.

- **Directory of Graduate Programs: 1990 and 1991.** Four volumes categorized by discipline, $14.00 each. Volume C: Physical Sciences, Mathematics, and Engineering. Educational Testing Service, P.O. Box 6014, Princeton, New Jersey 08541-6014.

Directory of Higher Education Courses 1989/1990. A complete directory to courses in all fields of study offered by Australian colleges and universities. Covers all higher education levels from the associate diploma

through the doctorate. Admissions contact information provided. $24.95pb. IIE Books, Institute of International Education, 809 United Nations Plaza, New York, NY 10017.

Directory of Special Programs for Minority Group Members. Career Information Services, Employment Skills Banks, Financial Aid Sources (5th Edition, 1990, 348 pages), Garrett Park Press, Garrett Park, Maryland 20896. $25.

Financial Aid for Minorities in Engineering and Science. Financial assistance, scholarship and fellowship programs, resources for further information, 1990, Garrett Park Press, P.O. Box 190, Garrett Park, MD 20896. $4.

Financial Resources for International Study: A Guide for U.S. Nationals. The book describes awards offered by governments, foundations, international organizations, research institutes and other organizations in the U.S. and abroad and provides informative grant descriptions, key facts on amount of award, what it covers, number offered, duration, purpose, and eligibility. Peterson's Guides, Box 2123, Princeton, NJ 08543-2123 (800-EDU-DATA). 250 pp. book. $36.95 Plus $5.75 Shipping.

The Foundation Center. The Foundation Center, 79 Fifth Avenue, New York, New York 10003, provides free library service through over 170 libraries across the country and publishes information about U.S. foundations and the grants they award, including the biennial publication, *Foundation Grants to Individuals,* (6th edition, 1988, $24). Call toll-free 800-424-9836 for further information.

Fulbright Scholar Program Grants for Faculty and Professionals: Research and Lecturing Awards. (Current Edition) Available from the Council for International Exchange of Scholars, 3400 International Dr., N.W., Suite M-500, Washington, DC 20008-3097;(202)686-4000.

Fulbright and Other Grants for Graduate Study Abroad. List of grants for graduate study and research abroad, administered by the I.I.E. for U.S. citizens. Request copy of brochure from U.S. Student Programs, Institute of International Education, 809 United Nations Plaza, New York, New York 10017, (212)984-5330.

Fulbright Teacher Exchange Program. Information on grants for teaching in elementary and secondary schools, and colleges, abroad, as well as study (seminar) opportunities abroad, may be obtained from the Teacher Exchange Branch, E/ASX-Room 353, United States Information Agency, 301 Fourth Street, S.W., Washington, DC 20547.

Funding for U.S. Study: A Guide for Foreign Nationals. The book lists awards offered by governments, foundations, international organizations, research institutes, and other organizations in the U.S. and abroad. It provides informative descriptions, facts on size and educational costs covered by the grant, eligibility, application, quantity of awards, duration and purpose. 250 pp. book. $39.95 (includes U.S. postage).

Graduate School and You: A Guide for Prospective Graduate Students. Council of Graduate Schools, 1989. Available from the Council of Graduate Schools, 1 Dupont Circle, N.W., Suite 430, Washington, DC 20036-1173, or call 202-223-3791.

- **The Grants Register.** 1989–1991. Craig Alan Lerner,(ed.), St. Martin's Press, 175 Fifth Avenue, New York, New York 10010. Lists scholarships, fellowships, and grants at all levels of graduate study, all over the world, available from government agencies and international, national and private organizations. List Price $75.00. Biennial.

International Research and Exchanges Board (IREX). Programs administered by IREX include exchanges for a semester or an academic year with the USSR and socialist countries of Eastern Europe, grants to promote new exchanges, collaborative projects in the social sciences and humanities, developmental fellowships, short-term travel grants, and language programs. The IREX programs provide access at the predoctoral and postdoctoral levels to East European and Soviet universities and academies of sciences. For a program announcement describing the full range of IREX programs, write to the International Research & Exchanges Board, 126 Alexander Street, Princeton, New Jersey 08540-7102 (609-683-9500).

Office of Naval Research. Supports research over a wide range of areas including applied mathematics, numerical analysis, discrete mathematics, operations research, signal analysis, statistics and probability. Proposals for research grants and requests for information on ONR Programs should be addressed to: Mathematical Sciences Division, Office of Naval Research, Arlington, Virginia 22217-5000. Information on ONR Fellowships is available from the Special Programs Office at the same address.

Study Abroad, XXVI, 1989-1991. Presents study programs world-wide for the years 1988-1991. Approximately 4,000 entries for more than 100 countries are included, covering a wide variety of fields. Trilingual (English/French/Spanish). 1,350 pp, pbk, 22cm x 11.5cm, $18.50, Order No. U1634. Contact UNIPUB, 4611-F Assembly Drive, Lanham, MD 20706-4391, (301) 459-7666; in Europe, UNESCO, Place de Fontenoy, Paris 7, France.

U.K. Central Bureau Publications. The Central Bureau is the agency funded by the education ministries of the U.K. to provide the most-needed information on international education. IIE is the U.S. distributor for the two Central Bureau books most widely used by U.K. students, librarians and campus professionals in planning study and work abroad. IIE Books, Institute of International Education, 809 United Nations Plaza, New York, NY 10017.

U.S. Information Agency (USIA). For information on USIA's international educational and cultural exchange programs, including the Fulbright Program, write the Office of Public Liaison, U.S. Information Agency, 301 Fourth Street, S.W., Washington, DC 20547.

Vacation Study Abroad. E. Marguerite Howard (ed.). A guide to over 1,300 summer and short-term study programs conducted around the world by U.S. colleges and universities, foreign institutions, and private organizations. Contains information on courses, costs, scholarships, and accommodations. 1990. Annual. $24.95 (includes book rate postage and handling). 1990 edition available in January 1990. IIE Books, Institute of International Education, 809 United Nations Plaza, New York, New York 10017.

Work, Study, Travel Abroad: The Whole World Handbook 1990/1991. $10.95 plus $1.00 postage and handling. CIEE Publications, 205 East 42nd Street, New York, NY 10017.

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 1990 RATE IS $50.00 per inch on a single column (one-inch minimum), calculated from the top of the type; $22 for each additional $1/2$ 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 $1/2$ 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 February 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 401-331-3842.

POSITIONS AVAILABLE

ARIZONA

NORTHERN ARIZONA UNIVERSITY
Flagstaff, Arizona

The Department of Mathematics announces tenure-track openings in mathematics, mathematics education and statistics for Fall 1991.

Ordinary Differential Equations. Assistant Professor with specialty in the geometric theory of dynamical systems supporting work of our existing special research focus. Current research of this group concentrates on planar systems with polynomial right hand sides and bifurcation theory.

Mathematics Education. Professor with commensurate record of research, leadership at the university and regional or national levels, and experience with teacher education programs. Specialty in the use of technology in instruction is preferred, but all areas will be considered. An Assistant Professorship in the same area may also be authorized.

Statistics. Assistant Professor with strong theoretical background, interest in applied statistics and intramural consulting, and the ability to contribute to the development of an interactive research group.

Each requires a doctorate, demonstrated potential for a productive, quality research program, and substantial evidence of high quality teaching.

Flagstaff is located in the cool pine forests of Northern Arizona, near high mountains, the Grand Canyon and numerous other natural attractions. NAU has an on-campus enrollment of approximately 14,000. The Department of 34 faculty offers bachelor's and master's degree programs.

Send vita and direct three letters of reference to: Screening Committee, Department of Mathematics, PO Box 5717, Northern Arizona University, Flagstaff, AZ 86011. The searches will remain open until the positions are filled; however, the Screening Committees will begin reviewing applications on January 7, 1991. Northern Arizona University is an Equal Opportunity/Affirmative Action Institution. Women and minorities are encouraed to apply.

CALIFORNIA

CALIFORNIA POLYTECHNIC STATE UNIVERSITY
Advertisement for Faculty Positions

Tenure-track positions for 1991-92 academic year, Mathematics Department. Salary and rank commensurate with qualifications and experience; assistant professor preferred. The teaching load is 12 units per quarter plus 3 units of instructionally related responsibilities. A doctorate in mathematics is required. A strong commitment to both teaching and research is expected. For additional information or an application, write to: Dr. Thomas E. Hale, Chair, Mathematics Department, California Polytechnic State University, San Luis Obispo, CA 93407. Closing date for receipt of applications is December 1, 1990. Cal Poly is an Affirmative Action/Equal Employment Opportunity Employer, and welcomes applications from women and minorities.

CALIFORNIA STATE UNIVERSITY AT LOS ANGELES

The Department of Mathematics and Computer Science invites applications for two tenure track positions at the assistant or associate level for a starting date of late June or September 1991. Our main area's of interest are Geometry, Combinatorics and Math Education. Ph.D. required (ABD in Math Education will be considered). Considerations will start February 1, 1991. Send inquires to:

Marshall Cates, Chair
Department of Mathematics and Computer Science
California State University at Los Angeles
5151 State University Drive
Los Angeles, CA 90032

An Equal Opportunity, Affirmative Action, Handicapped Title IX Employer.

CALIFORNIA STATE UNIVERSITY SAN BERNARDINO
Department of Mathematics

Applications are being accepted for the position of Assistant Professor or Associate Professor (tenure-track); a Ph.D. in mathematics education with at least a bachelor's degree in mathematics is required. Successful candidates will be expected to teach twelve hours per week, participate in scholarly activities, and help implement a new MAT program. Current salary range is $30,276-$52,896 dependent upon qualifications and experience. Applicants should submit a letter of application, vita, three letters of recommendation and all transcripts. Applications received after February 1, 1991, cannot be guaranteed consideration. Materials should be sent to:

Dr. John Sarli
Chair, Department of Mathematics
California State University
5500 University Parkway
San Bernardino, California 92407

AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION, SECTION 504, TITLE IX EMPLOYER

UNIVERSITY OF CALIFORNIA, BERKELEY
Department of Statistics

Pending final budgetary approval, applications are invited for several special Neyman Visiting Assistant Professor positions, beginning Fall 1991 or Spring 1992. The appointment is of two-year duration (but can be shorter by mutual agreement) and is not renewable. Applicants should have exhibited exceptional research potential in any of the following areas: Theoretical or applied statistics, computational statistics, probability theory, applied probability. Appointees will be expected to teach as well as carry out a vigorous program of research. Send applications or inquiries (including resume and names of three references) by January 31, 1991 to: T. P. Speed, Chair, Department of Statistics, University of California, Berkeley, California 94720. The University of California is an Equal Opportunity, Affirmative Action Employer.

UNIVERSITY OF CALIFORNIA
LOS ANGELES
Department of Mathematics

REGULAR POSITIONS IN PURE AND APPLIED MATHEMATICS

Subject to administrative approval, two regular positions in pure and applied mathematics. The six specific search areas are as follows: 1) logic and mathematical computer science; 2) algebra (including algebraic geometry and representation theory), number theory and combinatorics; 3) geometry and topology (including dynamical systems and geometric partial differential equations); 4) analysis and differential equations (including Lie groups and mathematical physics); 5) statistics, probability and game theory; 6) applied and computational mathematics. Very strong promise in research and teaching required. Positions initially budgeted at the assistant professor level. Sufficiently outstanding candidates at higher levels will also be considered. Teaching load: averaging 1.5 courses per quarter, or 4.5 quarter courses per year. To apply, write to Alfred W. Hales, Chair, Department of Mathematics, University of California, Los Angeles, CA 90024-1555. Attn: Staff Search. UCLA is an equal opportunity/affirmative action employer.

UNIVERSITY OF CALIFORNIA
LOS ANGELES
Department of Mathematics

TEMPORARY POSITIONS

(1) Two E. R. Hedrick Assistant Professorships. Applicants must show very strong promise in research and teaching. Salary $38,500. Three year appointment. Teaching load: four quarter courses per year, which may include one advanced course in the candidate's field. Preference will be given to applications completed by January 1, 1991.

(2) Subject to administrative approval, several Research Assistant Professorships in Computational and Applied Mathematics. Applicants must show very strong promise in research and teaching. Salary $38,500. One year appointment, probably renewable up to two times. Teaching load: at most four quarter courses per year, which may include one advanced course in the candidate's field. Preference will be given to applications completed by January 1, 1991.

(3) Subject to administrative approval, one or two Assistant Professorships in the Program in Computing (PIC). Applicants must show very strong promise in teaching and research, preferably in the general area of Logic and Computation. Teaching load: four quarter programming courses and an advanced quarter course of the candidate's choice per year. Two-year appointment, possibly renewable once. Salary range: $38,500-$44,000. Preference will be given to applications completed by February 1, 1991.

(4) Subject to administrative approval, one or two Lectureships in the Program in Computing (PIC). Applicants must show very strong promise in the teaching of programming. M.S. in Computer Science or equivalent degree preferred. Teaching load: five quarter programming courses per year. One-year appointment, possibly renewable up to five times, depending on the needs of the Program. Salary is based on experience and begins at $32,676. Preference will be given to applications completed by February 1, 1991.

(5) Subject to administrative approval, a few Adjunct Assistant Professorships. One year appointments, probably renewable once. Strong research and teaching background required. Salary $33,900-$38,200. Teaching load: five quarter courses per year.

(6) Subject to administrative approval, several positions for visitors and lecturers.

To apply, write to Alfred W. Hales, Chair, Department of Mathematics, University of California, Los Angeles, CA 90024-1555. Attn: Staff Search. UCLA is an equal opportunity/affirmative action employer.

CONNECTICUT

SOUTHERN CONNECTICUT
STATE UNIVERSITY
New Haven CT 06515
Mathematics Department

Tenure track position at asst/assoc rank beginning 8/26/91 to teach undergrad/grad math ed. and math, supervise secondary school student teachers. Teaching load: 12 hours/sem. Salary Range: $28,000 to $47,932. Qualifications: doctorate (or near completion) in mathematics or mathematics education with a strong mathematics background, evidence of quality teaching, experience in teacher ed. programs preferred, potential for scholarly growth. Send letter of application, vita, transcripts, three letters of reference to Dr. Bodh Gulati, Chair. Full consideration given to applications received by 1/19/91. (AA/EOE)

SOUTHERN CONNECTICUT
STATE UNIVERSITY
New Haven CT 06515
Mathematics Department

Tenure track position at asst/assoc rank beginning 8/26/91 to teach undergrad/grad statistics and math. Teaching load: 12 hours/sem. Salary Range: $28,000 to $47,932. Qualifications: doctorate (or near completion) in mathematical statistics, evidence of quality teaching, potential for scholarly growth. Send letter of application, vita, transcripts, three letters of reference to Dr. Bodh Gulati, Chair. Full consideration given to applications received by 1/19/91. (AA/EOE)

FLORIDA

STETSON UNIVERSITY
Department of Mathematics
and Computer Science

Applications are invited for a tenure track position in mathematics at the Assistant Professor level beginning Fall, 1991. A Ph.D. in mathematics is required. Applicants should have a strong commitment to undergraduate teaching in a liberal arts environment. Teaching load: 9-10 hrs/wk. Responsibilities include teaching mathematics courses at all levels of the undergraduate curriculum, and continuing scholarly activity. The department currently has 10 full-time faculty members. Stetson University, located in Central Florida, is a small, private, comprehensive university of 2500 students. Its three schools—the College of Arts and Sciences, the School of Business, and the School of Music—are dedicated to excellence in teaching and are united by a commitment to the liberal arts. Send vitae and three letters of recommendation to: Professor Dennis Kletzing, Department of Mathematics and Computer Science, Stetson University, DeLand, Florida 32720. Deadline for applications is December 31, 1990, or until position is filled. Stetson University is an equal opportunity employer and enthusiastically solicits applications from women and minorities candidates.

UNIVERSITY OF CENTRAL FLORIDA
Department of Mathematics

Applications are invited for at least three tenured track positions at Full, Associate, Assistant Professor level beginning August 1991. Ph.D. degree in Mathematics with strong research record and dedication to teaching required for appointment at Professor or Associate Professor level. Candidates with substantial completion of Ph.D. requirements with strong teaching and research potential will be considered for the Assistant Professor level. These appointments will be made preferably in the areas of graph theory and combinatorics, numerical analysis, computational mathematics, ordinary or partial differential equations, integral equations, applied functional analysis, or applied mathematics. However, other areas of specialization may be considered provided there are no strong candidates with preferred research areas. Candidates should send a detailed resume and arrange at least three letters of recommendation and transcript sent to: Search Committee Chairman, Department of Mathematics, University of Central Florida, Orlando, Florida 32816, postmarked by December 3, 1990. Some Search Committee members may be available at the San Francisco meeting in January 1991 for an interview. The University is an equal opportunity affirmative action employer. As an agency of the State of Florida, UCF makes all application materials and selection procedures available for public review.

THE UNIVERSITY OF FLORIDA
Department of Mathematics

In each of the next several years, the Department of Mathematics intends to fill a number of tenure-track faculty positions with mathematicians of exceptional caliber. In the coming year, special consideration will be given to filling positions in the following areas of research: algebraic geometry and number theory, topology, numerical analysis, and probability theory. However, outstanding candidates from all areas of pure and applied mathematics are invited to apply for these positions.

Candidates at all ranks will receive serious consideration, but it is expected that most positions will be filled at the level of assistant professor. Applications from junior candidates with post-doctoral experience are especially welcome.

Senior candidates should have distinguished research records, and junior candidates are expected to have made significant research contributions. Every candidate is expected to possess a strong commitment to teaching. Candidates should forward a resume (including a list of publications) and should arrange for at least four letters of recommendation to be sent to:

David A. Drake, Chair
Department of Mathematics
University of Florida
201 Walker Hall
Gainesville, FL 32611-2082

All applications for the academic year 1991-92 should be complete by December 31, 1990. The University of Florida is an equal opportunity employer and energetically solicites applications from women and minority candidates.

ILLINOIS

NORTHERN ILLINOIS UNIVERSITY

DEPARTMENT OF MATHEMATICAL SCIENCES, NORTHERN ILLINOIS UNIVERSITY. Anticipated full professorship with a specialization in nonlinear partial differential equations and a strong background in continuum mechanics, fluid mechanics and numerical methods for partial differential equations. Ph.D. or equivalent and a research record appropriate to a senior appointment at a major research university required. Application (vita) plus three letters of reference should be sent to: Dr. William D. Blair, Chair, Department of Mathematical Sciences, Northern Illinois University, DeKalb, IL 60115 by December 1, 1990. EO/AAE.

NORTHWESTERN UNIVERSITY
Department of Mathematics
2033 Sheridan Road
Evanston, Illinois 60208-2730

Applications are invited for one or more tenure-track positions starting September 1991. Although priority will be given to young, exceptional research mathematicians (no more than several years after Ph.D.), more senior candidates with very exceptional credentials may be considered for a tenured position. Fields of interest of the department include Algebra, Analysis, Dynamical Systems, Probability, Partial Differential Equations, and Topology. Northwestern is an affirmative action, equal opportunity employer committed to fostering a diverse faculty, so women and minority candidates are especially encouraged to apply. Candidates should arrange that at least three letters of recommendation be sent to Chair, Personnel Committee, Department of Mathematics, Northwestern University, Evanston, Illinois 60208. In order to receive full consideration, applications should be received by January 7, 1991. Hiring is contingent upon eligibility to work in the United States.

NORTHWESTERN UNIVERSITY
Department of Mathematics
2033 Sheridan Road
Evanston, Illinois 60208-2730

The Mathematics Department will sponsor an Emphasis Year in algebraic topology, cohomology of groups, and related topics. This program will include 2-year Assistant Professorship positions starting September 1991 and possible visiting positions for more senior mathematicians for part or all of the academic year.

Applications should be sent to Prof. Mark E. Mahowald at the department address and include a curriculum vitae and three letters of recommendation. In order to ensure full consideration, an application must be received by January 30, 1991.

Northwestern University is an Affirmative Action/Equal Opportunity employer. Hiring is contingent upon eligibility to work in the United States.

SOUTHERN ILLINOIS
UNIVERSITY AT CARBONDALE
Department of Mathematics
Carbondale, Illinois 62901

Applications are invited from qualified candidates for a tenure track position at the assistant professor level beginning on August 16, 1991. Ph.D. in mathematics with specialization in pure or applied combinatorics, cryptography, graph theory or combinatorial designs required. Candidates must have demonstrated excellence in research or potential for such. Evidence of teaching effectiveness is required. Send letter of application, resume and three letters of recommendation to:

Combinatorics Position
c/o Ronald B. Kirk, Chair
Department of Mathematics
Southern Illinois University at Carbondale
Carbondale, Illinois 62901

The closing date is December 15, 1990 or until the position is filled. SIUC IS AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER. Women and minorities are particularly encouraged to apply.

UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN
Department of Mathematics

Applications are invited for one or more tenure-track or tenured faculty positions commencing in August 1991. While we are particularly interested in the areas of applied mathematics, combinatorics, and optimization, outstanding candidates in all fields of mathematics are strongly encouraged to ap-

ply and will be seriously considered. Some visiting appointments for the 1991-92 academic year are also anticipated. Salary and teaching load are competitive. Candidates must have completed the PhD by the time the appointment begins. Candidates should send a letter of application, curriculum vitae and publication list, and arrange to have three letters of reference sent directly to

C. Ward Henson, Chair
Department of Mathematics
University of Illinois at
Urbana-Champaign
1409 W. Green St.
Urbana, Illinois 61801
tel. (217)333-3352

In order to ensure full consideration, all application materials including letters of reference should be received by December 1, 1990. Interviews may be conducted prior to December 1, but all completed applications received by that date will receive full consideration. Candidates are expected to present evidence of excellence, or potential for excellence, in research and teaching. Applications from women and minority candidates are especially encouraged. The University of Illinois is an Affirmative Action/Equal Opportunity Employer.

INDIANA

INDIANA UNIVERSITY-PURDUE UNIVERSITY AT INDIANAPOLIS (IUPUI)
Department of Mathematical Sciences

The Department of Mathematical Sciences at IUPUI is seeking applicants for a senior position, at the level of full professor, in scientific computing/numerical analysis. The preferred starting date is January 1, 1991. A later starting date is negotiable. The successful candidate is expected to provide leadership to a new interdisciplinary program in computational science to be developed jointly by the Department of Mathematical Sciences and the Department of Comptuer & Information Science.

Applicants must have an earned doctorate, a strong background in applied and numerical analysis, a commitment to excellence in teaching, and a demonstrated record of research accomplishments. Special preference will be given to candidates whose expertise and interest are in the development of asymptotics based numerical methods and their applications to large-scale scientific problems.

IUPUI is a rapidly growing comprehensive urban university with over 26,000 students. The department offers programs of study leading to Purdue University B.S., M.S., and Ph.D. degrees. The university offers competitive salaries and provides excellent fringe benefits. Applications and inquiries should be addressed to Prof. Bart S. Ng, Chair, Department of Mathematical Sciences, IUPUI, 1125 E. 38th Street, Indianapolis, IN 46205-2810. Closing date: December 1, 1990. Late applications will be considered until position is filled.

IUPUI is an Affirmative Action/Equal Opportunity Employer

Woman and minority candidates are encourage to apply

KANSAS

THE WICHITA STATE UNIVERSITY

The Department of Mathematics and Statistics invites applications for a tenure-eligible Assistant Professor position starting in August, 1991. The Ph.D. in Mathematics is required together with research credentials in partial differential equations and optimal control theory. At least two years of (postdoctoral) experience at the university level is preferred. We seek someone whose research interests are consonant with those of our faculty. All candidates should have a strong interest in teaching and the ability to participate in and contribute to our doctoral program in Applied Mathematics. Salary competitive. Send application letter, detailed resume, and arrange to have three reference letters sent by November 9, 1990 to:

The Wichita State University
Professor Stephen W. Brady, Search Committee Chair
Department of Mathematics and Statistics
Wichita, Kansas 67208

AA/EOE

MASSACHUSETTS

SMITH COLLEGE

Smith College anticipates a tenure-track opening in mathematics beginning fall, 1991. Level: entry, Assistant Professor, load: 5 courses; contract: three years; field: any; Ph.D. is presumed. Applications should include cv and letters addressing both teaching and research, and should be sent to: Mathematics Search, Clark Science Center, Smith College, Northampton, MA 01063 by January 15, 1991. Applicants will be informed beginning in December whether the position is indeed open. Smith College is an Affirmative Action/Equal Opportunity Institution. Minorities and women are encouraged to apply.

MICHIGAN

MICHIGAN STATE UNIVERSITY
CHAIRPERSON
Department of Mathematics

Michigan State University invites applications for the position of Chairperson of the Department of Mathematics. The Department has more than 70 regular faculty; over 125 graduate students are enrolled in its Ph.D. and Masters degree programs.

Applicants should have an outstanding record of research and scholarly activity in mathematics. Applicants should also possess the leadership and administrative skills necessary to chair a department with major research, teaching, and service responsibilities.

To apply, please send a vita and have at least three letters of recommendation sent to Professor Sheldon Axler, Chair Search Committee, Department of Mathematics, Michigan State University, East Lansing, MI 48824. Applications and recommendation letters should arrive by 31 December 1990. Inquiries and nominations should also be sent to the above address (or via e-mail to axler@msu.bitnet).

The position of Chairperson carries tenure at the rank of Professor and is available on 1 September 1991. Salary is competitive and will be commensurate with qualifications.

Applications are strongly encouraged from groups that are traditionally underrepresented in mathematics. MSU is an Affirmative Action/Equal Opportunity Institution.

NEW MEXICO

NEW MEXICO STATE UNIVERSITY

Visiting and tenure-track positions for Fall 1991, primarily assistant professor level. Under very special circumstances, appointments at higher rank may be possible. Strong commitment to research and teaching required.

Preference given to applicants with research interests related to strengths in the department. NMSU meets federal criteria for classification as a minority institution and welcomes applications from women and members of minority groups. Arrange for vita, short research description, and at least three reference letters to be sent to: Hiring Committee, Dept. of Mathematical Sciences, New Mexico State University, Las Cruces, New Mexico 88003. An EO/AA Employer.

NEW YORK

JOHN JAY COLLEGE
OF CRIMINAL JUSTICE
THE CITY UNIVERSITY OF NEW YORK
Department of Mathematics

Assistant Professor, tenure-track position, January, 1991. Requirements: Ph.D.; 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 December 1, 1990. Minorities and women are encouraged to apply. AA/EOE Employer.

NORTH CAROLINA

WAKE FOREST UNIVERSITY
Department of Mathematics and Computer Science

Applications are invited for two tenure track positions in mathematics at the assistant professor level beginning August 1991. Duties include teaching mathematics at the undergraduate and graduate levels and continuing research. A Ph.D. is required. The department has 22 members and offers a B.S. and M.A. in mathematics and a B.S. in computer science. Send letter of application and resume to Richard D. Carmichael, Chairman, Department of Mathematics and Computer Science, Wake Forest University, Box 7311, Winston-Salem, NC 27109. AA/EO employer.

NORTH DAKOTA

NORTH DAKOTA STATE UNIVERSITY

The Department of Mathematics at North Dakota State University has a vacancy for department chair. Responsibilities include all aspects of departmental administration and development (further strengthening of undergraduate and graduate programs), teaching, and research. Minimum qualifications include a PhD in mathematics, demonstrated research and teaching record, potential for leadership and managerial capability, and ability to work effectively with people and maintain collegiality. Salary will depend on experience and qualifications.

The Mathematics Department at NDSU is a growing department with numerous research interests and teaching duties. There are active research groups in ergodic theory, applied mathematics and numerical analysis, discrete mathematics, and commutative algebra. NDSU is home to the Higher Education Computing Network (HECN) as well as several computer networks such as GRAPHNET. NDSU has an enrollment of 9200 and is located in Fargo, part of a metropolitan area with population 120,000.

Interested applicants should submit a letter of application, current resume, and at least three letters of reference addressing the applicant's research, teaching, and administrative abilities to Chair Search Committee, Mathematics Department, NDSU, Box 5075, Fargo, ND 58105-5075. Screening process will commence 1 December 1990, and the position may be filled at anytime thereafter. NDSU is an EOE.

OHIO

THE OHIO STATE UNIVERSITY
Department of Mathematics

The Department of Mathematics of The Ohio State University hopes to have available several positions, both visiting and permanent, effective Autumn Quarter 1991. Candidates in all areas of applied and pure mathematics, including those with demonstrated interest in pedagogical matters, are invited to apply. Significant mathematical research accomplishments or exceptional promise, and evidence of good teaching ability, will be expected of successful applicants.

Please send credentials and have letters of recommendation sent to Professor Dijen Ray-Chaudhuri, Department of Mathematics, The Ohio State University, 231 W. 18th Avenue, Columbus, Ohio 43210. Review of resumes will begin immediately.

The Ohio State University is an Equal Opportunity/Affirmative Action employer. Qualified women and minority candidates are encouraged to apply.

THE OHIO STATE UNIVERSITY
Department of Mathematics
Research Instructorships in Mathematics

The Department of Mathematics of The Ohio State University hopes to have available a few research instructor positions for the academic year 1991-92. Candidates should hold a Ph.D. (or equivalent) in mathematics and show strong research promise.

Please send credentials and have letters of recommendation sent to Professor Dijen Ray-Chaudhuri, Department of Mathematics, The Ohio State University, 231 W. 18th Avenue, Columbus, Ohio 43210. The Ohio State University is an Equal Opportunity/Affirmative Action Employer.

OREGON

OREGON STATE UNIVERSITY

Assistant Professor positions in Algebra, Differential Geometry, Differential Equations, Dynamical Systems, Geometric Measure Theory and other fields will become available September 16, 1991. Salary depends on qualifications. Closing date is December 1, 1990. Write to:

Professor Bent Petersen, Chair
Staff Selection Committee
Department of Mathematics
Oregon State University
Corvallis, Oregon 97331-4605

OSU is an Affirmative Action/Equal Opportunity Employer and complies with Section 504 of the Rehabilitation Act of 1973. OSU has a policy of being responsive to the needs of dual-career couples.

OREGON STATE UNIVERSITY

The Andreotti Assistant Professor position in mathematics will become available September 16, 1991. The Andreotti position is a tenure-track position. Teaching duties consist of one course per term for the first two years. The position includes summer research support for the first two summers. It is restricted to individuals who have held a Ph.D. for at most three years. Salary depends on qualifications. Closing date is December 1, 1990. Write to:

Professor Bent Petersen, Chair
Staff Selection Committee
Department of Mathematics
Oregon State University
Corvallis, Oregon 97331-4605

OSU is an Affirmative Action/Equal Opportunity Employer and complies with Section 504 of the Rehabilitation Act of 1973. OSU has a policy of being responsive to the needs of dual-career couples.

PENNSYLVANIA

BRYN MAWR COLLEGE
Department of Mathematics

Bryn Mawr College invites applications for a tenure track assistant professorship in Mathematics, to start September 1991. Candidates should have a doctorate in a mathematical science, or expect to have completed it by Sept. 1, 1991. Candidates are expected to show promise in research and a commitment to teaching. All fields are acceptable, with a preference for algebra or applied mathematics. Bryn Mawr is an Equal

Opportunity/Affirmative Action employer, and seeks faculty and staff knowledgable about and concerned with multicultural and international issues. Minority candidates and women are especially encouraged to apply. Closing date January 1, 1991. (Late applications may be considered.) Send application and three letters of recommendation to:

Search Committee
Department of Mathematics
Bryn Mawr College
Bryn Mawr, PA 19019

Telephone: (215)526 5348.
Email: MSEARCH@BRYNMAWR.

CARNEGIE MELLON UNIVERSITY
Department of Mathematics

The Department expects to make one tenure-track appointment, to begin in the Fall of 1991, at the Assistant Professor level. We particularly seek candidates in the area of computational mathematics, but also will consider other areas of research which strongly intersect those of the current faculty of the Department. Applicants should send a vita, list of publications, and a statement describing current and planned research, and arrange to have at least three letters of recommendation sent to the committee. All communications should be addressed to: Appointments Committee, Department of Mathematics, Carnegie Mellon University, Pittsburgh, PA 15213. Carnegie Mellon University is an Affirmative Action/Equal Opportunity Employer.

CARNEGIE MELLON UNIVERSITY
Department of Mathematics

The Department expects to make at least one Post-Doctoral appointment for 1991-1992 in the area of applied analysis. This is a one-year (twelve-month) appointment. Applicants should send a vita, list of publications, and a statement describing current and planned research, and arrange to have at least three letters of recommendation sent to the committee. All communications should be addressed to: Appointments Committee, Department of Mathematics, Carnegie Mellon University, Pittsburgh, PA 15213. Carnegie Mellon University is an Affirmative Action/Equal Opportunity Employer.

CARNEGIE MELLON UNIVERSITY
Zeev Nehari Assistant
Professorship in Mathematics

The Zeev Nehari Assistant Professorships have been instituted in the Department of Mathematics of Carnegie Mellon University to honor the memory of Professor Zeev Nehari, a member of the Department from 1954 to his death in 1978. The position available is for an initial period of one or two academic years, beginning in September 1991, and extendable for one additional year when mutually agreeable. It carries a reduced academic year teaching load of six hours per week during one semester and three hours per week during the other. Applicants are expected to show exceptional research promise, as well as clear evidence of achievement and should have research interests which intersect those of current faculty of the Department. Applicants should arrange to have three letters of recommendation sent to the Appointments Committee, send a vita, a list of publications and a statement describing current and planned research. It is important that the latter explain the relation of the proposed work to that currently done in the Department. All communications should be addressed to: Appointments Committee, Department of Mathematics, Carnegie Mellon University, Pittsburgh, PA 15213. Carnegie Mellon University is an Affirmative Action/Equal Opportunity Employer.

COMMUNITY COLLEGE OF PHILADELPHIA

MATHEMATICS-Mathematics Dept. invites applications for a tenure-track Asst. Professorship position beginning Fall, 1991. The Department is actively engaged in course development. It has recently received grants from NSF and CASET. Teaching load is 12 credit hours per semester. Outstanding benefits. Candidates must have a PhD or Master's + 3 years teaching in Mathematics, and a commitment to quality teaching, both remedial and college level. Demonstrated strength in course development is essential. Candidates should provide clear evidence of a strong background in Mathematics, together with ability to bring to the first 2 years, mathematical topics usually delayed until later. Send curriculum vitae and 3 letters of recommendation by November 27, 1990 to: J. Mason, Head, Dept. of Mathematics, COMMUNITY COLLEGE OF PHILADELPHIA, 1700 Spring Garden St., Phila., PA 19130. Women and minorities are encouraged to apply. AA/EOE.

RHODE ISLAND

BROWN UNIVERSITY
Providence, RI 02919

One professorship at the Associate Professor level or above, with tenure to begin July 1, 1991. Salary to be negotiated. Preference to be given to applicants with research interests consonant with those of the present members of the Department. Preference will be given to those applicants with research interests in differential geometry and related fields. Candidates should have a distinguished research record and a strong commitment to teaching. Qualified individuals are invited to send a vita and at least three letters of recommendation, no later than October 31, 1990, to Professor Robert D. M. Accola (Senior Search), Executive Officer, Department of Mathematics, Brown University, Providence, Rhode Island 02912. Brown University is an Equal Opportunity/Affirmative Action employer.

UTAH

UNIVERSITY OF UTAH
Department of Mathematics

invites applications for the following positions:

1. At least two **full time tenure track appointments** on the professorial levels. The Department is primarily interested in applicants who work in the research areas represented in the Department and who received their Ph.D. degrees prior to 1990. Selection will be based on research expertise and teaching ability.

2. Two or more nonrenewable **three-year Instructorships**. Persons of any age receiving Ph.D. degrees in 1990 or 1991 are eligible. Applicants will be selected on the basis of ability and potential in teaching and research. Starting salary will be $31,500; cost of living increases are contingent on action by the State Legislature. Duties consist of teaching five courses during the three quarter academic year.

3. One **C. R. Wylie Instructorship**. The term of this instructorship is one year, but it may be renewed for up to three years. It will be awarded either to an incoming Instructor or to one of the Instructors already in residence on the basis of ability and potential in teaching and research. The stipend is $35,500. Duties consist of teaching four courses during the three quarter academic year.

4. One of more **visiting faculty positions** of one year or less in any of the professorial ranks. Selection will be based on potential contributions to the department's research program, and on teaching ability.

Applications will be accepted until January 31, 1991 or until the positions are filled.

Applications for any of these positions should include curriculum vitae, bibliography and three letters of reference. (Instructorship applications should also include an abstract of the thesis and either a list of graduate courses completed or a transcript of graduate work.) Visiting faculty applications should indicate the portion of the three-quarter academic year during which the applicant wishes to visit. Please send your application to Committee on Staffing, Department of Mathematics, University of Utah, Salt Lake City,

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The Department of Applied Mathematics at the University of Virginia seeks a new faculty member committed to teaching and research, with interests in the formulation, analysis, and solution of partial differential equations. Such interests should intersect at least one of the three areas of expertise in the Department: Continuum Mechanics, Control Theory, and Numerical Analysis/Scientific Computing. Rank and salary will be commensurate with experience and qualifications.

The Department, which currently has eleven faculty, 27 undergraduates, and 33 graduate students, is part of the School of Engineering and Applied Science, and also maintains close ties with the Mathematics Department in the College of Arts and Sciences.

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Applications should be sent to:
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The mathematics faculty numbers seven, all with PhD's. The University is primarily a liberal-arts college with 1600 undergraduates. It is 240 years old and is located in the lower Shenandoah Valley. *Address inquiries to Prof. R. S. Johnson, Search Committee, Mathematics Department. The selection process will begin in November, 1990.* AA/EOE

CANADA

UNIVERSITY OF BRITISH COLUMBIA
Department of Mathematics, Room 121,
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The Department is looking for outstanding candidates for a tenure track Assistant Professorship in Numerical Analysis or Applied Mathematics to begin 1 July 1991. For an exceptionally well-qualified candidate, this position may be upgraded to a non-tenured junior Associate Professorship. Applicants should have a demonstrated research record of high quality and have demonstrated interest and ability in teaching. It is expected that a successful candidate would become an active member of the Institute of Applied Mathematics. Preference will be given to candidates who have one or more years of postdoctoral experience. This position is subject to budgetary approval. The salary will be commensurate with experience and research record.

Applicants should send a C.V. including list of publications, statement of research and teaching interests and arrange for three letters of recommendation to be sent directly to: Dr. Dale Rolfsen, Head, Department of Mathematics, University of British Columbia, Vancouver, B.C. Canada V6T 1Y4. Applications must be received before January 1, 1991. In accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada. The University of British Columbia is committed to the Federal Government's employment equity program and encourages applications from all qualified individuals.

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The Department of Mathematics invites applications in all areas of mathematics and statistics for two and, perhaps, three tenure-track posts at the Assistant Professor level, starting July 1, 1991. Candidates are required to hold a PhD degree and have strong research potential. Ability to teach in English and French is a requirement for tenure for one of the posts, but either language suffices for the initial appointment. The teaching attached to the other post(s) will be in French. In accordance with Canadian immigration requirements, this advertisement is directed to Canadian citizens and permanent residents.

Applicants should send a resume and have three letters of recommendation sent directly to: **W. D. Burgess, Department of Mathematics, University of Ottawa, Ottawa, Ontario, Canada K1N 6N5.** The deadline for receipt is Dec. 14, 1990.

GERMANY

UNIVERSITY OF BIELEFELD
Department of Mathematics

Starting October 1st, 1990, a college for postgraduate and postdoctoral studies in mathematics will be instituted at Universität Bielefeld.

The main areas of research are: finite, discrete and Lie groups, potential theory, representation theory, topology, K-theory, combinatorics, numerical analysis, information theory and statistics.

Further information and application forms may be obtained from: Prof. Dr. Andreas Dress, Fakultät für Mathematik, Universität Bielefeld, Postfach 8640, 4800 Bielefeld 1, West-Germany (Telefax: (0521) 106-4743).

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OPERATOR THEORY/ OPERATOR ALGEBRAS AND APPLICATIONS

William B. Arveson
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Proceedings of Symposia in Pure Mathematics

Volume 51

American Mathematical Society

Operator theory has come of age during the last twenty years. The subject has developed in several directions using new and powerful methods that have led to the solution of basic problems previously thought to be inaccessible. In addition, operator theory has had fundamental connections with a range of other mathematical topics. For example, operator theory has made mutually enriching contacts with other areas of mathematics, such as algebraic topology and index theory, complex analysis, and probability theory. The algebraic methods employed in operator theory are diverse and touch upon a broad area of mathematics. There have been direct applications of operator theory to systems theory and statistical mechanics. And significant problems and motivations have arisen from the subject's traditional underpinnings for partial differential equations.

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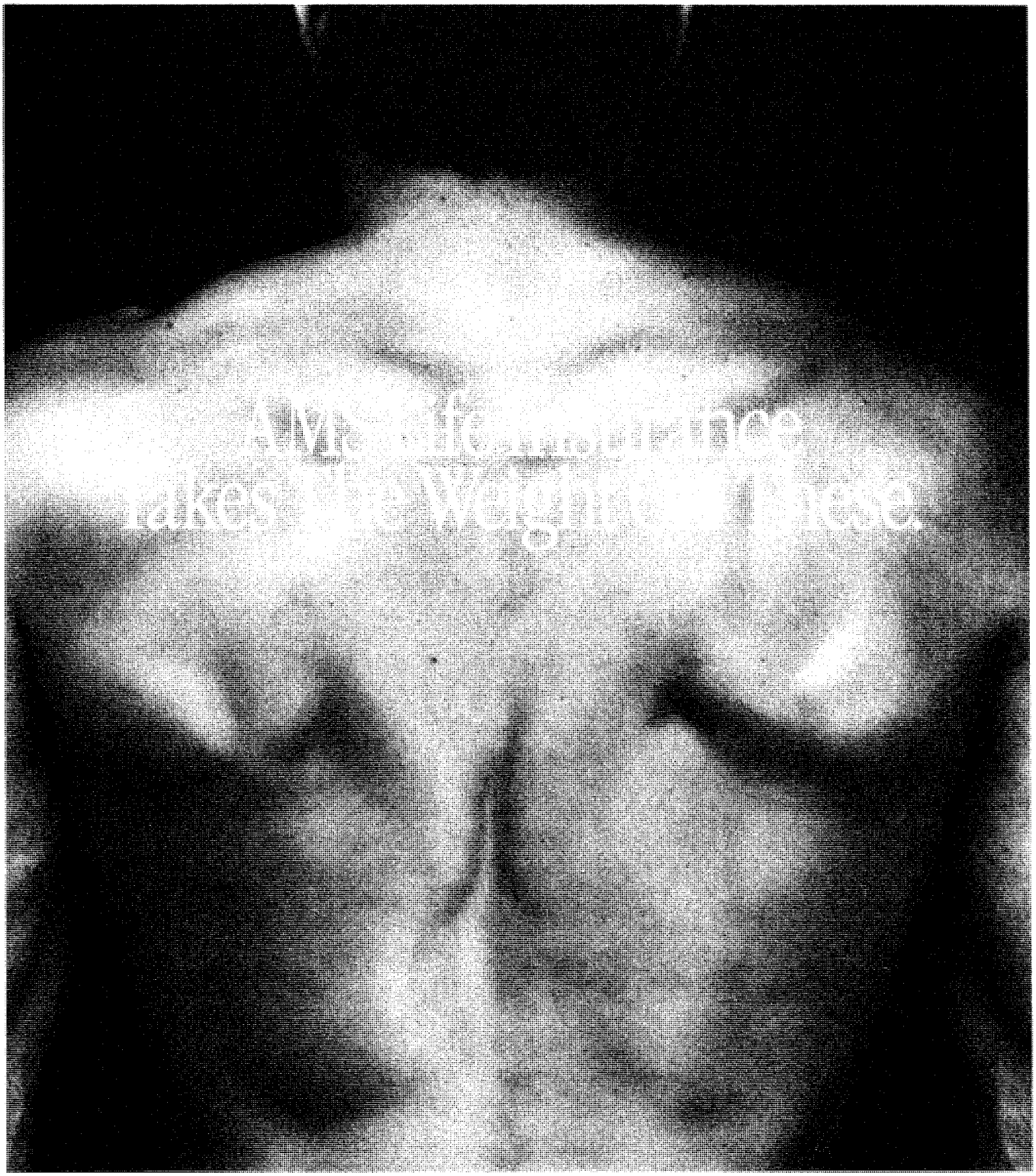

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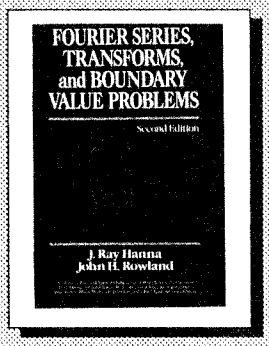

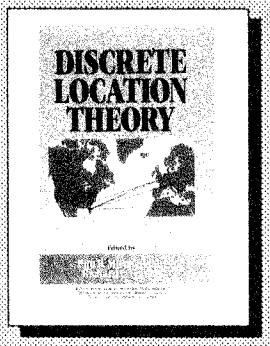

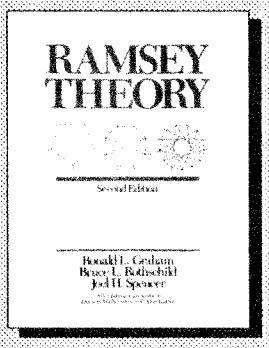

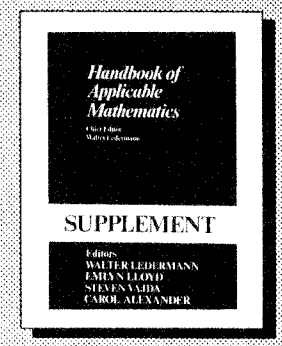

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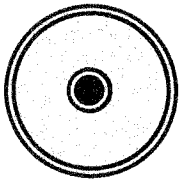

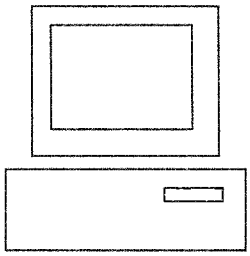

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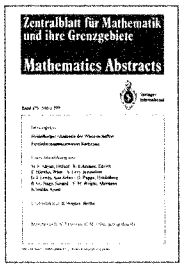

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Reciprocity member (please verify)[3] ..... ☐ $50 ☐ $75 ☐ $100

External member ..... ☐ $53

Multi-year membership ..... $ ..... for ..... years

1 Student Verification (sign below)

I am a full-time student at .....

..... currently working toward a degree.

2 Unemployed Verification (sign below) *I am currently unemployed and actively seeking employment. My unemployment status is not a result of voluntary resignation or of retirement from my last position.*

3 Reciprocity Membership Verification (sign below) *I am currently a member of the society indicated on the right and am therefore eligible for reciprocity membership.*

Reciprocating Societies

- ☐ Allahabad Mathematical Society
- ☐ Asociación Matemática Española
- ☐ Australian Mathematical Society
- ☐ Berliner Mathematische Gessellschaft e.V.
- ☐ Calcutta Mathematical Society
- ☐ Dansk Matematisk Forening
- ☐ Deutsche Mathematiker-Vereinigung e.V.
- ☐ Edinburgh Mathematical Society
- ☐ Gesellschaft für Angewandte Mathematik und Mechanik
- ☐ Glasgow Mathematical Association
- ☐ Indian Mathematical Society
- ☐ Iranian Mathematical Society
- ☐ Irish Mathematical Society
- ☐ Íslenzka Staerðfraeðafélagið
- ☐ Israel Mathematical Union
- ☐ János Bolyai Mathematical Society
- ☐ Korean Mathematical Society
- ☐ London Mathematical Society
- ☐ Malaysian Mathematical Society
- ☐ Mathematical Society of Japan
- ☐ Mathematical Society of the Philippines
- ☐ Mathematical Society of the Republic of China
- ☐ New Zealand Mathematical Society
- ☐ Nigerian Mathematical Society
- ☐ Norsk Matematisk Forening
- ☐ Österreichische Mathematische Gesellschaft
- ☐ Polskie Towarzystwo Matematyczne
- ☐ Punjab Mathematical Society
- ☐ Ramanujan Mathematical Society
- ☐ Real Sociedad Matemática Española
- ☐ Sociedad Colombiana de Matemática
- ☐ Sociedad de Matemática de Chile
- ☐ Sociedad Matemática de la Republica Dominicana
- ☐ Sociedad Matemática Mexicana
- ☐ Sociedade Brasileira Matemática
- ☐ Sociedade Brasileira de Matemática Aplicada e Computacional
- ☐ Sociedade Paranaense de Matemática
- ☐ Sociedade Portuguesa de Matemática
- ☐ Societat Catalana de Matemàtiques
- ☐ Société de Mathématiques Appliquées et Industrielles
- ☐ Société Mathématique de Belgique
- ☐ Société Mathématique de France
- ☐ Société Mathématique Suisse
- ☐ Southeast Asian Mathematical Society
- ☐ Suomen Matemaattinen Yhdistys
- ☐ Svenska Matematikersamfundet
- ☐ Union Mathemática Argentina
- ☐ Unione Matematica Italiana
- ☐ Vijnana Parishad of India
- ☐ Wiskundig Genootschap

.....

Signature

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(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
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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.

Customers in these areas should request price information from and direct their orders to the following distributors:
Europe/Middle East/Africa: Clarke Assoc.-Europe Ltd., 13a Small Street, Bristol BS1 1DE, England. Tel. 01-0272-268864, Telex 445591 CALORB G; Fax 0272-266437
Japan: Maruzen Co. Ltd., P.O. Box 5050, Tokyo International 100-31, Japan. Tel. Tokyo 272-7211, Telex J26516
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AMERICAN MATHEMATICAL SOCIETY
P. O. Box 6248
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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

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MAA Minicourse Preregistration Form, San Francisco, California

January 16–19, 1991

NOTE: This is NOT an AMS Short Course Form. Please use the Joint Meetings Pregistration/Housing Form to preregister for the AMS Short Course.

To register for MAA Minicourse(s), please complete THIS FORM or a PHOTOCOPY OF THIS FORM and return it with your payment to:

Linda Heineman
Mathematical Association of America
1529 Eighteenth Street, N.W.
Washington, DC 20036
Telephone: 202-387-5200

_____ Telephone: _____

(Please print) Surname First Middle

_____

Street address City State Zip

- Deadline for MAA Minicourse preregistration: November 16, 1990 (After this date, potential participants are encouraged to call the MAA headquarters at 800-331-1622.)
- Deadline for cancellation in order to receive a 50% refund: January 2, 1991
- Each participant must fill out a separate Minicourse Preregistration form.
- Enrollment is limited to two Minicourses, subject to availability.
- Please complete the following and send both form and payment to Linda Heineman at the above address:

  I would like to attend ☐ 1 Minicourse ☐ 2 Minicourses

  Please enroll me in MAA Minicourse(s): #____ and #____

  In order of preference, my alternatives are: #____ and #____

- PAYMENT

  Check enclosed: $ ____ Credit card type: ☐ MasterCard ☐ Visa

  Credit card # _____ Expiration date: _____

  _____ _____

  Your Employing Institution Signature (as it appears on credit card)

Minicourse Number and Name	Organized by	Fee
1. Calculus as a laboratory science	Marcelle Bessman	$60
2. The use of computing in teaching linear algebra	Eugene A. Herman & Charles H. Jepsen	$60
3. The mathematics of computer graphics	Jack Goldfeather	$36
4. Elementary robotics	Walter Meyer	$36
5. Using pocket computers to enhance the teaching and learning of precalculus and calculus	Bert K. Waits & Franklin Demana	$36
6. Pedagogical uses of Derive and GyroGraphics	Jerry Johnson & Benny Evans	$60
7. Symmetry analysis of repeated patterns	Donald W. Crowe	$36
8. The theory and application of discrete dynamics	James T. Sandefur	$36
9. Combinatorial designs	Walter D. Wallis	$36
10. Chaotic dynamical systems	Robert L. Devaney	$36
11. A survey of educational software	Virginia Knight & Vivian Kraines	$60
12. Writing in mathematics courses	George D. Gopen & David A. Smith	$36
13. Great theorems from mathematical analysis: 1689–1881	William Dunham	$36
14. Actuarial mathematics	Jonathan Kane	$36
15. Learning abstract algebra by programming in ISETL	Ed Dubinsky & Uri Leron	$60
16. A mathematician's introduction to the HP-48SX scientific expandable calculator for first-time users	John Kenelly & Don LaTorre	$36
17. Instituting a mathematics placement program: Creating order out of chaos in freshman mathematics	Mary McCammon	$36

☐ I plan on preregistering for the San Francisco, California meetings **ONLY** in order to attend the MAA Minicourse(s) indicated above. It is my understanding that, should the course(s) of my choice be filled, full refund of the San Francisco meetings preregistration fee will be made.

☐ I would like to preregister for the free Student Workshop organized by the MAA Committee on Student Chapters.

Instructions for Applicant's Form on facing page

The form. Applicants' forms submitted for the Employment Register will be photographically reproduced in the December 1990 issue of *Employment Information in the Mathematical Sciences (EIMS).* Résumés of only those attending will be posted at the meeting.

The forms **must be** carefully **typed** using a fresh black ribbon. The best results are obtained with a carbon-coated polyethylene film ribbon, but satisfactory results may be obtained using a ribbon made of nylon or other woven fabric if suitable care is exercised. It is important that the keys be clean and make a sharp, clear impression. Do not erase—it causes smudges which reproduce when photographed. Use a correcting typewriter or correction tape or fluid if necessary. Submit the original typed version only. Copies will not reproduce properly and are not acceptable. **Hand lettered forms will be returned. Do not type outside the box.**

Applicants' forms must be received by the Society by November 16, 1990 in order to appear in the special issue of *EIMS* and must be accompanied by the Preregistration/Housing Form printed in this issue, if attending the meeting.

(A) Specialties

AL = Algebra	AN = Analysis
BI = Biomathematics	BS = Biostatistics
CB = Combinatorics	CM = Communication
CN = Control	CS = Computer Science
CT = Circuits	DE = Differential Equations
EC = Economics	ED = Mathematical Education
FA = Functional Analysis	FI = Financial Mathematics
FL = Fluid Mechanics	GE = Geometry
HM = History of Math	LO = Logic
MB = Mathematical Biology	ME = Mechanics
MO = Modelling	MP = Mathematical Physics
MS = Management Science	NA = Numerical Analysis
NT = Number Theory	OR = Operations Research
PR = Probability	SA = Systems Analysis
ST = Statistics	TO = Topology

(B) Career Objectives

AR = Academic Research	AT = Academic Teaching
NR = Nonacademic R&D	NC = Nonacad. Consulting
NS = Nonacademic Supervision	

(H) (I) Duties

T = Teaching	U = Undergraduate
G = Graduate	R = Research
C = Consulting	A = Administration
S = Supervision	IND = Industry
GOV = Government	DP = Data Processing

Location

E = East		S = South
C = Central		M = Mountain
W = West	O = Outside U.S.	I = Indifferent

MATHEMATICAL SCIENCES EMPLOYMENT REGISTER

APPLICANT FORM JANUARY 16-18, 1991 SAN FRANCISCO, CALIFORNIA

1. **Form must be typed. (Please see instructions on facing page.)**
2. **This form CANNOT be submitted by electronic mail.**
3. **Hand lettered forms will be returned. Do not type beyond the box**
4. **Please check if Preregistration/Housing Form previously sent ☐**
5. **Return form with payment with your Preregistration/Housing Form by November 16 to AMS, P.O. Box 6887, Providence, RI 02940.**

APPLICANT: Name_____

CODE: Mailing address (include zip code) _____

_____

Ⓐ Specialties_____

Ⓑ Career objectives and accomplishments

ACADEMIC: ☐ Research, ☐ Teaching

NON-ACADEMIC: ☐ Research and Development, ☐ Consulting, ☐ Supervision

Near-term career goals_____

_____

Significant achievements or projects, including role_____

_____

Honors and offices_____

Other (e.g., paper to be presented at THIS meeting)_____

_____

Selected titles of papers, reports, books, patents_____

_____

Ⓒ Degree Year Institution

____ ____ _____ Ⓓ No. of abstracts, internal reports____

____ ____ _____ Ⓔ No. of papers accepted____

____ ____ _____ Ⓕ No. of books and patents____

EMPLOYMENT HISTORY:

	Present	Previous	Previous
Ⓖ Employer			
Position			
Ⓗ Duties			
Years	____ to ____	____ to ____	____ to ____

DESIRED POSITION:_____

Ⓘ Duties_____

Ⓙ Available mo.____ /yr.____ Location_____

Ⓚ References (Name and Institution)

_____

_____

_____

Ⓛ Citizenship: (check one) ☐ U.S. Citizen ☐ Non-U.S. Citizen, Permanent Resident

☐ Non-U.S. Citizen, Temporary Resident

Ⓜ AVAILABLE FOR INTERVIEWS:

(Interviews for Session 4 scheduled on the basis of employer's request only.)

Session 1 ☐	**Session 2** ☐	**Session 3** ☐	**Session 4** ☐
Thurs. AM 9:30-11:45	**Thurs. PM 1:15-5:00**	**Fri. AM 9:30-11:45**	**Fri. PM 1:15-5:00**

I do not plan to attend the San Francisco meetings ☐

EMPLOYER FORM MATHEMATICAL SCIENCES EMPLOYMENT REGISTER SAN FRANCISCO, CALIFORNIA JANUARY 16-18, 1991

This form CANNOT be submitted by electronic mail..

INSTRUCTIONS: Please read carefully before completing form below. **Circled** letters identify corresponding items in the FORM and the SUMMARY STRIP; abbreviations to be used are provided in the notes below. Please **print** or **type** in black ink. Block capitals are suggested. The FORM itself will be placed on display at the Register exactly as submitted. The SUMMARY STRIP (be sure to complete) will be used to prepare a computer printed list of summaries for distribution at the Register sessions. Employers are encouraged to provide more than one interviewer when they are able to do so, in order to increase the number of interviews which may be scheduled. Please take care to indicate on the Form the number of interviewers for whom simultaneous interviews may be scheduled. (If all interviewers will be interviewing for the same position, or for the same set of positions, only one form should be submitted and only one employer code number will be assigned; therefore, each interviewer would then receive a separate computer schedule and separate table number.) More than one employer code will be required if some interviewers will not interview for all positions. Thus, if there are two disjoint sets of positions, two forms are required and two employer codes will be assigned. **(Please refer to the section on the Employment Register following the San Francisco meeting announcement.) Return form with payment with your preregistrtion/Housing form by Nov. 16.**

EMPLOYER CODE Institution _____ Dept. _____

Name of Interviewer(s) 1. _____ 2. _____

3. _____ 4. _____

City, State, Zip _____

(A) Title(s) of Position(s) _____ (B) Number of Positions _____ Number of People Supervised _____

(C) Starting Date ____ / ____ (mo. / yr.) (D) Term of Appointment _____ yrs. (E) Renewal ( ) Possible ( ) Impossible Tenure Track Position Yes ( ) No ( )

Teaching hrs./wk _____ (F) Specialties Sought _____

(G) Degree Preferred _____ (H) Degree Accepted _____ (I) Duties _____ (J) Experience _____ (K) Citizenship Restriction _____

(L) **Available for Interviews**

Session 1 ( )	**Session 2 ( )**	**Session 3 ( )**	**Session 4 ( ) ***
Thurs. AM, 9:30-11:45	**Thurs. PM, 1:15-5:00**	**Fri. AM, 9:30-11:45**	**Fri. PM, 1:15-5:00**

(M) **Number of Interviewers** _____ **Interviewers** _____ **Interviewers** _____ **Interviewers** _____ **Interviewers**

Institution, City, State, (A) Title of position, (B) No., (C) Start mo. / yr.

(D) (E), (F) Specialities sought, (G) (H), (I) Duties, (J) Experience, (K), (L) Sessions

NOTES: (A) Inst, Lect, Asst Prof, Asso Prof, Prof, Dean, Open, MTS (Member Technical Staff), OPAN (Operations Analyst), PREN (Project Engineer), RESC (Research Scientist); (C) Date e.g. 01/91; (E) Possible=P, Impossible=I; (F) Algebra=AL, Analysis=AN, Biomathematics=BI, Biostatistics=BS, Combinatorics=CB, Communication=CM, Control=CN, Computer Science=CS, Circuits=CT, Differential Equations=DE, Economics=EC, Mathematical Education=ED, Functional Analysis=FA, Financial Mathematics=FI, Fluid Mechanics=FL, Geometry=GE, History of Mathematics=HM, Logic=LO, Mathematical Biology=MB, Mechanics=ME, Modeling=MO, Mathematical Physics=MP, Management Science=MS, Numerical Analysis=NA, Number Theory=NT, Operations Research=OR, Probability=PR, Systems Analysis=SA, Statistics=ST, Topology=TO; (G)(H) Bachelor=B, Master=M, Doctor=D; (I) (J) Teaching=T, Undergraduates=U, Graduates=G, Research=R, Consulting=C, Administration=A, Supervision=S, Industry=IND, Government=GOV, Data Processing=DP, no experience required=N; (K) U.S. Citizen=C, U.S. Citizen or permanent resident=CP, No restriction=NR; (L) Periods available for interviews: Check 1, 2, 3, and/or 4, see the FORM above.

* Interviews are scheduled in this session on the basis of employers request only.

Preregistration/Housing Form, San Francisco, California

January 16–19, 1991

Please complete this form and return it with your payment to
Mathematics Meetings Service Bureau
P.O. Box 6887, Providence, Rhode Island 02940 - Telephone: (401) 455-4143-Telex: 797192

DEADLINES:	Room Lottery Qualification	November 9, 1990
	Preregistration/Employment Register/Hotel Reservations	November 16, 1990
	Final Preregistration ONLY	December 17, 1990
	Housing Changes/Cancellations	December 12, 1990
	50% Refund Preregistration/Employment Register/AMS Short Course Cancellation	January 11, 1991 (no refunds after this date)
	Other Changes to Preregistration	January 2, 1991
	50% Refund on Banquets	January 2, 1991 (no refunds after this date)

		REGISTRATION FEES Preregistration by December 17, 1990	At Meeting
		$	$
JOINT MATHEMATICS MEETINGS			
	Member of AMS, CMS, MAA, NCTM	105	137
	Nonmember	163	212
*	Student, Unemployed, or Emeritus	25	33
AMS SHORT COURSE			
	Member/Nonmember	55	70
*	Student, Unemployed, or Emeritus	25	30
EMPLOYMENT REGISTER	- Employer fee (1st Interviewer)	120	160
	- Employer fee (2nd / 3rd Interviewer)	60	75
	- Applicant fee	25	40
	- Posting fee for job descriptions for noninterviewing employers	25	25

(N.B.: A separate form appears in this issue for preregistration for MAA Minicourses)

* All full-time students currently working toward a degree or diploma qualify for the student registration fees, regardless of income. The unemployed status refers to any person currently unemployed, actively seeking employment, and who is not a student; it is not intended to include persons who have voluntarily resigned from their latest position. The emeritus status refers to any person who has been a member of the AMS or MAA for twenty years or more and is retired on account of age or on account of long term disability from his or her latest position.

PREREGISTRATION SECTION: Please check the function(s) for which you are preregistering:

Joint Meetings ☐ AMS Short Course (January 14–15, 1991) ☐ Employer ☐ Co-Interviewer ☐ Applicant ☐ Posting ☐

1) _____ Telephone: _____
(Please print) Surname First Middle

2) _____
(Mailing address)
I do not wish my badge, program, and/or Employment Register material to be mailed; however, the mailing address for my acknowledgement is given above. ☐

3) Badge information: a) Nickname (optional):_____ b) Affiliation _____ c) City&State _____

4) I am a student at _____ 5) Emeritus member ☐ Unemployed ☐ MR Classification # _____

6) Member of AMS ☐ CMS ☐ MAA ☐ NCTM ☐ Nonmember ☐ Member of other organizations: AWM ☐ NAM ☐

7) Joint Meetings fee $ _____ 8) **AMS** Short Course fee $ _____ 9) Employer fee(s) $ _____ 10) Co-Interviewer fee(s) $ _____

11) Applicant fee $ _____ 12) Posting fee $ _____ 13) Hotel deposit $ _____ (**necessary ONLY if paying deposit by check**)

14) _____ AMS 25-Year Banquet ticket(s) @ $30 each = $ _____ 15) _____ NAM Banquet ticket(s) @ $32 each = $ _____

16) _____ MER Banquet ticket(s) @ $30 each = $ _____ 17) _____ AWM 20th Anniversary Banquet ticket(s) @ $30 each = $ _____

18) TOTAL AMOUNT ENCLOSED FOR 7 through 17 $_____ NOTE: May be paid by check payable to AMS (Canadian checks must be marked "U.S. Funds") or VISA or MasterCard credit cards.

Credit card type: _____; Card number: _____ ; Expiration date: _____
If this is your credit card, please print your name as it appears on the credit card on the line below as well as sign your name.
If this is not your credit card, please print card holder's name as it appears on the credit card on the line below, and have the card holder sign:

_____
(Printed name) (Signature)

Please complete the appropriate sections on the reverse.

For office use only:

Codes:	Options:	Hotel:	Room type:
Dates:	Hotel Deposit	Total Amt. Paid:	
Special Remarks:			

HOUSING SECTION: PREREGISTRATION/HOUSING FORM, San Francisco, California January 16–19, 1991

☐ PLEASE CHECK HERE IF YOU WILL **NOT** REQUIRE A ROOM ☐ PLEASE CHECK HERE IF YOU WILL BE STAYING AT A HOTEL/MOTEL **NOT** LISTED BELOW

EVEN IF HOUSING IS NOT NEEDED, PLEASE GIVE ARRIVAL/DEPARTURE DATES BELOW.

Please rank hotels in order of preference by writing 1, 2, 3, etc. in the spaces at the left on form, and by circling the requested room type and rate. If the rate requested is no longer available, you will be assigned a room at another hotel at the next available rate. **If not all hotels are ranked, and all rooms have been filled at the ranked hotels, the assignment will be made at an unranked hotel with the next available rate.** Rates listed below are subject to 11% sales/occupancy tax.

The hotels listed below are full service hotels. The Hilton, Handlery, and Raphael offer a **LIMITED** number of nonsmoking rooms. All of the rooms in the King George have windows that open. The Mark Twain does not have nonsmoking rooms. The hotels listed below are equipped for handicapped; however, the King George is not equipped for the handicapped with wheelchairs. Special attention will be given to participants with special needs. Please note that the King George and the Raphael offer a limited number of twin beds.

GUARANTEE REQUIREMENTS: $50 by check **OR** a credit card guarantee with VISA, MasterCard, or American Express (for housing only). No other credit cards will be accepted for room guarantees. PLEASE SUPPLY THIS INFORMATION ON THE REVERSE, together with mailing address for confirmation of room reservation.

Order of choice		Single	Double 1 bed	Double 2 beds	Triple 2 beds	Triple 2 beds w/cot	Quad 2 beds	Quad 2 beds w/cot	Suites* (starting rates)
	Hilton (Headquarters Hotel)	**(See Hilton categories below.)**							
	Deluxe	107	120	120	140	N/A	160	N/A	192 +
	Superior	95	107	107	127	N/A	147	N/A	192 +
	Standard - Regular	82	95	95	115	N/A	135	N/A	192 +
	Standard - Student or Unempl.**	65	65	65	65	N/A	65	N/A	192 +
	Handlery Hotel	75	75	75	85	N/A	95	N/A	125 +
	King George Hotel	71	75	N/A	N/A	N/A	N/A	N/A	178
	Hotel Mark Twain	70	70	70	N/A	85	N/A	N/A	165
	The Raphael	69	69	N/A	N/A	N/A	N/A	N/A	110 +

*** Reservations for suites must be made directly with the Service Bureau. The hotel can supply general information only.**

**** Participant must be a certified student or unemployed (as described on the opposite side of this form) to qualify for these rates.**

Special housing requests, handicapped needs, etc.: _____

I will arrive on (date) _____ at _____ a.m./p.m., and depart on (date) _____ at _____ a.m./p.m.

Please list other room occupants; indicating ages of children.

FULL NAME ARRIVAL DATE DEPARTURE DATE

_____

_____

Wadsworth & Brooks/Cole Advanced Books & Software

Probability: Theory and Examples
Richard Durrett

This text for a one-year graduate course in probability emphasizes results that can be used to solve problems. It assumes readers are familiar with measure theory, but provides proofs of the necessary facts in an appendix. Unusual topics include large deviations, local limit theorems, renewal theory, Markov chains on general state space, subadditive ergodic theory, and central limit theorems for stationary sequences and martingales. This book will be a useful reference for people who study probability or apply it in their work.
1991. 464 pages. Casebound. ISBN: 0-534-13206-5.

Complex Variables, Second Edition
Stephen D. Fisher

This undergraduate text for mathematics or engineering majors offers a direct route to the most important topics in the theory and applications of complex variables. Hundreds of solved examples, exercises, and applications help readers appreciate complex variables as both a practical tool and a mathematical structure of enormous beauty and elegance. The new edition offers a number of improvements in the exposition, including a rewritten and reorganized discussion of Cauchy's Theorem.
1990. 426 pages. Casebound. ISBN: 0-534-13260-X.

Introduction to Holomorphic Functions of Several Variables, Volumes I - III
Robert C. Gunning

These volumes provide an extensive introduction to the Oka-Cartan theory of holomorphic functions of several variables and holomorphic varieties. Each volume covers a different aspect and can be read independently.
Volume I: Function Theory. 1990. 206 pages. Casebound. ISBN: 0-534-13308-8.
Volume II: Local Theory. 1990. 300 pages. Casebound. ISBN: 0-534-13309-6.
Volume III: Homological Theory. 1990. 225 pages. Casebound. ISBN: 0-534-13310-X.

A Dictionary of Real Numbers
Jonathan M. Borwein and Peter B. Borwein

This book is designed for researchers who have encountered various numbers computationally and want to know if these numbers have some simple form. The book lists more than 100,000 eight-digit real numbers in the interval [0, 1) that arise as the first eight digits of special values of familiar functions. Generated by **Maple** and typeset in TeX, the book includes elementary and special functions, simple algebraic and transcendental constants, rational combinations of constants, common physical constants, real roots of cubic polynomials with small integer coefficients, and much more.
"*An invaluable aid to mathematicians who do computer-assisted research.*"
American Mathematical Monthly, June-July, 1990.
1990. 434 pages. Casebound. ISBN: 0-534-12840-8.
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