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Calendar of AMS Meetings

THIS CALENDAR lists all meetings which have been approved by the Council 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 yet been assigned. *Programs* of the meetings will appear in the issues indicated below. *First* and *supplementary* announcements of the meetings will have appeared in earlier issues.

ABSTRACTS OF PAPERS presented at a meeting of the Society are published in the journal *Abstracts of papers presented to the American Mathematical Society* in the issue corresponding to that of the *Notices* which contains the program of the meeting. Abstracts should be submitted on special forms which are available in many departments of mathematics and from the headquarter's 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.

MEETING #	DATE	PLACE	ABSTRACT DEADLINE	ISSUE
837	October 30–November 1, 1987	Lincoln, Nebraska	EXPIRED	October
838	November 14–15, 1987	Los Angeles, California	EXPIRED	October
839	January 6–9, 1988* (94th Annual Meeting)	Atlanta, Georgia	October 8	January
840	March 18–19, 1988	East Lansing, Michigan	December 14	February
841	March 25–26, 1988	Knoxville, Tennessee	January 18	March
842	April 23–24, 1988	College Park, Maryland	February 29	April
	August 8–12, 1988 (AMS Centennial Celebration)	Providence, Rhode Island		
	January 11–14, 1989 (95th Annual Meeting)	Phoenix, Arizona		
	January 17–20, 1990 (96th Annual Meeting)	Louisville, Kentucky		

* Preregistration/Housing deadline is November 6.

	DEADLINES		
Advertising	(*Nov.* 1987 *Issue*) *Sept.* 30, 1987	(*Jan.* 1988 *Issue*) *Nov.* 9, 1987	(*Feb.* 1988 *Issue*) *Dec.* 28, 1987
News	(*Nov.* 1987 *Issue*) *Sept.* 14, 1987	(*Jan.* 1988 *Issue*) *Nov.* 6, 1987	(*Feb.* 1988 *Issue*) *Dec.* 25, 1987
SMIC	(*Nov.* 1987 *Issue*) *Sept.* 14, 1987	(*Jan.* 1988 *Issue*) *Oct.* 26, 1987	(*Feb.* 1988 *Issue*) *Dec.* 14, 1987

Other Events Sponsored by the Society

January 5–6, 1988, AMS Short Course: Computational Complexity Theory, Atlanta, Georgia. Details: This issue.

February 13–14, 1988, Symposium on American Mathematics Entering its Second Century. Boston, Massachusetts. Details: This issue.

May 29–June 4, 1988, Symposium on The Legacy of John von Neumann, Hofstra University, Hempstead, New York.

June 4–August 11, 1988, Joint Summer Research Conferences in the Mathematical Sciences, Bowdoin College, Brunswick, Maine. Details: This issue.

July 3–23, 1988, Summer Research Institute on Operator Theory/Operator Algebras and Applications.

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Volume 34, Number 6, October 1987

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Notices: highlights

The 1987 Steele Prizes were awarded at the Summer Meeting in Salt Lake City to Martin Gardner for expository writing, Wendell Fleming and Herbert Federer for a fundamental paper, and Samuel Eilenberg for his mathematical career. Page 875.

Research Centers are examined. A feature article, "Science and Technology Centers: New Opportunities for Research Support in the Mathematical Sciences," analyzes the current plans for funding research centers and looks at existing centers. Page 879. A panel at the National Academy of Sciences has issued recommendations for the implementation of the NSF program on Science and Technology Centers. Page 887. A preliminary announcement of the NSF Science and Technology Centers Program gives deadlines and sources for additional information. Page 909.

The Commentary on Defense Funding dialog continues with several letters from the mathematical community. Page 895.

Kenneth Hoffman, in his Washington Outlook column, describes the plans for "100 Years of American Mathematics," a year-long event which builds on the AMS Centennial Celebration and encourages people to attend opening events at the Atlanta Meeting. Page 898.

National Academy of Sciences will present a new award, the NAS Award in Mathematics. This award was funded by the AMS and will be presented for the first time in 1988 in conjunction with the AMS Centennial Celebration. Page 904.

Computing in Undergraduate Mathematics is an issue paper prepared by Paul Zorn to examine the role played by computing in undergraduate mathematics programs. Page 917.

Atlanta Meeting, January 6–9, 1988. The first announcement contains information about invited speakers, a timetable for sessions and lectures, and registration information. Events associated with "100 Years of American Mathematics" are highlighted. Page 951.

Business and Council Meeting reports contain information about the motions on defense funding and plans for a referendum to the AMS membership. Page 1013.

1987 Steele Prizes Awarded at Summer Meeting in Salt Lake City

Three Leroy P. Steele Prizes were awarded at the Society's ninetieth Summer Meeting in Salt Lake City, Utah.

The Steele Prizes are made possible by a bequest to the Society by Mr. Steele, a graduate of Harvard College, Class of 1923, in memory of George David Birkhoff, William Fogg Osgood, and William Caspar Graustein.

Three Steele Prizes are awarded each Summer: one for expository mathematical writing, one for a research paper of fundamental and lasting importance, and one in recognition of cumulative influence extending over a career, including the education of doctoral students. The current award is $4,000 for each of these categories.

The recipients of the Steele Prizes for 1987 are MARTIN GARDNER for the expository award; HERBERT FEDERER and WENDELL H. FLEMING for research work of fundamental importance; and SAMUEL EILENBERG for the career award.

The Steele Prizes are awarded by the Council of the Society, acting through a selection committee whose members at the time of these selections were Frederick J. Almgren, Richard W. Beals (Chairman), Jerry L. Bona, Hermann Flaschka, John P. Hempel, William S. Massey, Lawrence E. Payne, Frank A. Raymond, Louis Solomon, and Richard P. Stanley.

The text that follows contains the Committee's citations for each award, the recipients' responses at the prize session in Salt Lake City, and a brief biographical sketch of each of the recipients. Professor Federer and Dr. Gardner were unable to attend the Summer Meeting to receive the prize in person. They did, however, send written responses to the award. Professor Eilenberg is out of the country at this time and could not be reached prior to the awarding of this prize.

Expository Writing

Martin Gardner

Citation

The 1987 Steele Prize for expository writing is awarded to MARTIN GARDNER for his many books and articles on mathematics, and particularly for his column "Mathematical Games" in *Scientific American*. Martin Gardner has introduced generations of readers to the intellectual excitement, the wonder, the variety, and the sheer fun of mathematics and mathematical ways of thought. With Dr. Matrix and his other friends, he has exposed spurious thinking and the misuse of mathematics in areas from numerology to economics. Martin Gardner has captured the attention of his readers, obtained their active involvement, and stretched their minds to an extent which is the envy of all of us who teach.

Martin Gardner

Response

Had I not developed a strong interest in philosophy when I was an undergraduate at the University of Chicago, I might have majored in mathematics, become a professional, and perhaps made some contributions to the field. As it happened, I had no formal training in math, only an amateur's passion for its marvels, and admiration and awe for its leaders. I think of myself as like a person who loves classical music, but whose talents never advanced beyond playing simple tunes on a musical saw.

There is no better way to teach oneself mathematics than to write about it. Every column I completed for *Scientific American* was a learning experience that gave me intense pleasure. If I have been able to convey to others something of the fascination of mathematics, it is because I did not know enough to write about it on a

technical level. Fortunately, my blunders were promptly called to my attention by readers, and I am able to bury most of them when I revise my columns for book collections.

At the risk of offending a few good friends, let me say I am a hopeless, unashamed Platonic realist. I think mathematicians discover theorems that in some sense are "out there," independent of human minds. I believe that when two trilobites crawled onto a rock to join two other trilobites, it made four trilobites on the rock even though no humans observed it and the trilobites were unaware of it. I believe that if humanity is ever exterminated by a nuclear holocaust, the orbits of planets will still approximate ellipses, and that the Pythagorean theorem will still hold for Euclidean geometry in all possible (noncontradictory) worlds.

To be given a Steele Prize, is the greatest honor I can imagine myself receiving. I rate it many cuts above obtaining, as I expect to next year, an Erdős number of 2.

Biographical Sketch

Martin Gardner was born in Tulsa, Oklahoma, October 21, 1914. After receiving a BA degree at the University of Chicago in 1936, he worked at various jobs including newspaper reporter, social worker, and publicity writer, until he enlisted in the Navy in 1941. Following World War II, he returned briefly to the University of Chicago, where he did graduate work in philosophy under Rudolf Carnap, later collaborating with Carnap on an *Introduction to the Philosophy of Science* (1966).

His first Mathematical Games column in *Scientific American* was an article on hexaflexagons in 1956. The column appeared monthly for 25 years, until Gardner retired in 1981 to the mountains of western North Carolina. Eleven book collections of his columns have been published. The twelfth, *Time Travel and Other Mathematical Bewilderments*, is scheduled for this fall. A third collection of his puzzle columns in *Asimov's Science Fiction Magazine* will be published this winter by the Mathematical Association of America.

Gardner's other books on recreational math include *Mathematics, Magic, and Mystery* (1956), *Aha! Insight* (1978), *Aha Gotcha!* (1982), and several puzzle books for children. He is also the author of *Logic Machines and Diagrams* (1958) and numerous books about philosophy, science, and literature, of which the best known is his *Annotated Alice* (1960).

Gardner received an honorary doctorate in 1978 from Bucknell University, and in 1983 was given the American Institute of Physics/U.S. Steel Foundation Award for science writer of the year.

Fundamental Paper

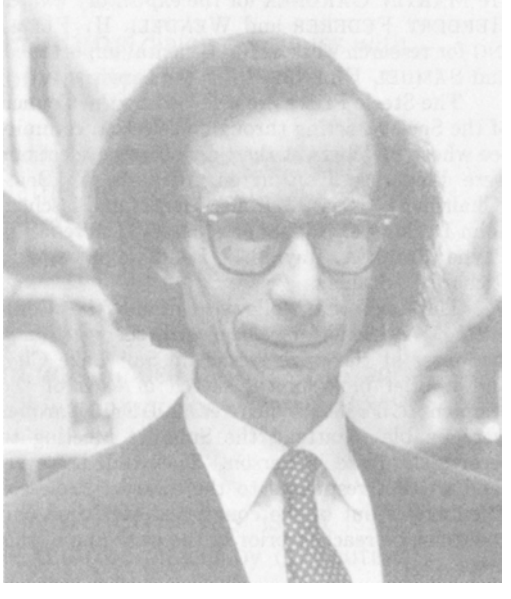
Herbert Federer and Wendell Fleming

Citation

The 1987 Steele Prize for a paper which has proved to be of fundamental or lasting importance in its field is awarded to HERBERT FEDERER and WENDELL FLEMING for their pioneering paper

Normal and integral currents, Annals of Mathematics **72** (1960), pages 458-520.

This paper gave birth to geometric measure theory, introducing and studying the "integral currents" which now appear to be the natural setting for the geometric calculus of variations in higher dimensions. Among the paper's striking achievements are the *Compactness Theorem*, giving the existence of minimizing integral currents representing integral homology classes, and the *Deformation Theorem*, which yielded the first isoperimetric inequality in general dimensions and codimensions. The methods and ideas introduced here revolutionized the study of geometric variational problems and provided the foundation for developments still in vigorous flower.



Herbert Federer

Response from Federer

With regrets that a prior commitment prevents me from attending this meeting, I am writing to express my sincere gratitude for the award of a Steele Prize.

Work on *Normal and Integral Currents* was a special pleasure because it accomplished the merger of measure theory with homology theory. Now general isoperimetric inequalities illustrate this connection. Intersection chains can be constructed through differentiation of measures. The

compactness of certain classes of chains is related both to density and projection properties of Hausdorff measures, and to deformations patterned after simplicial topology. Those limiting currents, which solve elliptic minimum problems of the multidimensional calculus of variations, are partially smooth in the sense of classical differential geometry, but often have essential singularities whose structure still presents extremely challenging questions.

I hope very much that this first award of a prize for work in geometric measure theory will encourage future research in the subject.

Biographical Sketch

Herbert Federer was born on July 23, 1920, in Vienna, Austria. He immigrated to the United States in 1938 and became a naturalized citizen in 1944. During 1944 and 1945 he served in the U.S. Army. He was educated at the University of California in Berkeley, receiving the degrees B.A. in Mathematics and Physics in 1942, and Ph.D. in Mathematics in 1944.

Since 1945 Herbert Federer has been a member of the Mathematics Department of Brown University. He became a full professor in 1951, Florence Pirce Grant University Professor in 1966, and Professor Emeritus in 1985.

Professor Federer has been a member of the American Mathematical Society since 1943. He served on the Invitations Committee for the 1958 Summer Institute, as an Associate Secretary during 1967 and 1968, and as Representative on the National Research Council from 1966 to 1969. He delivered an Invited Address (New York City, April 1951) and was a Colloquium Lecturer (Seattle, August 1977).

Professor Federer was an Alfred P. Sloan Research Fellow (1957-1960), a National Science Foundation Senior Postdoctoral Fellow (1964-1965), and a John Simon Guggenheim Memorial Fellow (1975-1976). He has been a Fellow of the American Academy of Arts and Sciences since 1962, and a Member of the National Academy of Sciences since 1975.

The major part of Professor Federer's scientific effort has been directed to the development of the subject of Geometric Measure Theory, with its roots and applications in classical geometry and analysis, yet in the functorial spirit of modern topology and algebra. This work includes more than thirty research papers published between 1943 and 1986, as well as a book published in 1969.

Response from Fleming

I would like to express my profound thanks for the award of the Steele Prize.

The paper by Federer and myself cited was a step in the development of what has since been called geometric measure theory. In the research during 1959 which led to this paper, we sought a theory dealing with objects which from the standpoint of algebraic topology behaved like chains with integer or real coefficients. The theory needed to be broad enough to allow for integration of differential forms over objects which differ in small measure from pieces of oriented manifolds of class C^1. Moreover, the class of objects admitted was required to have compactness properties needed to obtain existence theorems for geometric problems of the calculus of variations, including the problem of least area in arbitrary dimension.

Wendell Fleming

De Rham's theory of currents provided the setting in which to define these objects, which we called integral or normal currents in the respective cases of integer or real coefficients. We were significantly influenced by earlier results of a number of people, including works of De Giorgi and Federer on measure-theoretic extensions of the Gauss-Green theorem and L.C. Young's theory of generalized surfaces.

Within a few years after this paper was written I left geometric measure theory to work on different topics. Other mathematicians have carried on the tasks of developing geometric measure theory and of identifying its connections with other areas of mathematics. It is not an easy field. Such problems as to characterize the singularities of area minimizing integral currents have proved to be especially challenging. Even at the early stages connections were apparent between geometric measure theory and such areas as calculus of variations, nonlinear elliptic partial differential equations and complex varieties. It is pleasing that more recently applications, perhaps unexpected, to such topics as structural mechanics and liquid crystal theory have also been found.

Biographical Sketch

Wendell H. Fleming was born March 7, 1928, in Guthrie, Oklahoma. He received his Ph.D. in 1951 from the University of Wisconsin.

Professor Fleming worked as a mathematician at Rand Corporation beginning in 1951 before becoming an assistant professor at Purdue University (1955–1958). Professor Fleming has been at Brown University ever since, advancing from assistant professor (1958–1960) to associate professor (1960–1963) to professor (1963–present). He has served as chairman of the Mathematics Department and of the Division of Applied Mathematics at Brown.

Professor Fleming has served on a number of Society committees including the Committee on Employment and Educational Policy, 1975–1977, the Committee on Employment and Educational Policy's Data Subcommittee (1977–1981), and the Nominating Committee (1978–1979).

Professor Fleming has given Invited Addresses at the Summer Meeting (Missoula, August 1973), the Symposium on Stochastic Differential Equations (New York City, March 1972), the Special Session on Approximate Solutions of Random Equations (Atlanta, January 1978), the Short Course on Introduction to Systems and Control Theory for Mathematicians (Providence, August 1978), and a Special Session on Stochastic Analysis (Ann Arbor, August 1980).

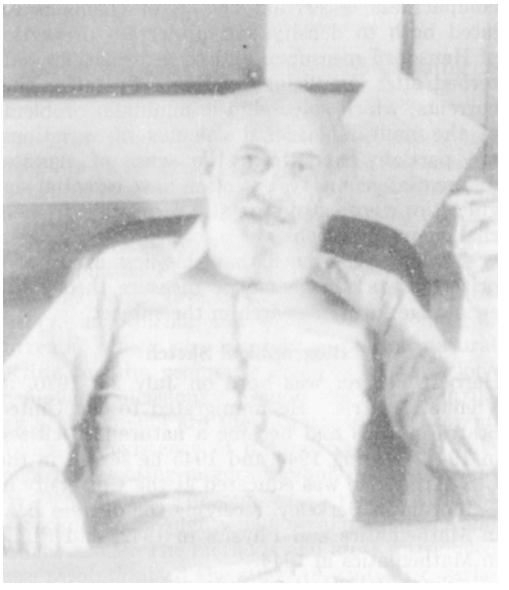
Professor Fleming was a National Science Foundation Postdoctoral Fellow (1968–1969) and a Guggenheim Fellow (1976–1977).

Career Award

Samuel Eilenberg

Citation

The 1987 Steele Prize for cumulative influence is awarded to SAMUEL EILENBERG for his fundamental contributions to topology and algebra. Eilenberg's classic papers on singular homology and his work with Steenrod on axiomatic homology theory had a profound influence on the development of algebraic topology. The Eilenberg-Zilber theorem is basic in singular homology theory, and the Eilenberg-Moore spectral sequences are a powerful tool for fiber spaces. With Mac Lane, Eilenberg founded category theory and advanced the study of group homology and cohomology; with Cartan, he founded cohomological algebra. By his example, his energy, his enthusiasm, and his encouragement of others, Eilenberg has left his mark on topology, on algebra, and on mathematics in America.



Samuel Eilenberg

Biographical Sketch

Samuel Eilenberg was born September 30, 1913, in Warsaw, Poland. He earned his M.A. in 1934 and his Ph.D. in 1936 from the University of Warsaw.

Professor Eilenberg advanced from instructor to associate professor of mathematics at the University of Michigan (1940-1946). He was a professor at Indiana University from 1946-1947. Since 1947, he has been a professor at Columbia University, and since 1981 he has been an emeritus professor there.

Professor Eilenberg served as a Member-at-Large of the Council (1947-1949) and as Vice President of the American Mathematical Society (1966-1967). He has served on a number of Society committees including the Transactions Editorial Committee (1948-1953), the Committee on Translations of Russian and Other Foreign Languages (1948-1951), the Committee on Visiting Lectureships (1956-1959), the Committee on Graduate Programs in Mathematics (1963), and the Colloquium Editorial Committee (1973-1978).

Professor Eilenberg gave Invited Addresses at the Summer Meeting (New Brunswick, September 1945) and at the Annual Meeting (Pittsburgh, December 1954). He gave an hour address at the International Congress of Mathematicians in 1958. He was a Colloquium Lecturer (Toronto, Summer 1967), and he spoke at the Symposium on Applications of Categorical Algebra (New York, April 1968).

Professor Eilenberg was a Guggenheim Fellow and a Fulbright Scholar (1950-1951). He is a member of the National Academy of Sciences.

Science and Technology Centers: New Opportunities for Research Support in the Mathematical Sciences

Research centers are not a new phenomenon in federal support of scientific research, but they are receiving a new attention from federal policymakers. One significant indication of this attention is the initiative of the National Science Foundation (NSF) to establish over the next five years new Science and Technology Centers. The centers are intended to promote research and education in science and technology in order to enhance the nation's economic strength. This article will discuss the NSF's plans and describe some examples of collaborative research having a mathematical focus.

History of the Centers Initiative

The NSF has had a significant amount of experience with centers in several disciplines. For example, the NSF has established over the past seventeen years twelve Materials Research Laboratories, that stress large-scale interdisciplinary research and the joint use of facilities. In addition, forty-five Industry/University Cooperative Centers have been established over the last fifteen years, combining more focused research with extensive industrial participation. They are jointly funded with industry from the outset and are required to become self-sufficient within five years.

It was the establishment of the NSF's Engineering Research Centers (ERCs), beginning in 1985, that marked the start of the current trend toward centers. George A. Keyworth II, former White House Science Adviser, and Erich Bloch, Director of the NSF, have promoted the idea of the ERCs as a means of utilizing the research capabilities of universities and facilitating the transfer of knowledge to industry. Emphasizing interdisciplinary research and industrial participation, the ERCs conduct projects ranging from basic research to technology transfer. The NSF intends to add more ERCs to the thirteen currently operating and has asked Congress for an increase for the ERC program from its present budget of $30 million to $48 million for fiscal year 1988.

The ERC program forms part of a broader scheme for the establishment of centers focusing on science and technology problems of national importance. Amid the current concern over the United States' trade deficit and the threat to its position as world leader in technological developments, the centers are seen by many political leaders as a means for economic rejuvenation.

Another milestone in the development of the NSF's centers initiative was a report, released in February 1986, by the Panel on the Health of U.S. Colleges and Universities, convened by the Office of Science and Technology Policy. Known as the Packard-Bromley report, it recommended the establishment of federally funded, university-based "research and technology centers" to address interdisciplinary problems of "broad national need and related to industrial technology."

The Packard-Bromley report further heightened enthusiasm for centers. In January 1987, President Reagan made the following announcement in his State of the Union address: "... I am proposing that we double over five years the budget of the National Science Foundation. My Administration will establish a number of new government-private 'science and technology centers' based at U.S. universities. These centers will focus on fundamental science that has the potential to contribute to our nation's economic competitiveness..." With this support from the Reagan Administration, NSF Director Bloch obtained a commitment from the Office of Management and Budget to double the NSF budget over the next five years. In addition, the President signed in April an Executive Order instructing all federal departments and agencies to investigate the feasibility of using the centers approach in their activities.

The Zare Report

The most recent development in the NSF's centers initiative came in June, when a panel of the National Academy of Sciences (NAS) released a report on Science and Technology Centers ("Science and Technology Centers: Principles and Guidelines," National Academy of Sciences, 1987). The NAS convened the panel in response to a request from Bloch for guidance on several policy matters concerning the formation and management of the centers. The panel consisted of scientists from both academia and industry and included mathematician D. J. Lewis of the University of Michigan. The report has been dubbed the "Zare Report," after the panel's chairman,

Richard N. Zare, Professor of Chemistry at Stanford University. (The full text of the report appears in this issue of *Notices.*)

Among the main recommendations of the Zare Report is that the centers should have the following features.

- They should have an intellectual focus on a theme that is best addressed by the collaboration of several scientists, within either a single discipline or several disciplines.
- They should be campus-based, led by regular faculty, and integrated into academic programs, with a tangible university commitment.
- They should provide education, training, and outreach programs involving undergraduate and graduate students, postdoctoral researchers, industrial fellows, and others.
- They should have a finite life with stable funding for a period not exceeding nine years. (The NSF has since extended the period to eleven years.)
- The annual cost to the NSF will typically be from $1 million to $5 million, but may be as low as $500,000 or as high as $10 million.

While the panel endorsed centers as an effective means of research in some scientific areas, some of the report's recommendations are at variance with the NSF's original plans for certain key features of the centers. The Zare Report's recommendations may alleviate some apprehensions the mathematical community has had about the centers initiative and may open up new opportunities for mathematicians to participate in the initiative.

For example, industrial participation, which had often been spoken of as a requirement for the centers, was not seen as such by the panel. The Zare Report does say, "Center proposals should include plans for involving the relevant research community beyond the sponsoring university—at other universities, colleges, and non-profit research organizations and in industrial and government laboratories." But, going on to say that "[corporate participation] should not be a prerequisite of science-based centers," the report states, "although leveraging the NSF investment is desirable, it should *not* be the primary reason for attracting the participation of industry, state governments, or other sectors." The report emphasizes the goal of encouraging "intellectual exchanges on a scale and frequency that do not ordinarily occur between the university and outside communities."

Another cause for concern within the mathematical community is that the centers had almost always been spoken of as involving interdisciplinary research. The panel relaxed any such prerequisite by saying that "a center's 'theme' or intellectual focus ... may derive from a single discipline or several disciplines."

But the greatest fear within the scientific community seems to be the expectation that the establishment of centers will undermine the traditional mode of funding individual investigators. This concern has been especially strong in the mathematical community because there are many areas of mathematics in which it seems clear that the individual investigator approach is, and will continue to be, the most suitable research mode.

On this sensitive topic, the Zare Report repeatedly cautions that the support of individual investigators should not decline because of the centers. "The major issue in inaugurating a new program of Science and Technology Centers is one of balance among modes of research support," the report states. "Individual investigator support has been enormously successful for the National Science Foundation and productive for the nation. Its preeminence must not be diminished." Indeed, the report goes so far as to say that if the NSF's budget "remains static or declines,... the projected budget of the NSF Science and Technology Centers program should be reduced proportionately." The panel received assurances from Bloch that, although he intends the number of centers to triple over the next five years, centers will never comprise more than 10% of the total NSF budget. In addition, 60% of the NSF budget will continue to go to individual investigators and small groups.

The Zare panel was hesitant to predict the focus and form of the centers. Although Bloch had asked the panel to name some of the "most promising areas of science where these centers can make a significant difference," the panel said in the report that to make any such predictions "might inadvertently steer researchers away from areas of even greater promise or prejudice the review process." "The science should determine what a center is and does, not the reverse," the report states, and the centers should "exhibit diverse forms of organization, participation, and operation." However, the report does propose three possible "models" for a center:

- a center organized around an intellectual theme requiring a "critical mass of researchers from within a single discipline or from several disciplines;"
- a center "organized around a common facility, set of experimental techniques, a common database, or research instruments." (Later the report notes that a center "must be more than merely a provider of services.");
- a center "without walls:" a network of research scientists at several instututions that interact frequently by electronic or other means.

Although the NSF has embraced the recommendations of the Zare Report with few amendments, it is not clear how influential the report ultimately will be. The report appears to have broadened the NSF's conception of the centers by relaxing certain conditions, such as industrial participation and interdisciplinary research. But some at the NSF feel that, because these same

conditions formed the basis of the centers initiative and have supplied much of its momentum, many of the proposals chosen are likely to fulfill those criteria, especially since those who have begun formulating proposals for centers are likely to have been including those criteria in their plans.

Nevertheless, mathematicians should look upon the centers initiative as a new opportunity for enhancing support of mathematics research. D. J. Lewis, the University of Michigan mathematician who was on the Zare panel, has told *Notices* that the mathematical community should be imaginative in its response to the centers initiative. Lewis and others on the Zare panel view the first round of centers proposals as an educational process in which the NSF will learn from the scientific community the most appropriate forms and functions of centers. Therefore mathematicians should not feel constrained by any preconceived notions of what the centers might be, for, according to Lewis, if the NSF receives enough proposals that are worthy of support but that do not exactly fit the centers criteria, then the NSF may be persuaded to change those criteria for future centers competitions. If, for example, good, creative mathematics can be done on a budget of less than the $500,000 floor that the Zare Report recommended for centers budgets, then there is no reason to enlarge the project to force it to fulfill the NSF's expectations. The planning and formulation of the proposals should be directed by the mathematical goals and not by what one thinks the NSF wants to see.

The Zare Report concentrated on centers and did not study other modes of research support. Wishing to remind the scientific community of the importance of a more extensive study, the panel's chairman made the following statement in the preface to the report. "The panel, in its brief lifetime, was unable to undertake a thorough examination and evaluation of the relative strengths and weaknesses of different modes of research support—from individual investigator grants to group awards to centers in various forms. Such an examination is needed and is under way by a panel of the Committee on Science, Engineering, and Public Policy (COSEPUP) of the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. That report is expected to be available early in 1988."

The NSF's Plans

On August 21, the National Science Board, the policy-making arm of the NSF, approved a program announcement for the first round of the centers competition. The announcement, made available in mid-September, describes specific guidelines for proposal preparation and explains the evaluation criteria. (For information on the announcement and how to obtain one, see **News and Announcements** in this issue of *Notices*.)

The most important criteria on which the proposals will be judged are the scientific merit of the proposed research and the relevance of the center mode to that research. Proposals should address research topics for which the complexity of the problems necessitates collaboration and should explicate a plan for integrating the proposed projects in a scientifically sound manner. Preparing such a cohesive proposal is not easy. Indeed, some program directors at the NSF have noted a marked lack of cohesion in group proposals submitted in response to the NSF's Computational and Science and Engineering initiative, part of which included the establishment of a program in Computational Mathematics in the Division of Mathematical Sciences (DMS) of the NSF. Many of these proposals consisted of plans for several different research projects with little explanation of how the projects related to one another and why collaboration was necessary.

The announcement also lists several aspects of the centers that must be specifically addressed in the proposal. For example, the centers must be open to students and investigators who do not have comparable facilities at their own institutions, and the proposal must specify a plan for accommodating such people. Proposals must also contain a management plan describing mechanisms for knowledge transfers, intellectual exchanges, and linkages with state and local governments, national laboratories, industry, etc. Such linkages would be primarily intellectual.

The centers will be reviewed every three years, at which time they will be continued or phased out over two years. The maximum lifetime of any center will be eleven years—this is longer than the nine years suggested in the Zare Report. However, a center could continue to be funded beyond eleven years by submission of a proposal at the start of a new competition.

The review process for the centers will differ from the usual NSF review due to the special criteria involved. First, proposals will be reviewed by panels drawn from the relevant NSF directorates. Next, a multidisciplinary panel will review the proposals the directorates have slected. Finally, there will be site visits.

Scientific Impetus

While the Zare Report played down the necessity for industrial participation in the centers, it does acknowledge the potential role the centers can play in boosting the nation's economic strength. Indeed, Bloch has obtained presidential support for doubling the NSF budget by 1992 precisely because he has linked the funding of basic research to the politically popular issue of economic competitiveness. Another feature of the centers—education and training—is also seen as politically important.

The idea of centers makes sense politically, but does it make sense scientifically? Many say it does and claim that the apprehension of some is nothing more than resistance to change. Indeed, it is clear that many scientific areas require the collaboration and extensive facilities that are most efficiently utilized in a center setting.

Some within the mathematical community have made this point. For example, the Rheinboldt Report ("Future Directions in Computational Mathematics, Algorithms, and Scientific Software," published by the Society for Industrial and Applied Mathematics, 1985) highlights the role computational mathematics has played in the interdisciplinary area of scientific computing. Called the "third scientific methodology," scientific computing has profoundly changed the character of research in many science and engineering fields not only by facilitating the solution of increasingly complex and difficult problems, but also by providing theoretical insight through the use of modeling, computer graphics, and computational "experiments." The report recommends the formation of interdisciplinary teams focused on problems in computational mathematics and cites persuasive scientific reasons why the team approach is essential.

The Rheinboldt Report and the Lax Report ("Report of the Panel on Large-Scale Computing in Science and Engineering," published by the NSF in 1982) were instrumental in last year's formation of the Computational Mathematics program at the DMS. In accordance with the recommendations of the reports, the program will support groups as well as individuals, and will provide funds for hardware, software, programmers, postdocs, and graduate students.

In addition, the DMS has proposed for future years (1990 and beyond) an initiative entitled "Innovative Interactions," which will promote collaborations between mathematicians and scientists in other disciplines. Andre Manitius, recently appointed Deputy Director of the DMS, has been developing a proposal for "Innovative Interactions Between Mathematics and Biology," which was discussed at the April meeting of the NSF Advisory Committee for the Mathematical Sciences (see "Highlights of the Meeting of the NSF Advisory Committee Meeting for the Mathematical Sciences," *Notices*, June 1987, page 603). The ideas were prompted by recent applications of mathematics to such biological problems as the structure of DNA, the human auditory mechanism, and modeling of articifial heart valves. With its interdisciplinary orientation, the Innovative Interactions program may in fact be developed through the centers initiative.

At that same meeting, the advisory committee also discussed the possiblity of developing the Innovative Interactions program through another mode of collaborative research now being discussed at the NSF, i.e. the "research group" mode. Smaller, less formally organized, and therefore more flexible than centers, research groups may, in many areas of mathematics, be a more feasible way of conducting joint research. At present, however, the NSF has not designated funds for group research as it has for the centers. But the Zare Report noted that "group projects receive a growing share of NSF research funding, ... [and] have many of the virtues of single investigator projects, and should be treated as favorably."

Examples of Institutes and Group Grants in Mathematics

At present there are no mathematical research centers of the type that the NSF seems to be envisioning. There are several mathematical institutes receiving funding from various sources, including the NSF, and several group grants in mathematics funded through the University Research Initiative (URI) of the Department of Defense. The URI, begun in 1986, is designed to strengthen the ability of universities to conduct research and to educate graduate and undergraduate students in areas important to national defense. While descriptions of all these enterprises would not be feasible in this article, descriptions of some of them may prove useful. We may refer to some of the group grants as "centers," but it should be understood that they may not be centers in the sense that the NSF is envisioning. These examples are not necessarily intended to be blueprints for centers, but simply to provide a perspective on collaborative research in mathematics.

Three mathematics institutes. The NSF funds two research institutes in mathematics: the Mathematical Sciences Research Institute (MSRI) at Berkeley, California, and the Institute for Mathematics and its Applications (IMA) at the University of Minnesota. Another similar institute is Cornell University's Mathematical Sciences Institute (MSI), funded by the Army Research Office. These are large-scale operations that foster scientific collaboration and promote education and training, but they appear to differ in significant ways from the NSF's proposed centers.

MSRI and IMA are "revolving door" institutes: they have very small permanent staffs connected to their respective universities, and most of the researchers at the institutes are visitors. The NSF and the Zare Report emphasized that the proposed centers should have strong university ties. In the case of MSRI, there are no formal ties to the University of California at Berkeley. Even the building that houses MSRI, though built on university property, is not formally a part of the university. With IMA, the situation is somewhat different, for the University of Minnesota supplies the IMA with office space, overhead, half-time positions, etc.

By contrast, MSI has stronger ties to Cornell University. While MSI does sponsor many visitors and postdoctoral researchers, it also allows for the participation of approximately twenty-five mathematical scientists from the Cornell faculty. The only facilities for the institute are the administrative offices located on the Cornell campus, but there is an extensive selection of computer equipment available through the university. The research at MSI focuses on several specific areas of applied mathematics—applied analysis, physical mathematics, numerical analysis and computing, and statistics and applied probability.

MSI and IMA do focus only on applied mathematics, but even at those institutes the research ranges over a wide variety of topics and is often quite theoretical. At MSRI, the largest of the three institutes, the research emphasizes pure mathematics and also covers a wide spectrum of mathematical topics. Since all three of these institutes vary their topics of concentration from year to year, they probably cover more research areas and therefore have a broader "intellectual focus" than would the proposed NSF centers.

Mathematics and Computation. Several of the URI grants involve mathematics and scientific computation. One example is the URI program funded by the Office of Naval Research and directed by William Verry at Clemson University. With its focus on research in discrete mathematics and computational analysis, this program may provide an example of the "facility or equipment based" center model referred to in the Zare Report. After receiving the URI grant from the Office of Naval Research, the group purchased an eight-node Floating Point Systems hypercube computer. The university then augmented the award by adding eight more nodes and an advanced computing facility. When the group first purchased the computer, little software was available, so, in addition to utilizing the computer for research in parallel algorithms and modeling, the group has been developing hypercube languages for use on the computer.

However, as recommended in the Zare Report, the Clemson program is more than a provider of facilities. The faculty includes Charles R. Johnson, Coordinator for the discrete mathematics portion of the program, which focuses on basic research utilizing combinatorics in the areas of matrix theory, network reliability, and linear algorithms. Daniel D. Warner is the Coordinator for the computational analysis portion, which seeks to establish new methodologies in the subject. The emphasis of the program is on encouraging researchers to explore other scientific areas and applying the research by using the appropriate computational tools, such as the hypercube computer.

Geometry and the Computer. Another group with a computational focus is at the University of Massachusetts, Amherst. Mathematicians David A. Hoffman, William H. Meeks III, and Joel Spruck work with computer graphics expert James T. Hoffman on geometric problems arising in the calculus of variations and in partial differential equations. The problems this group works on have two major components: they arise from, or are intimately connected to, physically significant problems; and their solution involves the development of new computational algorithms.

The group has also been successful in using computer graphics to solve certain mathematical problems. One example is the discovery by David Hoffman and William Meeks of new minimal surfaces. By improving the researchers' geometric insight, the computer stimulated their theoretical insight as well. Computer-generated pictures of the surfaces—some of them strikingly beautiful—have appeared in many newspaper and magazine articles.

Over the past year, the group has been collaborating with polymer physicists on certain problems concerning block copolymers. Their work has led to a number of theoretical discoveries, as well as to the development of computational techniques (including computer graphics) to investigate questions about period surface interfaces of constant mean curvature.

The group's use of the computer often requires them to be within viewing distance of a graphics terminal while they do their research. They have attempted to integrate the office/blackboard setting into the computer room so that several groups, even small seminars, can work simultaneously. The new facility that the group begins using this fall has been designed with this kind of flexibility in mind and includes several graphics devices, computers, and videotaping equipment. The group is also planning a high-speed link to the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign.

Mathematics and Oil Recovery. Another program utilizing scientific computation in mathematically related research is run by Richard E. Ewing at the University of Wyoming. This unusual program actually consists of three separate but interrelated centers: the Enhanced Oil Recovery Institute (EORI), the Institute for Scientific Computing, and the Center for Mathematical Modeling.

The first to be established was EORI, begun in 1984 with funds from a variety of sources, including the state of Wyoming, Chevron Corporation, the Air Force Office of Scientific Research, the Department of Energy, and the NSF. The institute now has eighteen to nineteen faculty, about one-fourth of them mathematicians. EORI paved the way for the Institute for Scientific Computing and the Center for Mathematical Modeling. The Center started with a planning grant awarded about two and a half years ago by the NSF's University/Industry Cooperative Cen-

ters program and began with full funding about a year and a half ago. The Institute for Scientific Computing began in October 1986 with grants from the state of Wyoming and from the NSF's EPSCoR (**E**xperimental **P**rogram to **S**timulate **Co**mpetitive **R**esearch).

Much of the research at the two Institutes and the Center is related to oil recovery and mathematics. For example, the understanding of oil recovery can be improved by mathematical models of certain fluid flow problems. The modeling requires an understanding of the nonlinear partial differential equations that arise, the development of numerical methods to solve the equations, and finally the efficient implementation of these methods on the computer. Because the Center and the Institute for Scientific Computing are fundamental to so many different research areas, they are contributing to many other projects on the university campus, such as research in robotics, seismology, and environmental science.

In particular, the Institute for Scientific Computing, with its focus on large-scale computing and algorithm development, has interested researchers in many different disciplines on the university campus. However, the computer provides more than just a quick way of calculating; it can be used to generate new ideas and results and to stimulate further studies even in theoretical areas. It is this type of use of the computer that Ewing wishes to stimulate, and he said that he does not want the Institute to become simply a computing center.

Intellectual Focus. The URI program at the Courant Institute of Mathematical Sciences provides a good example of a strong "intellectual focus" or "unifying theme," referred to in the Zare Report. Focusing on nonlinear partial differential equations and their applications to physical modeling, scientific computing, and various problems, this group integrates the theoretical aspects of the research with computational implementation.

The Courant group is small—it involves only four or five faculty—but it stimulates interactions among scientists by conducting meetings, participating in exchanges with government and industrial laboratories, and bringing in visitors and postdoctoral researchers.

While the group mostly focuses on problems in nonlinear optics, dynamics of fluid interfaces (including vortex dynamics), composite materials, and random media, the wide applicability of the research has brought some interesting and unusual scientific problems to the group. For example, mild physical ailments that are hard to detect can become major physical problems under stressful conditions, such as those that pilots encounter. A researcher at an Air Force medical facility was interested in noninvasive methods for detecting such mild ailments, especially in the circulatory system and is now collaborating with some researchers in the group to develop mathematical models to study this problem.

Russel Caflisch is the principal investigator for this URI program, which is funded by the Air Force Office of Scientific Research. Related research is conducted with a group grant from the NSF to George Papanicolaou. There is some overlap of investigators in the two groups, and there is cooperation between the two grants. For example, NSF funds were used to purchase computer equipment, and later URI money was used to upgrade it.

Mathematics and Biology. Another example of an interdisciplinary group with a cohesive unifying theme is Nancy Kopell's Center for the Study of Rhythmic Processes, which focuses on mathematics and biology. Also funded through the URI program, the Center receives more than 50% of its funds from the Life Sciences Directorate at the Air Force Office of Scientific Research and the remainder from the Mathematical and Information Sciences Directorate.

The group investigates the collection of neural networks that govern stereotypic rhythmic processes such as chewing, running, and swimming. To an extent these processes are "preprogrammed," but they can also be modulated by higher brain structures. Mathematics can be helpful on the small scale, for developing models of the neural networks, and on the large scale, for understanding the way the entire ensemble organizes itself into the correct spatio-temporal patterns.

The Center for the Study of Rhythmic Processes grew out of several years of ongoing collaboration. When the URI competition was announced, Kopell expanded a project she had been planning in order to include one more investigator and to adopt the broader aim of fostering interactions between mathematics and biology. To accomplish this goal, the members of the group keep up on certain areas of biological research with an eye to pinpointing problems that might benefit from a mathematical perspective. In addition, Kopell has been attending biology meetings to make contact with more biologists. As Kopell put it, it is this "commitment to outreach" that makes her group a center, rather than a collection of people working on related problems.

This center provides an example of the "center without walls" referred to in the Zare Report. Kopell's group is widely distributed geographically: Kopell is at Boston University; there is another mathematician, G. Bard Ermentrout, who is at the University of Pittsburgh; and there are two biologists, one at Cornell University and one at Brandeis University. In addition to graduate students, postdocs, and laboratory technicians, a number of experimentalists, ranging from California to London, also work with the Center. The group maintains close contact by telephone, and although they have no regularly scheduled

meetings, talks given by the many invited visitors often expand into workshops which bring the group together.

This wide distribution of the Center's faculty multiplies the usual administrative details that go along with any center, but is also an asset in that having four "outposts" allows the group to interact with more people than if all the members of the group were at the same institution.

Rationale for Centers

When asked what advice she might have for those who are considering formulating a group proposal, Kopell stressed that the group mode of research only makes sense when it springs "organically" from the scientific topics to be investigated. She maintains that, if one has clear scientific goals, the means of attaining them—by establishing a center, doing individual research, organizing a year-long workshop, etc.—will follow naturally.

These sentiments are echoed by Allan C. Newell, whose Arizona Center for Mathematical Sciences focuses on mathematical modeling of nonlinear phenomena with applications to optics and fluids. Newell said that his center, which has about thirteen faculty, was a natural outgrowth of previous research and built upon ongoing interactions among the mathematics department, the mechanical engineering department, and the university's Optical Sciences Center. Because it concentrates on a rich area that not only produced results in the past but also has potential for further important research, the center is an attractive focus for investment.

According to Russel Caflisch, principal investigator of the URI program at the Courant Institute, it is important that a group proposal put the research into a broad context to identify the real advantages of collaboration. The proposal should not be a collection of several separate proposals, but should explain why funding the group would have a synergistic effect.

Expressing a similar view, Thomas L. Morin, who heads a URI program in computational combinatorics at Purdue University, says that proposers must make the case that the center is "more than just a collection of individuals" who could just as well be funded separately. He also notes that, when proposing a center, one must convince the relevant groups both outside and inside the university that the center makes sense. Morin's program, which is funded by the Office of Naval Research, consists of ten investigators drawn from four different departments at Purdue (mathematics, industrial engineering, management, and computer science). According to Morin, his program has been effective because it forms a "critical mass" sufficient to have an impact on research in computational combinatorics.

Potential Problems

Kopell pointed out that one of the difficulties of involving mathematicians in interdisciplinary research is the fact that mathematicians are evaluated by the quality and volume of their mathematical output, and not by their participation in other fields. Learning enough about another field of science to make a contribution in it means, as Kopell put it, "proving a lot fewer theorems." For young people trying to establish a research career, the investment of time and energy necessary to become familiar with another field can be especially risky. Interdisciplinary groups and centers can provide postdoctoral positions that reduce the risk of becoming involved in interdisciplinary research.

Another perspective on this subject is offered by Michael J. Wozny in a report on the NSF's Engineering Research Centers published by the National Research Council ("Engineering Research Centers: Leaders in Change," National Academy Press, 1987). Wozny, Professor of Electrical, Computer, and Systems Engineering at Rensselaer Polytechnic Institute, established the Center for Interactive Computational Graphics in 1977 and has had extensive experience in interdisciplinary research. He notes that in most cases in which cross-disciplinary collaboration produced substantial progress, the collaborators were experts in their own disciplines. He states that "we tend to overlook the fact that researchers must be firmly grounded in their own discipline before they can contribute meaningfully to a cross-disciplinary research effort."

The descriptions given above may leave the impression that there is already substantial support for centers and groups in mathematics. However, that impression is misleading. The David Report ("Renewing U.S. Mathematics: Critical Resource for the Future," National Academy Press, 1984), which documented serious deficiencies in mathematics funding, also pointed out the crucial supporting role that mathematics plays in all sciences. The overall funding for mathematics is still below the level recommended in the David Report, and the mathematical community still represents a great untapped potential upon which the rest of the scientific community should draw. Indeed, it is difficult to imagine a substantial effort on the part of the U.S. to reassert its leadership in science and technology without the active participation of mathematicians. The centers initiative therefore represents an opportunity not only for the mathematical community to improve its research support, but also for the scientific community in general to make the fullest possible use of the nation's mathematical talent.

The centers initiative also represents a new challenge to the mathematical community and may be the source of some apprehension. The Zare Report warns that the NSF must take

care to balance the different modes of research support and to safeguard funds for individuals from encroachments by larger projects. There is evidence that the NSF has been sensitive to these concerns, and, at the same time, there is evidence that centers will be an important component of federal support of scientific research. That the centers be scientifically sound and relevant and appropriate to the science they pursue is now the responsibility of the scientific community. By the same token, in mathematics, the centers will be what the mathematical community makes of them.

Allyn Jackson
Staff Writer

Science and Technology Centers: Principles and Guidelines

A Report by the Panel on Science and Technology Centers
National Academy of Sciences, Washington, DC, 1987

The following report was issued in June by the Panel on Science and Technology Centers, under the auspices of the National Academy of Sciences (NAS). The NAS formed the panel in response to a letter from Erich Bloch, Director of the National Science Foundation (NSF), to NAS President Frank Press. In his letter, Bloch requested guidance from the NAS in the implementation of an initiative of the Reagan Administration to establish Science and Technology Centers.

The panel examined several aspects of the centers initiative, including:

- the role of the NSF in the centers initiative;
- the relationship between the centers and other modes of research supported by the NSF;
- essential and desirable features of the NSF-funded centers;
- mechanisms and criteria for soliciting and selecting proposals to encourage the most promising ideas;
- principles and methods of governance, including the relationships of the centers to their parent universities, to the NSF, and to their scientific constituencies;
- concerns raised within the scientific community by the proposed expansion of the center mode of research.

In its study, the panel sought the advice of the chairs of various advisory boards at the NSF and the National Research Council, and of the chair of a National Academy of Engineering panel which had provided guidelines for the creation of the NSF's Engineering Research Centers. In addition, the panel examined the operation of various types of existing centers.

Panel on Science and Technology Centers

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Executive Summary

The National Science Foundation's proposed program for Science and Technology Centers at universities can have an important place in the Foundation's portfolio of research support and make significant contributions to science and to the nation's economic competitiveness. To accomplish this will require proper management, adequate resources, and, above all, the selection of programs for which the centers are the most effective form of organization. Great care will be needed to keep the Science and Technology Centers program in proper balance with other modes for supporting U.S. science.

Centers have advantages over other support modes for those areas of scientific inquiry that would benefit from formal, sustained collaboration in pursuit of an intellectual objective. Such work may involve one or more disciplines; it may depend upon research facilities or instrumentation large enough or costly enough that their use is best shared.

Centers can contribute to the nation's economic competitiveness by advancing the frontiers of knowledge; providing the opportunity for timely exploitation of new discoveries; educating young researchers at the highest professional level to fill university, government, and industrial positions; and accelerating the application of new knowledge to the resolution of economically important problems.

Features of NSF Science and Technology Centers. The panel believes that centers should have the following features:

- Their primary goal is to exploit opportunities in science where the complexity of the research problems or the resources needed to solve these problems require the advantages of scale, duration, or facilities that can be provided only by the center mode of research.
- They have a set of related research objectives that may entail work across disciplines or within a single discipline.
- They are campus-based, led by regular faculty, and integrated into academic programs; there is a tangible commitment to the centers by their home universities.
- They provide education and research experience for undergraduate and graduate students,

postdoctoral researchers, industrial fellows, and others.

- Through outreach activities, whose type and scope will vary with the mission of the center, they provide opportunities for intellectual exchanges with researchers in other scientific fields and in industry, government, and other sectors. They may have financial support from non-federal sources, but that should not be a prerequisite.
- They display diverse organizational structures, ranging from a center of activity at a single university to a linkage of several centers of activity.
- They may range widely in size. Typically, their annual cost to the NSF will be from $1 million to $5 million, but may be as low as $500,000 and, in some instances, as high as $10 million.
- They have a finite life with stable funding for a period not to exceed nine years.

NSF Management. The panel recommends that the Science and Technology Centers program be managed as follows:

- NSF should maintain a separate budget for Science and Technology Centers administered by a new program office for Science and Technology Centers. The panel assumes that the Foundation will receive proposals for this program annually.
- Proposals for centers should have a two-stage review—an initial merit review of the quality of the proposed research, followed by a review that determines whether the work to be done justifies a center form of organization.
- Centers should be reviewed by outside visiting committees every three years.

Cautions. The panel endorses Science and Technology Centers as one valuable mode of research support. At the same time, the panel cautions that

- There is a risk that a significant portion of federal funds and university resources will be diverted from the support of individual investigators, especially if the Foundation's budget remains static or declines. In those circumstances, the projected budget of the NSF Science and Technology Centers program should be reduced proportionately.
- The number of centers should not be increased unless existing centers have adequate resources to carry out their missions.
- Centers, like other organizations, may in time become resistant to new ideas and unreceptive to new members with different perspectives and backgrounds. It is easily forgotten than scientific advances flow from dedicated researchers and their ideas, not from institutions.
- Interdisciplinary research, although essential for the solution of many problems, should be pursued only when there is a demonstrated need or opportunity, not because of current fashions or the enhanced likelihood of funding.
- No single type of center should be allowed to dominate the program relative to other types of centers.
- Science and Technology Centers are only a partial cure for deficits of facilities, staffing, and instrumentation in academic research.
- The work of centers should not focus on near-term commercial applications to the neglect of scientific advances of greater long-term economic significance.

Notwithstanding these cautions, the panel believes that Science and Technology Centers can make significant contributions to science and the nation's economic competitiveness with proper management, resources, and evaluation, provided there continues to be a balance among the principal modes of research support.

I. Introduction

Economic Competition, Research, and the National Science Foundation. This nation's preeminence in scientific innovation is a major and durable strength. In looking to the future, however, many knowledgeable observers have raised serious concerns about our ability to sustain a high rate of innovation and to transfer new knowledge rapidly to industrial and social needs. The National Science Foundation has a crucial role to play in addressing these concerns.

In view of its mission "to promote the progress of science and engineering" and "to address the national health, prosperity, and welfare," the Foundation has responsibility for the creation of new scientific knowledge and for providing students with the quality and breadth of instruction required to meet the changing needs of science and society. The Foundation must ensure that today's scientific frontiers are being explored vigorously and that the results of this research are made available to society as rapidly as possible. As many of today's new industries represent the harvest of research in former decades, today's basic research sows the seeds for new industries of future decades. Any strategy for economic competitiveness that fails to recognize the importance of a long-term commitment to basic research will be self-defeating.

Goals. Viewed in the aggregate over the long term, the economic payoff of investment in education and research is enormous, but its sources and timing are uncertain. In some cases, science evolves along fairly predictable lines whose benefits can be largely anticipated; but revolutionary discoveries of much greater long-term economic significance usually depend on knowledge whose utility was unforeseen. No one envisioned that basic studies in the microwave spectrum of ammonia would lead to the invention of the laser, whose contemporary uses range from printing documents to long-distance communication to ship welding to

repairing detached retinas. Similarly, no one anticipated that research on magnetic moments and nuclear spin would lead to nuclear magnetic resonance, which today finds countless uses ranging from chemical analysis of compounds to medical diagnostics; or that work on the molecular biology of bacterial viruses and intestinal bacteria would create a new industry. And who would have predicted that research on perovskites, a common class of mineral insulators, would lead to the discovery of high-temperature conductivity, whose potential applications seem enormous?

The lesson of these and other examples is that the United States must continue to support a wide variety of research activities—short and long term, basic and applied—organized in the many different ways that are appropriate to the various research problems and opportunities.

The principal rationale for the NSF Science and Technology Centers is to ensure continued preeminence in science and an adequate base of trained scientists—two ingredients essential to our success in economic competition. They should not be intended to respond to government or industry perceptions of what is required to remedy deficiencies in U.S. competitiveness in the short term.

Balancing Modes of Research. The major issue in inaugurating a new program of Science and Technology Centers is one of balance among modes of research support. The single investigator with a small research team remains the appropriate mode for many fields of scientific inquiry. This mode has the advantages of pluralism, decentralization, and flexibility to move in new directions as opportunities unfold. Individual investigator support has been enormously successful for the National Science Foundation and productive for the nation. Its preeminence must not be diminished.

Although not identified separately in the NSF budget, group projects receive a growing share of NSF research funding. They are concentrated in its materials, physical, and biological sciences. Groups typically involve a few researchers collaborating or simply sharing equipment. They usually lack an administrative structure, an educational mission independent of university departments, and the ability to fund promising new projects; but they have many of the virtues of single investigator projects and should be treated as favorably.

The term "center" implies a larger scale activity with a formal management and organizational structure. Centers are not a new idea for NSF. On the contrary, they are already an important part of the Foundation's funding portfolio. In view of the need to support more collaborative research and build university infrastructure in many areas where progress is otherwise limited, centers should be expanded as one component of increased research funding.

It is in the context of the President's intention to double the NSF budget over five years that the panel supports the Foundation's Science and Technology Centers initiative. At the outset of its deliberations, the NSF Director assured the panel that, although he envisages a three-fold increase in the total number of NSF centers during that period, the centers will still represent only about 10 percent of the Foundation's budget. Awards to principal investigators for single and collaborative projects will continue to represent about 60 percent of the budget for research. In the event that the additional funds are not appropriated as anticipated, the panel believes that the Science and Technology Centers program should be reduced proportionately.

II. The Mission and Characteristics of NSF-Funded Science and Technology Centers

What are Science and Technology Centers? The panel conceives a Science and Technology Center as a group of researchers who share common goals or common means such as a laboratory, an instrument or set of instruments, or a data base. Centers are on a scale between the single investigator or a small group of investigators and large national facilities such as the National Center for Atmospheric Research or the national laboratories. Centers contribute to science by enabling researchers to accomplish challenging, longer term projects that they could not undertake at all or as efficiently as individual investigators because of the need for stable support, large facilities or support teams, or simply the need to bring together diverse experiences and expertise. By involving external parties as well as students in their research activities, centers contribute to the more rapid transfer of new knowledge and to the training of professionals with an awareness of potential applications.

No single type of center fits the needs or exploits the potential of contemporary research in every field. The science should determine what a center is and does, not the reverse. Innovative researchers and their ideas, not institutions, drive science and, ultimately, economic progress. Thus, the general features of Science and Technology Centers should exhibit diverse forms of organization, participation, and operation.

Science and Technology Centers should have research as their major function. Their success should be measured by the quality of the science and the significance of the new knowledge generated. In addition, they should be judged for their effectiveness in transferring knowledge and educating a variable population of undergraduate and graduate students, postdoctoral fellows, and visiting scientists and other professionals.

Theme. A center's "theme," or intellectual focus, should emphasize important research op-

portunities. It may derive from a single discipline or several disciplines. In either case, centers should be effective in promoting active intellectual collaboration among researchers with varied backgrounds and perspectives acquired in different kinds of science (e.g., basic and applied), different modes of research (e.g., experimental, computational, and theoretical), and different sectors (industrial, government, and university).

The panel considered the request by the NSF Director for suggestions of promising areas for which the funding of a center might be the best mode of support. Recognizing that some of today's most exciting scientific opportunities were unknown a short time ago, the panel concluded that identifying a small number of candidate areas might inadvertently steer researchers away from areas of even greater promise or prejudice the review process. For these reasons, it would be unwise for the panel or the Foundation to pre-select a limited number of scientific and technological areas. Instead, the scientific community should define the range of research goals through the quality of the proposals it generates for Science and Technology Centers.

The panel points out that in recent years there have been a range of reports in which the scientific community described potentially explosive advances in many fields and subfields of science; for example, the research briefings by the Committee on Science, Engineering, and Public Policy and the disciplinary surveys in chemistry, physics, and other fields by the National Research Council. Many of the opportunities described in these reports could be facilitated by the Science and Technology Center mode of research.

Finally, the panel considered the balance between science and technology in Science and Technology Centers. It concluded that such a balance should emerge across the Science and Technology Centers programs of the Foundation and other government agencies but that the mix will vary considerably from one center to another. Some centers will emphasize basic research, while others will have a major technological component. The panel anticipates that NSF, by virtue of its traditional mission, will concentrate its resources on activities involving basic scientific research.

Education. Centers can enhance educational opportunities for undergraduate and graduate students and postdoctoral researchers by increasing the resources available to universities and by providing exposure to leading-edge research that might not be undertaken otherwise. In some cases, centers will introduce students to large-scale collaborative ventures that characterize some industrial research organizations. The instructional mission of centers need not be limited to full-time students and postdoctoral fellows. Some centers will provide continuing education for industrial researchers, visitor programs for scientists from other institutions, personnel exchanges, and conferences and seminars. Where these occur, students will be better equipped to deal with practical problems if they move to industry. By the same token, industrial researchers will be better acquainted with new developments in science.

Centers and their Universities. The integration of a center into its parent institution is essential. The center's core leadership should comprise faculty belonging to one or more departments of the host university or other participating universities.

The intellectual and administrative home of a center should be on or contiguous to the campus, although a major facility of the center may be located elsewhere. Further, in any proposal for a center, there should be a tangible demonstration of the university's support in the form of space, faculty positions, capital equipment, or access to existing facilities and instrumentation.

Models for Science and Technology Centers. Although no current program has precisely the characteristics envisioned for the President's Science and Technology Centers initiative, the National Science Foundation has experience in several closely related activities. Among these are Materials Research Laboratories (9 facilities currently funded at a total of $26 million annually with 15 years of experience); Industry-University Cooperative Research Centers (39 centers currently funded at $3.2 million annually with 7 years of experience); Engineering Research Centers (13 centers currently funded at $30 million annually with nearly 3 years of experience); and several specialized centers not part of larger programs. Finally, beginning in fiscal year 1987, NSF will support several new Biological Facilities Centers at an aggregate level of up to $8 million. Together, support for these and other existing centers totals approximately $115 million in fiscal year 1987.[1]

These NSF centers exhibit a diversity of structures, missions, and modes of operation that may be reflected in the Science and Technology Centers program, but none can be considered a perfect model for the new centers. The panel anticipates and encourages wide variation in the design of center proposals, limited only by the imagination of the scientific community.

Possible models for Science and Technology Centers include:

- Centers organized around an intellectual theme that requires drawing together a critical mass of researchers from within a single discipline or from several disciplines. The focus may be experimental, theoretical, or computational; the organization may be within a single university or it may draw researchers from several institutions. For example, theoretical institutes focusing on a

[1] Figures provided by the Office of the Comptroller, National Science Foundation.

single discipline might be characterized by topical programs of limited duration, small permanent staffs, a large number of short-term visitors, and broadly attended conferences on topics of current research.

- Centers organized around a common facility, set of experimental techniques, a common data base, or research instruments. The latter may be existing techniques and instruments, or the center may be designed to develop new tools of research. The facility need not consist solely or primarily of hardware; multiple uses of a common data base may provide the focus of a center's activities.
- A "center without walls," a network of research scientists at several institutions who interact frequently by electronic or other means. Such a center could stimulate cooperative research when no single institution has the resources to form a center. Furthermore, it could avoid what might be an undesirable concentration of effort and talent at a single institution or, alternatively, a duplication of activities and investment at several institutions.

Outreach and Participation. The resources available to centers should enable them to undertake a variety of outreach activities to transfer new knowledge to researchers in disciplinary subfields or other sciences or to industry and other sectors. The most effective way to transfer knowledge generated by research is through direct intellectual exchanges—seminars, conferences, visitor programs, and exchange visits. Knowledge transfer is a "body contact sport." Such activities must be commensurate with the size of the center and appropriate to its research theme.

External participation by industry, government, and other sectors can facilitate knowledge transfer, bring different perspectives to research problems, and augment resources. The nature of the problems and opportunities selected for support should govern the form and extent of such participation. It is to be expected that the role of participants and the extent of their involvement will vary greatly among centers and over time. Participants may be state governments, national laboratories, foundations, and non-profit research institutions as well as industrial enterprises. Opportunities for continuing intellectual exchanges that acquaint academic researchers with practical problems and convey new knowledge and techniques to researchers elsewhere in the public and private sectors are more important than financial support.

III. Solicitation and Selection of Proposals

General Guidelines. The Foundation's solicitation of proposals should impose as few constraints as possible on the subject matter, size, and organization of proposed centers. NSF should accept proposals in any field. Universities and departments with diverse capabilities should be encouraged to submit more than one proposal. Researchers should be able to work within a center while also receiving individual investigator grants.

In view of the large scale and long duration of centers, thorough merit review is critical. External reviewers should evaluate the scientific quality of the proposed research and the capabilities of the institution and investigators to meet the criteria of a successful center. There should be face-to-face and on-site reviews of the leading candidates among competing proposals.

The creation and operation of a center is a major undertaking, requiring not only research, education, and facilities development within the parent institution, but also outreach to the scientific community and, in many cases, to industry. To realize their potential, centers selected for support must be adequately funded, even if the consequence is the creation of fewer centers than the Foundation has projected.

Following the initial selection, new centers should be created only to the extent that funding is available without detriment to the support of individual investigators or existing centers. If the projected budget increases are not approved by Congress, the Science and Technology Centers program should be reduced proportionately so that a balance is maintained among modes of research support.

Funding, Review, and Selection. NSF should maintain a budget for Science and Technology Centers separate from current program and division budgets and administered by a new program office for Science and Technology Centers. The panel assumes that the Foundation will receive proposals for the program annually.

Authors of proposals should, at an early stage, consult with a program officer within one of the existing NSF research directorates or in the new office. Proposals should be submitted to existing program offices or directly to the program office for Science and Technology centers. The latter should be charged with serving as an advocate and ombudsman for proposals that do not fall into current program areas. NSF should ensure that all of the program offices involved in evaluating proposals are adequately staffed to perform these functions.

The selection of proposals should proceed in two stages. First, under the direction of the Science and Technology Centers office, program officers responsible for fields in which applications are submitted should participate in setting up an initial merit review of the scientific quality of the proposed research. Program officers from the discipline-based directorates are the most knowledgeable people in the Foundation to select reviewers for scientific quality. The first round

of review may be conducted by mail ballot or by convening panels of reviewers.

For proposals judged to have significant scientific merit, there should be a second level of review, addressing:

- whether a center is needed to do the proposed work,
- whether the preconditions of an effective Science and Technology Center are likely to be met,
- and what should be the balance of awards among scientific fields to meet the goals for the NSF Program for Science and Technology Centers, including enhancing the nation's economic competitiveness.

This second review should be conducted by a single multidisciplinary committee reflecting the full spectrum of NSF research activities and composed of scientists from universities, industry, and national laboratories, selected for their broad perspective on science, education, and knowledge transfer. The committee might convene ad hoc panels of specialists to interview applicants at a central location or to conduct on-site visits. Site visits are essential, although they may be practical only for those few proposals tentatively selected for awards. The review committee should advise the NSF Director on the final selection.

Criteria for Selection: Scientific Quality. The principal selection criterion will be the scientific quality of the proposal. The proposed center should enable new science or the application of new techniques or instruments to important scientific problems. The proposal may be cross-disciplinary or limited to a single discipline, as appropriate for its objectives.

Intellectual Theme. A proposal should have a unifying research theme and should demonstrate that the proposed center can accomplish significant results more effectively and in a more timely manner than its participants could achieve as individual investigators. A center's theme should be sufficiently long term to justify a center form of organization and broad enough to permit changes in focus and approach as the research proceeds, but it should have sufficient focus to have definable goals. In some instances, the theme may derive from various uses of a common facility or piece of equipment, but the center must be more than merely a provider of services.

Education and Training. The proposal should include plans for the education and training of a mix of undergraduate and graduate students, postdoctoral and industrial fellows, and faculty of undergraduate institutions and secondary schools. The instruction plan should indicate how the center's activities will be integrated into the university's structure and academic programs.

Staffing. Science and Technology Centers can succeed only with outstanding leadership. It was apparent from the panel's examination of existing centers that the presence of one or two highly effective administrators often makes a critical difference. The usual mode should be a single director with strong scientific qualifications and administrative skills.

The university should demonstrate its willingness to provide regular teaching faculty who meet university and departmental standards to constitute the core research staff of the center. Where interdisciplinary research activities are contemplated, the university should demonstrate how its academic departments will recognize and reward faculty, research fellows, and students for their accomplishments within the center.

Additional scientific staff may occupy non-tenure track positions. Proposals should anticipate the career and career development opportunities that will be available to scientific staff who do not hold faculty appointments; and they should address the kinds of interaction expected to occur among a center's principal investigators and other research staff.

Size and Cost. The purpose of a center is to achieve greater productivity and inventiveness in an important area of science. The size and cost of a center derive from the demands of the subject matter. The annual NSF investment might be as low as $500,000 and as high as $10 million, with the cost of most centers falling in the range of $1 million to $5 million.

The number of personnel associated with centers also may vary widely. Lower limits are set by the center's objectives. Upper limits are set, in addition, by the need to maintain focus and coherence and by the availability of specialists. The size of a proposed center should be commensurate with the size of the field; the majority of research talent in a field or subfield should not be concentrated in a single center.

Outreach and Participation. Center proposals should include plans for involving the relevant research community beyond the sponsoring university—at other universities, colleges, and non-profit research organizations and in industrial and government laboratories. This outreach can take many forms, including timely publication of research results, visitor programs, personnel exchanges, computer linkages, conferences and seminars, institutional affiliations, work-study programs, consulting arrangements, continuing education programs, contract research, student placement in summer jobs, and academic-year cooperative programs.

Although leveraging the NSF investment is desirable, it should *not* be the primary reason for attracting the participation of industry, state governments, or other sectors. Rather, the goal should be to encourage intellectual exchanges on a scale and with a frequency that do not ordinarily occur between the university and outside communities. Larger centers should have proportionately greater external participation and outreach efforts. Foreign participation with recip-

rocal arrangements should be encouraged where appropriate.

Industry. An important mode of industrial cooperation is the exchange of personnel to help develop and transfer new knowledge. Although it should not be a prerequisite of science-based centers, corporate participation also may include direct financial contributions or equipment donations. It is to be expected that such participation will be small during the start-up phase of a center and increase over time; in some instances it may not develop during the lifetime of the center. Center research activities should be open to the maximum extent.

States. Although the benefits of Science and Technology Centers are national, state governments increasingly perceive advantages in supporting local centers of scientific research and training to provide additional jobs and revenue, attract out-of-state talent and industrial investment, and produce research on areas of state responsibility or interest. State participation might include providing sites, financing construction, matching funds for instrumentation or equipment, enabling the host institution to create new faculty positions, and facilitating knowledge transfer to state agencies and local industries.

Foundations and Private Donors. Foundations and private donors differ from states and corporations in having fewer local or proprietary interests. Their participation in centers is likely to be primarily financial, except in the case of operating foundations with in-house research activities.

IV. Governance of Science and Technology Centers

Relationship to Universities. Centers must be located at a university or affiliated with a consortium of universities. Centers should be partners in their parent institutions' educational, research, and service missions. In view of the outreach function of centers, host universities should create an external mechanism for obtaining advice on center activities and regular evaluation of their performance.

Beyond these general prescriptions, the details of administration should be left to the universities' discretion with a minimum of federal involvement.

NSF Review. The panel recommends a nine-year funding cycle to provide centers a reasonable opportunity to achieve their scientific objectives. Typically, this period should include three years of funding growth, three years of stable funding, and a terminal three years.

Because Science and Technology Centers are privileged to receive substantial funding over a relatively long period, they should be subject to periodic review of the highest standard. The Foundation should evaluate a center at three-year intervals to determine the funding level to follow. After each review, the center should be given either a three-year renewal or a three-year period in which to terminate its activities. Thus, barring evidence of gross mismanagement or poor performance, each center that does not itself propose an earlier termination will be assured of funding for at least six years from its start-up. At the end of nine years the original grant should be terminated.

Because the three-year start-up period is necessarily one of organization, exploration, and adjustment of original plans to new or unanticipated circumstances, the first evaluation should focus more on scientific promise and administrative progress and less on research accomplishments. All reviews should be conducted by external committees of scientists appointed by the Foundation. NSF should require written administrative reporting by the centers no more often than once a year.

Finally, separate from the process of reviewing individual centers, there should be a mechanism to monitor and evaluate the Foundation's entire Science and Technology Centers program in the context of all programs supporting basic science. This function might be assigned to a standing committee external to the Foundation.

V. Some Cautionary Observations

The panel agreed that centers as a mode of research support can produce significant scientific accomplishments. By assembling where they are needed the critical number of researchers, scale of facilities, and types of instrumentation, centers can accelerate the generation of new knowledge and its application.

Thus, if implemented wisely, the Science and Technology Center program will strengthen the Foundation's role as the nation's premier agency for the support of basic science. In acknowledging the potential value of such centers, however, the panel recognizes several potential problems:

- Science and Technology Centers may divert funds from individual investigator grants, which continue to be the best means of supporting research and training in many scientific fields. The panel envisions increasing support for centers only in the context of a rising NSF budget and has received assurances that the Foundation's leadership is of the same view.

In particular, the panel cautions strongly against a repetition of the experience with the Defense Department's University Research Initiative (URI) program. Supporting the URI program without providing for an increase in total basic research (6.1) funds has weakened not only the existing basic science programs of the military ser-

vices but also the URI program in its formative stages.[2]

Further, it is unavoidable that, within universities, Science and Technology Centers will compete with individual investigator projects for such university resources as land, building construction, and tenured faculty positions. This problem is real but not unique to programs supported by the Foundation. Although acknowledging that universities labor under severe constraints in funding instrumentation and facilities, the panel believes that it is the responsibility of each research university to face this issue squarely. The centers program should be evaluated periodically to inform NSF of the cumulative effect of the program on the universities.

- There is a risk that centers will in time become unresponsive to new ideas and unreceptive to new people. The administrative apparatus and size of centers may become obstacles to innovation. The review procedures outlined above are designed in part to guard against this danger, but university administration must also be alert to it.
- Cross-disciplinary research, which is one of the rationales for centers, must have natural reasons for its existence. Sometimes the best science can be done at the interfaces of disciplines, sometimes not. It would be unfortunate if the Science and Technology Centers program induced able scientists to abandon important problems simply because they are not regarded as sufficiently cross-disciplinary to be funded under the program.
- No single type of Science and Technology Center should become so predominant that other kinds of centers are excluded from receiving support. For example, the likely popularity of facility-based centers that furnish instrumentation and related services should not preclude centers devoted to experimental or theoretical work in single disciplines or across disciplines.
- The objective of accelerating technology transfer could lead to a narrow focus on near-term commercial applications in center activities. There should be no requirement that Science and Technology Center applicants have the prior assent or support of industry. Academic laboratories have a special responsibility to furnish leadership in breakthrough science and to call attention to new opportunities for commercial exploitation. There may be some lag between a discovery and recognition by business that it warrants investment. A related danger is overemphasis on outreach activities to the point that they detract from research efforts.
- The funding of one or two centers in a relatively small scientific field could concentrate a large fraction of the talent, weakening other institutions and reducing healthy competition. The decision to create a center should take into account the need to maintain institutional diversity in the field.

Finally, the panel believes that the entire continuum of size and scale of NSF research funding should be addressed by experts outside the Foundation. Not only large-scale activities but also individual and small group research suffer from insufficient funds, support of too short duration, obsolete equipment, and inadequate staffing. These are problems that the NSF Science and Technology Centers program will not solve but that urgently need attention.

Notwithstanding these cautions, the panel believes that Science and Technology Centers can make significant contributions to science and the nation's economic competitiveness if they have proper management, resources, and evaluation and if the Foundation maintains a healthy balance among the principal modes of research support.

[2] See the February 26, 1987, memorandum of Dr. Cornelius J. Pings, Co-chair of the Department of the Defense-University Working Group on Engineering and Science Education, to Hon. Chapman B. Cox, Assistant Secretary of Defense, Force Management and Personnel.

Commentary on Defense Funding

At the Council Meeting in Salt Lake City, it was decided to place five motions on a mail referendum which would be sent to the AMS membership following the January 1988 Annual Meeting. (See the reports of the Council Meeting and the Business Meeting in the AMS Reports and Communications section of this issue of *Notices*.)

Readers are invited to comment on these motions or on issues related to these motions in this section of the *Notices*. In order for items to be considered for publication in the January 1988 issue of *Notices* (which will be the last issue prior to the mailing of the referendum), they must be received no later than **November 2, 1987**. Items should be sent to the Managing Editor of *Notices*, Commentary on Defense Funding, American Mathematical Society, P.O. Box 6248, Providence, RI 02940 and should be limited to approximately 1,000 words.

Jair Koiller
Visitor, Yale University
Home Institution
Universidade Federal do Rio de Janeiro

As a Third World mathematician, trained in the U.S., I would like to present my support to the colleagues which oppose military funding for mathematics.

I found very encouraging that many responsible voices are raising to curtail military expenditures worldwide. Having done my military service in peacetime (although in a period called "internal warfare" in my country) I reached the conclusion that the military approach cannot solve the problems of mankind.

For the sake of our children and future generations, let's not only oppose military funding, but also work to end the waste of Earth resources. Military organizations should be transformed into rescue agencies in case of natural disasters, and training schools for young men and women for prevention of such disasters.

When this occurs, then I believe that scientists should be encouraged to work together with the military.

Pankaj Topiwala
University of Chicago

After Star Wars, Who Could Ask for More?

Several interesting issues have been raised recently regarding the SDI motions, and I would like to address some of them here. Among the opinions offered are: 1. if you can get money to do what you want, take it; 2. SDI may or may not work—not for us to decide; 3. Politicians aren't going to listen to us anyway; 4. some in the AMS want to weaken U.S. security (!); 5. I'm for SDI, a sound defense investment.

Now 1. I agree with in the short-run, but one must consider long-term effects, what we reinforce or reject by our actions, and consider this singular issue of SDI. 2. better us than politicians. We as intellectuals can and should address outstanding issues of the day. Other groups from physicians to physicists have already expressed collective views. 3. they'd better! Again, not mathematicians alone, but the American intelligentsia together *can* be heard. 4. paranoia. We're good citizens to the core—we just disagree on how to achieve security. For it is not measured only in how many guns we have, but how few our enemy has, or even more, on how well we get along with him (her, them).

5. I believe to be a serious mistake. As a defense, it is at best unacceptably leaky, at worst a lie. It can possibly defend point targets (silos) but not populations. It emerges then on close inspection as a first-strike weapon, which must be opposed even in principle.

It is the simplest lessons of life which the war-planners fail to understand (or apply). If we move war up from earth to near earth orbit, who can believe it will stop there? No matter how you feel about the Soviet Union, it makes sense to negotiate arms control, now.

As for SDI motions, for me they are but a vehicle for expressing serious concern. In this regard, this debate generated is already useful.

Mikhail Katz
SUNY at Stony Brook

I will argue that the shallowness of the current debate on military funding in mathematics stems from the lack of a historical perspective. It is a common misconception that the history of the events relevant to the debate is common knowledge and needs not be discussed in detail. I will show that this argument does not hold water.

Bill Thurston writes in the January issue of the *Notices* that,

> Many mathematicians who came of age during or after World War II but before the Vietnam War decry the current nature of the military,... and would like to see a return to the seemingly more benign relationship between science and the military, as it was after World War II.

The distinction is between the generally praised management of funding of mathematics by ONR, AFOSR, and ARO (research organizations of the Navy, Air Force, and the Army) in the period after World War II, and the situation since the Vietnam war. Thurston includes himself among "those of us who came of age during the Vietnam War." Thurston will be 41 this year. According to the AMS, there are now 9,522 members aged 41 or younger, out of a total membership of about 20,000. Those of use who compose nearly half the membership are anxious to learn some history!

I think that Peter Lax, in the August issue of the *Notices*, was groping for a residue of historical discussion in the debate when he cited Wendell Fleming's letter to the effect that "DOD has provided much needed diversification." Unfortunately, Fleming's comments in the April issue of the *Notices* are rather general:

> The long-term DOD support... has been an important factor in the development of applied mathematics in the U.S. since World War II.

Paradoxically, the only substantive discussion of post-World War II funding was authored by Thurston, whose perspective is avowedly shaped by Vietnam.

The dearth of historical data prior to 1968 in the David Report is rationalized by the lack of complete data for that period. Even more striking is the off-hand manner in which the Report mentions John von Neumann, on page 2 (in a dependent clause) and on page 18 (parenthetically).

Now von Neumann was a key figure among mathematicians working with the government in the fifties. He joined the RAND corporation (the Air Force Thinktank) in 1947 as a part-time consultant. In 1953 he was appointed head of the Teapot Committee which studied the feasibility of the ICBM. President Eisenhower admired him greatly. Thurston might well be challenged to produce a figure of von Neumann's stature on his side of the fence.

Thurston alludes to conversations with older mathematicians on the subject of pre-Vietnam funding. Would these mathematicians please step up and tell us all?

Keith Ramsay
Harvard University

If there is concern being expressed about military funding of mathematics, I do not think that it is based on an assumption that the DOD is somehow inherently evil. Care must be used in treating any goal however good which has assumed the relation to the mathematical community which security interests have taken currently. If we were in the position of having the same kind of emphasis being placed by federal funding agencies on producing mathematics relevant to space travel, or a "war", on cancer, or industrial competitiveness, or any other limited range of aims, as is currently given to national security, we should rightly be concerned.

Many of us hear about certain mission-directed students whose interest in mathematics derives principally from the knowledge that they need to have some mathematics for their careers. Some of these students, in particular, feel that one ought to be able to restructure the teaching of mathematics in such a way that they could avoid what they see as "irrelevant" knowledge.

One day I watched the hearings of a congressional committee discussing the industrial applications of the recent breakthroughs in superconductivity. The natural question arose: how can the congress help make superconductivity research more useful? As the discussion continued, it began to appear as though some congressmen had the notion that one should be able to draw some kind of line between the industrially helpful part of the research and the industrially not-so-helpful part. It might be noted that until recently, the research did not seem to be making many useful results.

Similarly, it would seem that military funding of mathematics is partially justified by the notion that we should be able to divide mathematics into the militarily useful part and the rest. The fact that this is the justification as understood in the administration should not cause us to feel obliged to agree with it, however.

Paragraph 17g of the NSF Information for Graduate Fellows pamphlet from last year reads as follows: National Security. Fellows are obliged to report promptly to the Foundation, prior to disclosure to others, any discoveries that are made or data that are developed which could reasonably be considered as likely to affect the national security or the national defense. Doubtful cases should be referred to the Foundation prior to disclosure of any information concerning them.

I wrote to the NSF for clarification and got a response from the office of general counsel there, reading in part, "We ask in essence that our awardees use their best judgment...," and noting that we all have the not-always-easy task of setting the right "balance" between First Amendment rights and national security needs.

I am willing to suppose that the people responsible for making decisions of this kind are generally attempting to use sound judgement. I don't think it is necessary to suppose that these people are malicious, however, or that mathematicians are inherently wiser on these matters to argue that a fundamental mistake is being made.

There are several reasons why it is easy to overemphasize the value of attempting to channel knowledge into selected directions.

First, it is somewhat possible to select for knowledge which will be useful, especially when choosing from fields which are already well understood. In hindsight we can see that some fields have produced more applications in certain directions. In general, however, a student, however sophisticated he may be, will not be able to gauge the usefulness of a piece of knowledge until after he has learned it.

A combination of basic scientific results opened the door to the development of nuclear weapons. Further efforts then produced the weapons. A combination of scientific and technological processes produced a remarkable result. We give scientists too much credit if we suppose that the desire to produce powerful weapons made the knowledge of fission come into existence. We would similarly be engaging in a bit of misleading advertising if we suggested that wanting to make strategic defenses should make the necessary basic science and mathematics (if it exists) materialize. It has been claimed by some that SDI is a research project. When discussing treaty obligations the administration sometimes claims that it falls into the category of systems based on "new physical principles." Others claim that we are in a position to carry on predictably with development based on currently available knowledge. Equivocating between these two pictures unfortunately suggests more of an ability to channel science to these ends than is realistic.

The limits to the usefulness of placing curbs on research should also be noted. If the NSF asks nothing more from graduate student fellows than that we use sound judgement, by the same token terming it an "obligation" will not help much. The potential discoveries with which the administration is concerned are not likely to occur in isolation, and the benefits from limiting them will likely to be temporary so long as there exists a segment of the scientific community not under restraint by the same guidelines. By placing emphasis on proximal causes, it is possible to imagine that such events can be controlled by modest, "balanced" treatment of individual cases, without putting blocks in the path of the overall trend of research, whether or not this is actually so.

Patricia Clark Kenschaft
Montclair State College

When I was a graduate student, I joined a civic organization and attended monthly meetings. After a year the leader said to me, "Pat, I can't get over it. You are studying mathematics but I have never seen horns growing out of your head or a tail trailing out behind." That perception is not unusual, although its vivid, honest statement may be.

Too often mathematicians are perceived as cold, insensitive people. This perception harms us in seeking research funding and graduate fellowships, in recruiting teachers, and in convincing elementary school teachers to learn the math needed to prepare their pupils for a technological economy. We need to change our image.

I support all five resolutions on the forthcoming mail ballot. In particular, the Star Wars Program (SDI) appears to me and many others to contribute nothing to national defense. At best it waste precious resources, but in various ways it also threatens the survival of humankind. I believe that the AMS should promote alternative applications of our talents and resist attempts to coerce mathematicians.

Kenneth M. Hoffman

1988: A Very Special Year

Next year, the national mathematics community will be engaged in a special year-long celebration called "100 Years of American Mathematics." Its underlying idea is to build on the American Mathematical Society (AMS) Centennial (officially celebrated next August) and on nine other special events scheduled throughout 1988, to create a "centennial of American mathematics." Announcements about "100 Years," and its events can be found elsewhere in this issue. It is a "happening" for the benefit of our whole community and your participation is vital to its success.

Our goals in linking 10 major events in 1988 go beyond festive ones to the creation of a unique vehicle for increasing public understanding and for stimulating dialogue in the math community about its future. This special year provides us with the biggest public education opportunity the mathematics community in the U.S. will have for many years to come. It also presents major issues it faces in research, in education, and in its relations with its several publics. Following is the background for the year, viewed from these two perspectives.

Public Understanding of Mathematics in the United States

As the language in which nature speaks to us, mathematics has been a vital ingredient in physics, chemistry and engineering for centuries. After WWII, it came to permeate the intellectual fabrics of a broad range of disciplines, increasing its impact on such diverse areas as space science, management and the social sciences. More recently, the fundamental role of mathematics has been recognized in biology and medicine. Moreover, it has long been an essential component of the school and college curriculum, especially for the preparation of scientists and engineers. Yet, mathematics has not consistently held a place of importance in American society.

What is disturbing in America today is that few adults recognize that mathematics is the foundation of our technological society, and that it is a growing, changing discipline with new results constantly being discovered. Nor do they recognize that the computer has greatly extended the reach and power of mathematics, making it even more crucial that young people be solidly grounded in the subject. Equally disturbing are recent studies which show conclusively that American grade and high school students lag significantly behind their Chinese, Taiwanese, and Japanese counterparts in mathematics. Additionally, fewer and fewer Americans are studying enough mathematics to prepare them for any of the wide variety of technically-based careers, let alone for mathematics teaching and research.

All this indicates that public awareness and understanding of mathematics need to increase, both in quantity and in accuracy of perception.

This situation was recognized several years ago by the leadership of three major U.S. mathematical organizations, the American Mathematical Society located in Providence, R.I.; the Mathematical Association of America located in Washington, D.C.; and the Society for Industrial and Applied Mathematics based in Philadelphia, PA. The AMS, MAA and SIAM joined together in order to develop a governmental and public affairs program broadly representing American mathematics. The result was the Joint Policy Board for Mathematics (JPBM), created in 1984. Interactions with federal agencies began immediately and the public information program got underway in 1985.

In its first few months of operation, the JPBM public information office called reporters and editors across the U.S. to ascertain who covered mathematics, who was assigned to cover the field, and how much and what kinds of interest existed regarding mathematics. Not too surprisingly, there were fewer than 12 reporters who regularly and knowledgeably covered the field. Moreover, reporters from many media outlets expressed chagrin over covering mathematical stories, the same outlets which were already covering space flights, education, and the computer sciences.

For the past two years the JPBM has communicated about mathematics with the various publics on Capitol Hill and in governmental agencies, in addition to the general public via television, newspapers and radio. Because of the efforts of this program understanding within government has improved; the number of reporters covering mathematics has grown; and the number of stories and quality of coverage concerning mathematics has increased.

1983—The JPBM—The American Mathematical Society (AMS), the Mathematical Association of America (MAA), and the Society for Industrial and Applied Mathematics (SIAM), create a nine-member joint executive action arm, the Joint Policy Board for Mathematics, to begin implementing the recommendations of the David Committee. The JPBM emphasizes unity across the discipline, one of

the five basic recommendations to the mathematics community later made by the David Committee.

1984—The David Report—The June, 1984 report, "Renewing U.S. Mathematics: Critical Resource for the Future" highlights the flowering of mathematics and its uses since World War II and calls attention to serious signs of trouble: (i) the growing shortage of mathematicians; (ii) a marked imbalance between federal support of mathematics research and support for related fields of science and engineering. Based on a careful analysis, it calls for more than a doubling of FY 1984 federal support level, and lays out a ten-year implementation plan, with specific roles for government, universities, and the mathematical sciences community.

1984—The BMS—In September, 1984, the NRC established the Board on Mathematical Sciences (BMS) to provide objective advice to federal agencies, and to identify promising areas of mathematics research, along with suggested mechanisms for pursuing them.

1985—The MSEB—At the urging of the mathematics community*, the NRC established the Mathematical Sciences Education Board (MSEB) to provide "a continuing national assessment capability for mathematics education"—kindergarten through college. A 34-member board is appointed, which is a unique working coalition of classroom teachers, college and university mathematicians, mathematics supervisors and administrators, members of school boards and parent organizations, plus representatives of business and industry. This step reflects another of the basic recommendations of the David Committee: Strong involvement of all sectors of the mathematics community in issues of pre-college education.

1986—The JPBM Washington Office—The JPBM's Washington activities come to embrace enhanced congressional contact and a vigorous public information effort. An office of Governmental and Public Affairs is opened and it launches National Mathematics Awareness Week, to become an annual April event. Contact with media and resultant coverage of mathematics are increased, thus starting the "long-term, coordinated effort" in public information recommended by the David Committee.

* The recommendation came from the Conference Board of the Mathematical Sciences (CBMS), which comprises the presidents of 14 professional societies in the field.

1987—Project MS 2000—At the urging of JPBM, the NRC is launching a comprehensive review of the college/university mathematics enterprise, analogous to the David Committee's review of the health and support of mathematics research nationally, and also analogous to the MSEB's first overview and analysis of mathematics education in the nation's schools, planned for 1988 publication.

1988—Report to the Nation—The first BMS/MSEB 'Report to the Nation' on the state of mathematics education in the U.S., kindergarten through college, based on MSEB's pre-college work and preliminary work of MS 2000. It will emphasize the potential of a modified mathematics education for contributing to the national welfare, and will outline a national game plan for bringing about needed change in the 1990's.

Mathematics: Planning for the Future

The U.S. mathematics community is engaged in a multi-stage, multi-year critical examination of its roles in research, in education, and in public policy. This ambitious undertaking, which will take another major step forward in 1988, began in 1980 when leading mathematicians became alarmed over markedly decreased flows of talent and resources into their field, and into science and technology more broadly. They mobilized the professional societies in mathematics and enlisted the aid of the National Academy of Sciences (NAS) and the National Academy of Engineering (NAE) in analyzing the forces undermining the infrastructures of mathematics research and education. The initial goal was to develop national game plans for reversing the trends of declining Ph.D. production, erosion of federal support, deterioration within mathematics departments, increasing student and public apathy toward mathematics, and growing complacency within the field itself about some of its responsibilities. The focus for the analyses was not on the past, however, it was on the opportunities which mathematics provides for the future well-being of science and technology, the nation, and its individual citizens.

The comprehensive assessment which these actions set in motion will last throughout this decade and is generating in successive steps the plans and organizational mechanisms needed at the national level to renew and continuously maintain the vitality of the country's broader mathematics enterprise. 1988 is the first year the mathematics community will have before it for widespread discussion organizational plans for its several futures—in research, in pre-college education, in college/university education, and in relations with its various publics. Following are some of the major steps which brought the dialogue to its present stage:

1981—The David Committee—The National Research Council (NRC), public policy arm of the NAS and NAE, establishes prestigious committee of scientists and engineers, chaired by Dr. Edward E. David, Jr., to review health and support of research in the mathematical sciences in the U.S.

1982—The Browder Briefing Panel—At the request of the White House, NRC's Committee on Science, Engineering and Public Policy (COSEPUP) establishes panels to brief the Science Advisor to the President on research opportunities in six fields. First to report is the Mathematics Panel, chaired by Professor William Browder, pointing out that mathematics is flourishing intellectually but its research infrastructure is eroding rapidly.

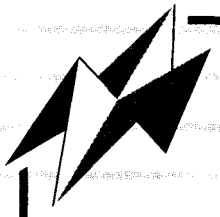
However—mathematics is still largely unrecognized for what it is: a crucial component of our culture and a discipline essential to the well-being of American science and technology, to U.S. economic strength and industrial competitiveness, and to national defense.

Fortunately, a number of significant events in mathematics are taking place in 1988, among them the Centennial of the American Mathematical Society, the first U.S. professional organization of mathematicians. Because of the convergence of the Centennial with numerous other noteworthy events, the JPBM has designated this year as a celebration called '100 Years of American Mathematics.'

These events during 1988 cover research, education and application of mathematics and will involve individual mathematicians, mathematical sciences departments, educators, industrialists, public policy makers, media and other audiences. 1988, therefore, is the first year the American mathematics community has had an opportunity to markedly increase and enrich public understanding and appreciation of mathematics.

Your Participation

Our special year-long celebration begins on the evening of January 7 at the Joint Mathematics Meeting in Atlanta, with a "100 Years of American Mathematics" kick-off banquet. Whatever you had been planning to do, come to Atlanta and join in this festive occasion. It will cost you some money to attend, but it is a unique chance for us to get together to (i) celebrate a century of achievement by our community, and (ii) commit ourselves to a year of reflection and renewal. To help us on both counts, the Hewlett-Packard Company is producing an enhanced "100 Years" model of its state-of-the-art HP 28C calculator (list price $235), which meeting registrants can purchase for $60 if they attend the banquet. If you haven't seen the HP 28C and its competitors you should. Its numerical, graphical and symbolic manipulation capabilities exemplify the power of the computer to markedly alter the way we teach mathematics—and all in a machine the size of a cigarette case. The computer is one of the "Forces for Change in Mathematics Education" to be discussed at Atlanta in a special session the following evening, January 8. And that will just be the beginning of 1988, a very special year.



CENTENNIAL CELEBRATION

The New York Mathematical Society was modeled after the London Mathematical Society.

AMERICAN MATHEMATICAL SOCIETY • PROVIDENCE • AUGUST 8-12, 1988

Preliminary announcement

CANADIAN MATHEMATICAL SOCIETY WINTER MEETING

Dec. 13–15, 1987

Vancouver, Canada

Principal Speakers

J. Borwein, *Dalhousie*; D. Burkholder, *University of Illinois*; I. Frenkel, *Yale*; V. Jones, *UC Berkeley*; J. Marsden, *UC Berkeley*; V. Snaith, *University of Western Ontario.*

Special sessions and partial list of invited participants

Non Linear Boundary Value Problems: Organizer—Frederick Atkinson, *Toronto*;
W. Allegretto, *U of A*; L. Erbe, *Paris*; R. Finn, *Stanford*; J. Marsden, *Berkeley*; J. Mawhin, *Catholic U., Louvain*; L. A. Peletier, *Leiden*; C. Swanson, *UBC.*

Knot Theory and its Applications: Organizer—Dale Rolfsen, *UBC*;
P. Holmes, *Cornell*; L. Kauffman, *U of I, Chicago*; K. Millett, *UCSB*; K. Murasugi, *Toronto*; S. Strogatz, *Cambridge, Mass.*; D. Sumners, *Florida State*; J. White, *UCLA.*

Lie Algebras and Physics: Organizer—Robert Moody, *Saskatchewan*;
V. Kac. *MIT*; J. Patera, *CNRS*; A. Pianzola, *Alberta*; D. Petersen, *UBC*; N. Warner, *MIT.*

Probability: Organizer—Ed Perkins, *UBC*;
D. Bakry, *Strasbourg*; R. Bass, *U of W*; M. Csőrgő, *Carleton*; J. F. LeGall, *Paris VI*; N. Madras, *Toronto*; C. Mueller, *Rochester*; T. Salisbury, *York.*

Contributed Papers

There will be a special session for 15 minute talks. Abstracts must be ready for photocopying in the form shown below and received by Denis Sjerve before Nov. 9, 1987. A TEX source code file may be sent instead of hardcopy.

PETER L. DOE, University of Saskatchewan, Saskatoon, Canada S7N 0W0. *Holomorphic functions and their boundary values.*

The abstract should be typed within the frame with no side margins. Please use LETTER GOTHIC TYPE, 12 pitch and draw handwritten symbols in black ink. The authors's name should be capitalized and the name of the paper should be underlined. This heading is indented ten spaces or 2 cm. Your help in maintaining the style of the abstract will be appreciated by both the organizers of the conference and the editors of the CMS Notes. A margin may be left at the bottom of the abstract. This frame is 17.8 cm. wide and 9.9 cm. high.

Information

Denis Sjerve, Department of Mathematics, 1984 Mathematics Road, UBC, Vancouver, Canada, V6T 1Y4; (Bitnet address, MATH@UBCMTSG).

MacArthur Fellowships

The John D. and Catherine T. MacArthur Foundation has announced the selection of thirty-two new MacArthur Fellows. The present group includes three mathematicians. They are Robert F. Coleman, University of California, Berkeley; Eric Steven Lander, Harvard University; and David Mumford, Harvard University. This announcement brings to 223 the number of Fellows named since May 1981. The Foundation does not accept applications for Fellowships. Instead, anonymous nominators recommend Fellowship candidates to an independent selection committee. There are no set times for announcements or yearly quotas of Fellows. The awards range from $150,000 to $350,000 over five years depending upon the age of the recipient.

Unlike conventional grants, the MacArthur Foundation imposes no requirements, restrictions, or performance standards on MacArthur Fellows. John E. Corbally, MacArthur Foundation President, states "The MacArthur Fellows Program is designed to create an atmosphere in which experimentation, and ultimately, discovery can take place. The award recognizes outstandingly talented and promising individuals and gives them the freedom to create." Among the several categories of individuals who are most likely to benefit from this particular award are the young, who need freedom from economic burdens which may force them into the predictable routines of standard career patterns; those in mid-career who wish to change fields, which is discouraged by many employers; those older people who lose or never had institutional support but who have important work to continue; those whose interdisciplinary work cannot fit existing funding patterns; those who are outside the usual institutional networks and career patterns, or in remote areas; those involved in unconventional or seemingly obscure, but in fact important, endeavors; and those engaged or who intend to engage, in courageous "long shots" which, because of the risk of no payoff, cannot get support from other granting agencies.

ROBERT F. COLEMAN is known for devising new techniques in algebraic-geometric number theory and for formulating a theory of p-adic integration of differential forms, which has had unexpected arithmetic applications.

Robert Coleman was born on November 22, 1954, in Glen Cove, New York. He received his B.A. from Harvard University in 1976 and his Ph.D. from Princeton University in 1979. He received a Graduate Fellowship (1976–1979) and a Postgraduate Fellowship from the National Science Foundation (1979–1980).

An an assistant professor of mathematics at Harvard University, he held a Benjamin Peirce Lectureship (1980–1983). In 1983, he went to the University of California, Berkeley, as assistant professor, and in 1985 he was promoted to his current position of associate professor. Professor Coleman has held visiting professorships at the University de Paris-Sud (June 1982), University of Grenoble (Winter 1985), and Harvard University (January 1985). In 1985, Professor Coleman received an Alfred P. Sloan Research Fellowship.

As an undergraduate, Robert Coleman was profoundly influenced by two of his teachers, Raoul Bott in topology, and John Tate in number theory. Facing the decision of choosing between the two fields for his specialty, Coleman chose number theory, but has continued to pursue his interest in topology. In trying to apply the ideas of topology to number theory, he has attempted to make his study of number theory as topological as possible. While in graduate school, Coleman had three major influences: John Coates, who indicated to Coleman the project that became Coleman's thesis; Kenkichi Iwasawa, who gave him inspiration; and Bernard Dwork, who gave him advice.

ERIC STEVEN LANDER applies his expertise in mathematics to problems in both business and science. He has special interest in genetics, molecular biology, and computer science.

Born on February 3, 1957, in Brooklyn, New York, Eric Lander graduated from Princeton University with a B.A. in mathematics in 1978. He was then named a Rhodes Scholar and received the D.Phil. degree in mathematics from Oxford University in 1981. Since then he has been at Harvard University, where he is assistant professor of managerial economics in the Graduate School of Business. Lander teaches mathematics and economics and has developed curricula on bidding and negotiation and on the applications of artificial intelligence.

Professor Lander has continued to pursue his interest in algebra and combinatorics and in computer science. His book on information theory, *Symmetric Designs: An Algorithmic Approach*, was published in 1983. In addition, he developed an interest in genetics and inherited diseases; he began studying molecular biology, genetics, and neurobiology informally at laboratories at Harvard and during a summer course at Wood's Hole Oceanographic Institute.

He currently holds positions as visiting scientist at the department of biology at Massachusetts Institute of Technology and as Fellow of the Whitehead Institute for Biomedical Research. His research in biology focuses on the development of laboratory and mathematical strategies in human

genetics and gene mapping. In particular, he has developed methods which can be used to locate the genes which cause complex human diseases.

DAVID MUMFORD has played a central role in the field of algebraic geometry for the past quarter-century. He has worked on invariant theory, the global theory of moduli, and the deep analysis of algebraic surfaces. He expanded the classical theory of theta functions and applied it to arithmetic questions and differential equations.

David Mumford was born in Three Bridges, Sussex, England, in 1937. His professional career has been closely tied to Harvard University, where he received his B.A. in 1957, received his Ph.D. and was appointed assistant professor in 1962, and is now Higgins Professor of Mathematics. He served his term as chairman from 1981 to 1984. He has traveled extensively, spending various years at the IAS in Princeton, at the Institut des Hautes Etudes Scientifiques in Paris, at the Mathematics Research Centre in Warwick, and especially at The Tata Institute in Bombay where he has visited frequently and is an Honorary Fellow. He received the Fields Medal in 1974, was elected to the National Academy of Sciences in 1975, and received a D.Sc. (hon) from Warwick in 1983.

David Mumford has spent most of his career working in the field of algebraic geometry. He entered the field in 1962 at a time of great excitement. Mumford, Michael Artin, and Heisuke Hironaka were students of Oscar Zariski at Harvard when Grothendieck also came to Harvard to learn from Zariski and to teach his extraordinary new insights. The synthesis of the older tools of the Italian school with the newer tools of cohomology led to rapid progress in the field. Mumford's specific contributions came from his application of the ideas of classical invariant theory (especially the ideas of Hilbert) and of the theory of Riemann's theta function in many variables to the problem of constructing a moduli space for the set of algebraic curves of fixed genus. (See *Geometric Invariant Theory*, second edition by Mumford and Fogarty, Springer-Verlag, 1982, and *On the equations defining abelian varieties*, I, II, and III, Invent. Math. **1** (1966) and **3** (1967).) A long term interest was in the global structure of this moduli space: this led to his proof with Joe Harris that moduli spaces of large odd genus are 'of general type' (*On the Kodaira dimension of the moduli space of curves*, Invent. Math. **67** 1982) extended to large even genuses by Eisenbud and Harris.

In recent years, Mumford's interests have shifted to computer and cognitive science—a shift which the MacArthur Fellowship will help to support. His first project, stimulated by the pioneering work of B. Mandelbrot, was the computer generation of the limit point sets of Kleinian groups (see *An Atlas of Kleinian Groups*, Cambridge University Press, to appear). His primary interest now is the study of vision, both the process of vision in natural intelligences and the algorithms for duplicating these abilities by computer. He is working with J. Shah on a free boundary value problem suggested by the visual process of 'figure/ground segregation' and with S. Kosslyn and R. Herrnstein on psychological aspects of vision.

News from the Institute for Mathematics and its Applications

University of Minnesota

Plans for the 1988–1989 IMA program on Nonlinear Waves are well advanced. The organizers are James Glimm, Daniel Joseph, Barbara Keyfitz, Andrew Majda, Alan Newell, Peter Olver, David Sattinger, and David Schaeffer. During the fall of 1988, the program will concentrate on nearly integrable systems and applications. This part is being organized by Alan Newell, Peter Olver and David Sattinger; David Kaup and Yuji Kodama will be in residence.

The winter program will consider problems which involve hyperbolicity, change of type, wave propagation in non newtonian, and multiphase flows. Such problems arise in variety of applications such as viscoelasticity and granular flows. The spring program will be on multidimensional hyperbolic problems and computations. During the winter and spring quarters Barbara Keyfitz, David Schaeffer, Rudolfo Rosales, and Michael Shearer will be in residence.

Postdoctoral memberships and other support will be available for the 1988–1989 program. An advertisement in this issue gives further details.

After a fall quarter devoted to computational geometry and combinatorial optimization, the 1987–1988 IMA program on Applied Combinatorics will turn to concurrent periods of concentration on applied graph theory (organized by D. Kleitman) and on interaction between combinatorics and other parts of mathematics (organized by G. C. Rota and D. Stanton). The first of these will be inaugurated by a workshop on combinatorics and geometric problems in VLSI design December 14–18 with R. Graham, L. Snyder, and R. Tarjan as organizers, and will also feature a workshop on applications of combinatorics to graph theory, January 18–22, organized by J. Cohen and F. Roberts. A workship on invariant theory and tableaux, March 21–25, organized by G. C. Rota and D. Stanton, will be a feature of the latter period of concentration, which will extend from January through April.

NAS Award

In commemoration of the AMS Centennial, the National Academy of Sciences (NAS) has established a major new prize in mathematics. Entitled the NAS Award in Mathematics, the prize will be given every four years for excellence of published research in the mathematical sciences within the past ten years. The NAS Award in Mathematics will be sponsored by the AMS, with the first award of $5,000 to be made in 1988. The major sources of funds for the prize are generous gifts to the Society from two AMS members, Morris Yachter and the late Sydney Henry Gould.

Yachter, an applied mathematician and engineer, has degrees in civil engineering and aeronautical engineering from New York University and a Ph.D. in mathematics from the Courant Institute of Mathematical Sciences. Yachter worked in the defense industry for about thirty-five years and is now retired, but has continued to pursue his research in mathematics. He has been an AMS member since 1957.

Gould had a long history of association with the Society as Executive Editor of Mathematical Reviews and then as Editor of Translations. With a B.A. and an M.A. in mathematics and a Ph.D. in classics, Gould pursued his interest in mathematics as well as in languages. In 1972, he became a research associate at the Mathematics Institute of the Academia Sinica in Taipei, Taiwan. In 1982, he returned to Providence, where he remained until his death in 1986.

Nominations for the 1988 award are now under consideration by the prize committee. Those wishing to make nominations must submit the following materials by **October 10, 1987**.

- a 1–2 page letter of recommendation describing the nominee's accomplishments for which the award would be given;
- the nominee's curriculum vita;
- a selected bibiliography of the nominee's publications;
- a citation of 25 words or less describing the nominee's accomplishments.

These materials should be sent to: National Academy of Sciences, Office of the Home Secretary, 2101 Constitution Avenue N.W., Washington, DC 20418.

Persons wishing to contribute to the prize fund should communicate with the Secretary of the AMS. If the endowment were increased from its present capital value, the prize could be awarded more frequently or in larger amount.

AMS and ACM Sign Database Agreement

The American Mathematical Society is very pleased to announce that an agreement has been signed with the Association of Computing Machinery to add to the ACM monthly *Computing Reviews* (CR) and the annual *ACM Guide to Computing Literature* (GCL) to Math\Sci, the AMS online database. These ACM publications provide comprehensive coverage of the international research literature in computing and computer science.

According to the agreement, signed on July 31, 1987, by the Executive Directors of AMS and ACM, William J. LeVeque and Richard F. Hespos, respectively, the ACM files will become an integral part of Math\Sci as the CR and GCL subfiles. The AMS will convert the ACM files into Math\Sci format; information in overlapping ACM/AMS records will be merged into composite records retaining both the AMS and ACM classifications and both the ACM review and MR review or abstract.

It is expected that the conversion work and loading of the ACM subfiles on DIALOG, BRS, and ESA will be completed by the end of the year.

With the addition of CR and GCL, Math\Sci will offer comprehensive international coverage of research in mathematics, statistics, and computer science, as well as their applications in other fields.

Math\Sci, online since 1982, is produced by the AMS and consists of the following subfiles: *Mathematical Reviews* (MR)—with reviews and abstracts; *Current Mathematical Publications* (CMP)—the current awareness subfile; *Current Index to Statistics* (CIS)—published by the American Statistical Society and the Institute of Mathematical Statistics; and *Index to Statistics and Probability* (TUKEY) by Tukey and Ross. Math\Sci currently contains over 800,000 entries, with over 6,000 added monthly. The ACM files will add approximately 100,000 records to Math\Sci.

Access to Math\Sci is available on BRS, DIALOG, ESA-IRS, EasyNet, CompuServe, and several gateway systems. For further information, contact Taissa T. Kusma, American Mathematical Society, P.O. Box 6248, Providence, RI 02865. Telephone: 401-272-9500. –AMS News Release

Fulbright and Other Grants

The 1988–1989 competition for Fulbright and other grants for graduate study will close **October 31, 1987**. Only a few more weeks remain in which qualified graduate students may apply for one of the approximately 700 awards which are available to over 70 countries.

The purpose of these grants is to increase mutual understanding between the people of the United States and other countries through the exchange of persons, knowledge and skills. They are provided under the terms of the Mutual Educational and Cultural Exchange Act of 1961 (Fulbright-Hays Act) and by foreign governments, universities, corporations, and private donors.

Most of the grants offered provide round-trip transportation, tuition and maintenance for one academic year; a few provide international travel only, or a stipend intended as a partial grant-in-aid.

Applicants must be U.S. citizens at the time of application, must generally hold a bachelor's degree or its equivalent before the beginning date of the grant, and, in most cases, should be proficient in the language of the host country. Except for certain specific awards, candidates may not hold the Ph.D. at the time of application.

Application forms and further information may be obtained from IIE's New York headquarters at 809 United Nations Plaza, or one of its regional offices.

The deadline for receipt of completed applications **is October 31, 1987**. Requests for application materials received after October 15, 1987, will not be honored. –IIE News Release

U.S. Team Places Fifth in International Math Olympiad

A team of six American high school students placed fifth in the 28th International Mathematical Olympiad (IMO) held July 5–15 in Havana, Cuba, and two of the U.S. students won gold medals for receiving a perfect score in the rigorous examination.

The IMO judges awarded individual first, second, and third prizes to deserving team members. Jordon Ellenberg of Potomac, Maryland, and Eric Wepsic of Boston, Massachusetts, received first prizes with perfect scores of 42 points. Three U.S. team members received second prizes: Robert Southworth of Winchester, Massachusetts, with a score of 38, William Schneeberger of Oklahoma City, Oklahoma, with a score of 36, and John Woo of Pepper Pike, Ohio, with a score of 32. Matthew Cook of Evanston, Illinois, received a third prize with a score of 30.

The Americans had a team score of 220 points out of a possible 252. Ahead of them were teams from Romania (250), West Germany (248), U.S.S.R. (235), and East Germany (231).

The U.S. team was chosen on the basis of performance in the United States of America Mathematical Olympiad (USAMO), held this year on April 28, and on an evaluation of their work at a rigorous four-week training session. The winners of the 1987 USAMO, including U.S. team members Cook and Schneeberger, were honored on June 2 at the National Academy of Sciences in Washington, DC.

The Mathematical Olympiad activities are sponsored by seven national associations in the mathematical sciences with arrangements made by the MAA. Financial support was provided by IBM, the Army Research Office, the Office of Naval Research, Hewlett-Packard.

–MAA News Release

Mathematical History

The AMS Centennial Celebration in 1988 provides an opportunity for the Society to highlight the role mathematics has played in the development of science and technology. One activity planned in this connection is the publishing of books and articles of a historical nature. The publication of such manuscripts is a departure from the Society's traditional involvement with research-oriented material and, therefore, assistance from the mathematical community is requested in acquiring historical works. The Society is also interested in locating existing manuscripts about twentieth-century mathematicians and historical accounts, which could be incorporated into a collection of reprints. A committee has been appointed for this project: Peter Duren, University of Michigan, Chairman; Richard Askey, University of Wisconsin; and Uta Merzbach, Smithsonian Institution.

If you are planning to write or are currently writing a manuscript on the history of mathematics, or if you have information about existing manuscripts, you are invited to contact Ms. Mary C. Lane, Director of Publication, P. O. Box 6248, Providence, RI 02940, for further details about this activity. Information and manuscripts may also be forwarded directly to the committee members.

U.S.-China Exchange Program

The Committee on Scholarly Communication with the People's Republic of China (CSCPRC) offer a short-term research and lecture program for American and Chinese scholars in the sciences, engineering, social sciences, and humanities. American scholars may apply directly to CSCPRC. Chinese scholars must be nominated by American scholars who agree to serve as their hosts.

Visits can be of one to three months' duration and must take place between September 1988 and August 1989. All American applicants must be U.S. citizens or permanent residents and must have a Ph.D. or equivalent at the time of application. Chinese nominees must be university faculty members or research institute associates. American applicants and Chinese nominees must specify one primary host institution where the majority of academic activity will be carried out; visits to more than five institutions cannot be arranged.

The deadline for mailing all applications, nominations, and references is **October 10, 1987**. All application and nomination materials should be sent to the Visiting Scholar Exchange Program, CSCPRC, 2101 Constitution Avenue, Washington, DC 20418. –CSCPRC News Release

Electronic Addresses at the AMS

The AMS has been investigating and evaluating the features of the various communications networks over the past few years and has decided to connect its computers to ARPANET. This network will provide the AMS with great flexibility in its role as a publisher and as a center for information transfer in the mathematical sciences. The target date for the connection was late August and, by the time this issue of *Notices* is mailed, communications should be established.

ARPANET will provide the AMS with electronic mail, file transfer, and remote terminal services. Some staff members at the AMS will have their electronic addresses in the 1987–1988 *Combined Membership List.* In addition to individual addresses, the Society has set up some general addresses that can be used to contact departments at the AMS, or to communicate specific types of information. In particular,

- EXDIR@SEED.AMS.COM can be used to contact the administrative offices in Providence;
- MEET@SEED.AMS.COM can be used to send information to the Meetings Department;
- PUB@SEED.AMS.COM can be used to send correspondence of a general nature to the Publication Division; and
- MEMBSA@SEED.AMS.COM can be used to communicate membership and customer services needs.

Two other addresses are also available for special purposes:

- COMDEPT@SEED.AMS.COM can be used to send manuscripts in electronic form for AMS publication;
- MATHREV@SEED.AMS.COM can be used by reviewers to submit reviews and related correspondence to *Mathematical Reviews.* For detailed information on submitting reviews, see the item "Electronic Correspondence with MR" in this section of *Notices.*

Computerization in the mathematical community is becoming more universal, and this connection to ARPANET provides the speed and convenience of computer-based communications that will better serve the AMS membership.

Request for Photos

In conjunction with the Centennial of the American Mathematical Society, which is to be celebrated in Providence in 1988, the AMS would like to set up an exhibit of group photos from meetings and similar items of interest.

If anyone has memorabilia of this kind which they would like to give or loan to the AMS, please write to William J. LeVeque, Executive Director, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

Electronic Correspondence with MR

The editors of *Mathematical Reviews* invite reviewers to submit reviews and related correspondence electronically by mail through ARPANET or INTERNET to the following address:

MATHREV@SEED.AMSCOM

Files should be sent in 7-bit ASCII and should be no larger than 10K bytes. Review texts sent electronically should be TEX source files which make use of the $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX macro package. (See *The Joy of TEX* by M. D. Spivak, Amer. Math. Soc., Providence, RI, 1986.)

There is a standard format for a review text file using TEX encoding. It is the following:

```
\beginrev    % the tags of the form
should start lines
% Note: you don't have to type material
% on lines from a % sign on.
% Note: you shouldn't insert extra blank
% lines in between lines at the
% start of this form.
\reviewer Dr. N. E. W. Mathematician
\address
\author First Author, Second Author, ...
% enough to confirm identification
\shorttitle Sample paper for rev
% the first 20 characters of the title
will do
\mcno 856781 % the control number found at
the top left of a review sheet
\mmrno  % should be left blank
\mpclass 00A99  % a suggested primary
classification
\msclass 00-03 94-03 % suggested secondary
classifications
\revtext
% \revtext is on a line by itself with no
following % sign

The text of the review should start on the
line immediately following the
{\tt \revtext} control sequence.
```

Within the review text all the usual conventions of TEX and $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX may be used, except that one should avoid making new definitions. In particular, you may make use of the extra symbols, Fraktur, an Cyrillic fonts obtainable from the AMS in the AMSFonts package.

Note that it is important to ensure that the last line of the file ends in a carriage return. Copies of this form can be obtained by the mail method intended for submission of reviews.

Reviews may also be submitted on floppy diskettes. Both IBM PC and Macintosh floppies will be accepted, in standard ASCII text format at standard densities.

```
\remarks{Inside this remarks field
can be contained any special comments
that are not part of the review text
but may help in processing it.}
\endrev
\remark{\electrosubmitted}
```

Reciprocity Agreement

For several years, the American Mathematical Society has had a reciprocity agreement with the Secció de Matemàtiques of the Societat Catalana de Ciències Físiques, Químiques i Matemàtiques. The Societat Catalana has now formed separate societies according to speciality, with the mathematics section newly established as the Societat Catalana de Matemàtiques. The following is an update of the information on the Secció de Matemàtiques of the Societat Catalana de Ciències Físiques, Químiques i Matemàtiques that appeared on page 840 of the August 1987 issue of *Notices*.

Apply to: Secretari de la Societat Catalana de Matemàtiques, Carrer del Carme 47, 08001 Barcelona, Spain.

Dues: 1000 pessetes for members of the AMS, payable to the Societat Catalana de Matemàtiques.

Privileges: *Butlettí de la Societat Catalana de Matemàtiques*, (2 numbers a year).

Officers: J. Girbau (President), Carles Perelló (Secretary), Rubi Corberó (Associated Secretary).

Errata

In the August 1987 *Notices* list of Officers and Committee Members, one of the Committee names was omitted from the listing of Representatives of Committees who are members of the Council. The following persons in fact are representatives of the *Transactions* and *Memoirs* Editorial Committee; they are not representatives of the Science Policy Committee.

Vaughan F. R. Jones
Lance W. Small
Joel A. Smoller

Polking Awarded Meritorious Service Award

Erich Bloch, NSF Director, presented the NSF's Meritorious Service Award to John C. Polking for his service to the Foundation. The following is the text of the award.

Dr. Polking joined the National Science Foundation in 1984 as Director, Division of Mathematical Sciences, while on leave from Rice University.

Throughout his tenure at the NSF he has maintained a very effective leadership role in the community of mathematicians. He has been a strong supporter of the David report and has been very effective in implementing the recommendations of the report with special emphasis on the expansion of the support of graduate students and postdoctoral fellows.

Dr. Polking realized the major importance of computational methods to all aspects of science and engineering and was a major force in initiating the Foundation's interdisciplinary program of Computational Science and Engineering. He also recognized that recent advances in mathematics and computational mehtods made a complete revision of the calculus curriculum both possible and imperative. The new program in this area is largely due to his leadership.

During Dr. Polking's three years at the Foundation, the Division of Mathematical Sciences has worked hard to attract women and minorities into the discipline. Dr. Polking has been consistently supportive of these efforts. In a similar vein he has encouraged the external mathematical community to be more active in considering the needs of the discipline and in explaining these needs to the external community. His strong support of the Mathematical Sciences Education Board and the Board of the Mathematical Sciences of the National Research Council epitomizes this concern.

Such professional dedication warrants the deep appreciation of the National Science Foundation and the entire scientific community. I am therefore conferring the Meritorious Service Award on John C. Polking for his outstanding intellectual and administrative leadership in planning and implementing programs in the mathematical sciences.

Postdoctoral Research Fellowships

NSF Postdoctoral Research Fellowships in the mathematical sciences will be offered only to persons who 1. are U.S. citizens or nationals as of January 1, 1988; 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, 1988; and 4. will not previously have held any other NSF postdoctoral fellowship.

For copies of the application brochure or further information, contact the Special Projects Program, Division of Mathematical Sciences, National Science Foundation, Washington, DC 20550, 202-357-9764; or the American Mathematical Society at 401-272-9500.

The deadline for applications is **November 16, 1987**.

Nominations Sought for Waterman Award

The National Science Foundation Alan T. Waterman Award Committee has issued a call for nominations of candidates for the thirteenth annual award. 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 award was established by Congress in 1975 to mark the twenty-fifth anniversary of the NSF and to honor the first director of the Foundation, Dr. Waterman.

In addition to the medal, the recipient receives up to $500,000 for a period of 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.

Deadline for nominations for the 1988 award to be received by the award committee at the NSF is **December 31, 1987**. Announcement of the award will be made in May 1988.

Candidates must be U.S. citizens or permanent residents and must be thirty-five years of age or younger, or not more than five years beyond receipt of the Ph.D. degree by December 31 of the year in which nominated. Candidates should have completed sufficient scientific or engineering research to have demonstrated, through personal accomplishments, outstanding capability and exceptional promise for significant future achievement. In addition, candidates should exhibit quality, innovation, and potential for discovery in their research.

Nominations for the award may be submitted by the scientific and educational communities, individuals, professional societies, industry, and other appropriate organizations. Six copies of each nomination should be submitted to the Alan T. Waterman Award Committee, National Science Foundation, Washington, DC 20550.

The award committee is composed of twelve members appointed by the director, NSF, and four ex officio members. The ex officio members are: Erich Bloch, Director, National Science Foundation; Frank Press, President of the National Academy of Sciences; Roland W. Schmitt, Chairman of the National Science Board; and Robert M. White, President of the Academy of Engineering.

Additional information and/or a copy of the nomination form may be obtained by contacting the Executive Secretary for the Committee, Lois J. Hamaty, at the NSF. Telephone: 202-357-7512.

–NSF News Release

Computing Research Equipment for the Mathematical Sciences

The Division of Mathematical Sciences of the NSF plans a limited number of grants for the purchase of scientific computing equipment for research in the mathematical sciences. Eligible institutions include U.S. graduate degree granting institutions with departments or research programs in mathematics, applied mathematics, or statistics. Proposals involving interinstitutional or interdepartmental sharing arrangement are welcome. Character of equipment requested should be such that it is required jointly by several (two to five) research projects and difficult to justify for a single project. Minimal cost should be by $20,000. Significant cost-sharing on the part of the institution is expected. Deadline for proposals is **December 4, 1987.** For further information, contact the Program Director for Special Projects, Division of Mathematical Sciences, National Science Foundation, 1800 G Street, N.W., Room 339 Washington, DC 20550. Telephone: 202-357-9764.

Centers Program Announced

In its fiscal 1988 budget, the NSF proposed the establishment of a Science and Technology Centers (STC) program to support basic research and to strengthen economic competitiveness. The STCs will combine research with education, training, and outreach programs.

The NSF has been formulating guidelines for the development of the program, and on August 21, the National Science Board, the policy-making arm of the NSF, gave its final approval of the guidelines.

By the time this issue of *Notices* reaches its readers, the STC program announcement, released September 15, will have been sent to science and mathematics departments across the country. The program announcement contains detailed instructions for the preparation of proposals in addition to information on the evaluation process and the criteria to be used.

The NSF is concerned that information about the program be widely circulated to the mathematical community. At the time of this writing, the announcement was not yet available, but the NSF did provide *Notices* with verbal information about some of the major points of the announcement:

1. The STCs should address complex problems that require collaboration. They must have a unifying intellectual theme deriving from a single discipline or several disciplines.

2. They must be based at a university or college campus, with a tangible commitment from the host institution.

3. They must provide for education and training opportunities. Proposals must describe mechanisms for making the STCs available to students and investigators who do not have comparable facilities at their own institutions.

4. STC Proposals must describe mechanisms for knowledge transfer, intellectual exchanges, and linkages with other sectors, such as state and local governments, national laboratories, and industry. Such linkages may be primarily intellectual.

5. STC Proposals will first be reviewed at the directorate level by panels representing the relevant disciplines. These panels will then send their recommendations to a single multidisciplinary panel. Finally, there will be site visits.

6. Each STC will be reviewed every three years, at which point it will be phased out over two years, or will receive continued funding, but its total lifespan will not exceed eleven years. However, after that eleven-year period, an STC may reenter the competition with the submission of a new proposal.

7. There will be a planning grant competition for the STCs.

The most important criteria in the evaluation will be the quality of the research proposed and whether or not a center is the best means of pursuing that research.

Those wishing to submit a proposal should send a letter of intent to the NSF by **November 15, 1987**. The deadline for proposals is expected to be **January 15, 1988**. The program announcement may be obtained from the Office of Science and Technology Centers, National Science Foundation, 1800 G Street N.W., Washington, DC 20550, 202-357-9808.

Increase in S/E Doctorates to Foreign Citizens

In 1986, the number of new engineering doctorates awarded to U.S. citizens continued to rebound from a 1983 low, but the trend toward fewer new science doctorates persisted, according to the latest "Survey of Earned Doctorates." The National Research Council conducts the survey annually for the NSF.

While foreign citizens have continued to increase their ranks among the new doctorates in science and engineering (S/E), the number of U.S. students, by contrast, has been declining since the peak years of the early 1970s. The data reveals that, since 1980, the number of S/E doctorates awarded yearly to foreign citizens has risen 40%, while the number awarded to U.S. citizens has decreased nearly 5%.

In 1986, foreign citizens earned 55% of the 3,400 engineering doctorates, up from 48% in 1980, and 23% of the 15,400 science doctorates, up from 17% in 1980.

The number of all S/E doctorates awarded by U.S. universities rose 3% from 1985 to 1986, but this overall increase was due entirely to advances made by foreign citizens. The decline in the number of S/E doctorates awarded to U.S. citizens continued in 1986 despite increases in the number of science and engineering doctorates earned by U.S. women and Hispanics. These increases were not sufficient to offset decreases in the number of S/E doctorates earned by men and blacks. The survey also indicates that women and minorities remain significantly underrepresented among recipients of S/E doctorates.

The healthy increases in the number of women earning S/E doctorates during the 1970s have slowed in recent years. From 1970 to 1980, the number of women earning S/E doctorates increased by an average of 9% yearly, but from 1980 to 1986, these increases averaged only 4% per year.

U.S. minority groups (including U.S. citizens and non-U.S. citizens on permanent visas) earned about 1,450 S/E doctorates in 1986, essentially the same number as in 1985. Blacks earned about 300 of the degrees in 1986, 10% fewer than in 1985, and about the same number as in 1980. In contrast, the 325 S/E doctorates awarded to Hispanics, up from 200 in 1980, reflect steady yearly increases. The share of the minority doctorates earned by Asian-Americans and Asians on permanent visas was essentially unchanged in 1986: 46% in science and 80% in engineering.

Science/Engineering Doctorates: 1986

Field	1986 Total	% change from 1985	Percent of 1986 total Women	Foreign	Minority
Total, Science/Engineering	18,766	+3	26	29	11
Engineering, total	3,375	+7	7	55	19
Chemical	476	+8	11	51	23
Civil	386	+8	5	66	18
Electric, Electronics	707	+12	5	54	21
Mechanical	442	+4	3	71	16
Other	1,364	+4	8	50	18
Sciences, total	15,391	+2	30	23	10
Physical Sciences	3,089	+6	16	31	10
Physics	1,187	+10	9	37	8
Chemistry	1,902	+4	21	27	11
Earth, Atmospheric, Marine	588	−5	17	23	5
Mathematics	731	+6	17	46	11
Computer Sciences	399	+28	12	45	18
Agriculture	999	−10	17	39	9
Biological Sciences	3,782	0	34	14	9
Psychology	3,060	−1	51	5	9
Social Sciences	2,743	+5	33	14	11
Non-Science/Engineering	13,016	+1	49	14	12

Source: National Science Foundation, SRS

DMS Staff

The program directors for 1987–1988 are:

Classical Analysis	
John Ryff	202-357-3455
Modern Analysis	
William Paschke	202-357-3697
Geometric Analysis	
Paul Goodey	202-357-3451
Topology and Foundations	
Ralph Krause	202-357-3457
Algebra and Number Theory	
William Adams	202-357-3695*
Ann Boyle	
Applied Mathematics	
William Lakin	202-357-3686
Peter Bates	
Computational Mathematics	
Raymond Chin	202-357-3691
Statistics and Probability	
Nancy Flournoy	202-357-3693
Yashaswini Mittal	
Special Projects	
Bernard MacDonald	202-357-3453
Albert Walker	

The administrative staff includes:

Division Director	
Judith Sunley	202-357-9669
Deputy Division Director	
Andre Manitius	202-357-9669
Administrative Officer	
Tyzcer Henson	202-357-3683

The permanent staff consists of Krause, MacDonald, Ryff, and Sunley. The incoming rotators are Paschke, University of Kansas; Lakin, Old Dominion University; Bates, Brigham Young University; Chin, Lawrence Livermore Laboratory; and Walker, New Mexico State University. The remainder are continuing rotators.

Andre Manitius, program director for Applied Mathematics for the past two years, became deputy division director in August. He has a one year appointment. He will continue his leave for the 1987–1988 academic year from Rensselaer Polytechnic Institute to fill this position. His duties include long-range planning and development of initiatives. In addition, he will act as a coordinator for the NSF's Science and Technology Centers initiative.

*This is the correct telephone number for these program directors. Please disregard the telephone number change that was reported in this section of the August 1987 issue of *Notices*.

Advisory Committee Meeting

The Advisory Committee for the Mathematical Sciences will meet at NSF headquarters on November 2–3, 1987. The Committee's advice is very important to the Division of Mathematical Sciences (DMS) in setting priorities and developing long-range plans. The last meeting included discussions with DMS staff and with NSF Director Erich Bloch, in addition to presentations by several NSF officers (see "Highlights of the Meeting of the NSF Advisory Committee for the Mathematical Sciences," June 1987 *Notices*, page 603). The mathematical community is welcome to attend the public portions of the meeting. If you wish to attend or to suggest topics for discussion, contact Trudy Sensibaugh at the DMS at 202-357-9669.

Undergraduate Students to Participate in Research

In June 1987, the NSF awarded a total of $10 million in grants through its Research Experiences for Undergraduates (REU) program, which is designed to provide undergraduate students with opportunities for hands-on participation in active research in science, mathematics, and engineering. Involving 2,500 undergraduate students, the awards were the first to be made in the newly established program.

Awards typically fit into two categories. REU Site grants support the development of undergraduate research participation sites where approximately eight students can take part in research programs and use state-of-the-art instrumentation. REU Supplements augment ongoing NSF research awards to provide research training experience for one or two undergraduates. Each type of award may be used during the academic year, the summer months, or both.

In response to the first program announcement, the NSF received over 600 REU Site proposals requesting a total of almost $50 million. Of these, 128 projects received awards averaging $42,000 each and involving a total of 1,256 students in 43 states. The projects are housed at a diverse range of institutions, including small colleges, major research universities, NSF Engineering Research Centers, national optical and radio astronomy facilities, and a major industrial corporation.

REU Supplement awards average $4,000–$8,000 apiece and this year will involve a total of about 1,240 students. The supplements cover stipends for students and participating faculty, relevant student housing costs, indirect costs, and a modest allowance for supplies.

Initiated in late 1986, the REU program is one component of the NSF's increased emphasis on activities designed to insure an adequate supply of high quality mathematicians, scientists, and engineers for the future by attracting talented students to these disciplines while the students are still undergraduates and are in the process of making career choices. Such programs also seek to enhance the opportunities for women, minority, and physically disabled students to participate in research.

The following REU Site awards were made in mathematics. The institution, the principal investigator, and the research topic are listed: Harvey Mudd College, John Greever et al., Applied analysis and discrete mathematics; University of Colorado, James Curry, Parallel algorithms in nonlinear dynamics; University of Minnesota-Duluth, Joseph Gallian, graph theory; Oklahoma State University, P. L. Claypool et al., Applied statistics; Oregon State University, Robert Robson et al., Computation in number theory and dynamics; University of Tennessee, L. Husch et al., Computational methods in algebra, geometry, and optimization; Rice University, B. Frank Jones et al., Laplace operator on spheres; University of Utah, Robert Brooks et al., Geometry and groups in statistics.

In addition, the following awards were made in computer science: California Institute of Technology, Jerome Pine; Northern Michigan University, Hal Martin; University of New Hampshire, Philip J. Hatcher; and Clemson University, John S. Davis.

Trends in Graduate S/E Enrollment

Science Resource Study Highlights, a publication of the NSF's Division of Science Resource Studies, recently presented data collected in the NSF's Survey of Graduate Science and Engineering Students and Postdoctorates, Fall 1985. The following summarizes findings of the survey that may be of interest to the mathematical community. Unless otherwise indicated, enrollment data are from doctorate-granting institutions.

Total enrollment. Total graduate enrollment in science and engineering (S/E) reached 371,000 in fall 1985, up 2% from fall 1984. By comparison, total enrollment at all levels of higher education rose by less than one-tenth of 1% during the same period.

With a 5% increase over the previous year, full-time graduate enrollment in the mathematical sciences reached 11,200 in 1985. In the computer sciences, the figure is 12,400, which represents a 23% increase during that period—more than three times the increase for any other S/E field.

Foreigners. An 8% rise in the number of foreign graduate students enrolled in full-time S/E programs accounted for two-thirds of the net increase in total enrollment; the number of U.S. citizens enrolled full-time fell by 1% from 1984 to 1985, after three successive years of slow growth.

Foreigners comprised 26% of total full-time graduate S/E enrollment and more than 40% in the mathematical sciences, the highest percentage of all the sciences. In 1977, by contrast, only 15% of all full-time graduate students in S/E fields were foreign, and in the mathematical sciences the figure was 25%.

Choice of field. The data reveal a difference in field choices between foreigners and U.S. citizens. The percentages of foreigners enrolled in the mathematical, physical, and computer sciences were higher than the proportion of U.S. citizens choosing these fields. Conversely, relatively more Americans than foreigners were enrolled in life, social, and environmental sciences and psychology. It should be noted, however, that the number of foreign students increased in all major fields in 1985, while the number of U.S. citizens fell in all fields except the mathematical sciences, computer sciences, and engineering. Thus the proportion of foreigners was higher in all major fields in 1985 than in 1977.

Postdoctorates. The 22,700 postdoctorates employed by doctorate-granting institutions in fall 1985 represented a 5% increase over 1984, continuing the steady increase of the past several years. Accounting for nearly all the growth, the number of foreign postdoctorates increased by 12%, compared to a growth of less than 1% for U.S. citizens. Nearly two-fifths of the postdoctorates were non-U.S. citizens, up from one-third in 1979. More than 60% of all postdoctorates were in the life sciences.

Women. The growth rate in number of women enrolled full-time fell to less than 1%, much less than the 1979–1984 average annual growth rate of 5% and less than the 2% rate of increase in male graduate enrollment. Women constituted 23% of the postodoctorates employed by doctorate-granting institutions, up from 18% in 1979.

Estimated total figures in the survey are based on responses from all 325 doctorate-granting institutions in the U.S. and a stratified random sample of 293 U.S. institutions with one or more master's-level program in S/E fields. Responses were received from 94% of the departments surveyed. For a copy of the survey highlights ("Foreign Students Fueled 2% Rise in 1985 Graduate Sciences and Engineering Enrollment," *Science Resource Study Highlights*, June 12, 1987), or more detailed statistical tables, contact J. G. Huckenpahler, Division of Science Resource Studies, 202-634-6082.

National Medals of Science Awarded

On June 25, 1987, President Reagan awarded National Medals of Science to twenty individuals in recognition of their achievements in mathematics, science, and engineering. Among the science medal recipients were two mathematicians, Raoul Bott of Harvard University, and Michael Freedman of the University of California, San Diego.

The National Medal of Science was established by Congress in 1959 to provide special recognition to individuals for their outstanding contributions to knowledge in the physical, biological, mathematical, engineering, behavioral, or social sciences. Selection is based on the total impact and importance of an individual's work on the present state of his or her chosen field. In addition, achievements of an unusually significant nature are considered in relation to their potential effects on the development of scientific thought.

Raoul Bott was honored "in recognition of his profound studies in the topology of Lie groups and differential geometry over many decades, and in particular for his 'periodicity theorem.'"

Raoul H. Bott was born September 24, 1923, in Budapest, Hungary. He received his D.Sc. in mathematics from the Carnegie Institute of Technology in 1949. He was a member of the Institute for Advanced Study from 1949–1951, and from 1955–1957. From 1951–1959, he advanced from instructor to professor of mathematics at the University of Michigan. He moved to Harvard as a professor in 1959, was Higgins Professor of Mathematics from 1974–1977, and has been William Caspar Graustein Professor of Mathematics there since 1977.

Professor Bott served as member-at-large of the Council of the AMS from 1961–1963, and from 1968–1970. He was vice-president of the Society from 1974-1975. He has served on the following AMS committees: the *Proceedings* Editorial Committee (Associate Editor, 1956–1958); the Committee to Select Hour Speakers for Western Sectional Meetings (1958-1959); the Committee to Nominate Officers and Members of the Council for 1961; the Mathematical Reviews Coverage Committee (1961); the Executive Committee (1961-1962, 1971); the Invitations Committee for the Symposium in Algebraic and Differential Topology (1963); the Committee to Nominate Members of the Council to Run for the Executive Committee (1964); the Nominating Committee (1965); the Committee to Select the Winner of the Veblen Prize (1966, 1971, 1981); the Organizing Committee for the 1973 Summer Research Institute; the Organizing Committee for the Summer Institute on Algebraic and Geometric Topology, July 1976; and the Committee on Affirmative Action Procedures (1976–1978). He was a member of the *Colloquium* Editorial Committee (1985–1987) and is currently chairman of the same committee.

Professor Bott has given Invited Addresses in Ann Arbor (August 1955), in Philadelphia (October 1966), and in Providence (August 1978). He gave a 30-minute address at the International Congress of Mathematicians in Edinburgh in 1958. He has spoken at the Symposium on Differential Geometry in Tucson (February 1960); at Summer Research Institutes on Differential Geometry (Stanford, 1973) and on Algebraic and Geometric Topology (Stanford, 1976); and at the Symposium on the Mathematical Heritage of Henri Poincaré in Bloomington (April 1980). He delivered Colloquium Lectures at the Summer Meeting in Eugene, Oregon in August 1969 and at the Summer Meeting in Providence in August 1978.

An honorary member of the London Mathematical Society, Professor Bott was their Hardy Lecturer in 1985. He holds honorary degrees from McGill University and the University of Notre Dame.

Professor Bott was AMS representative to the Board of Editors of the *American Journal of Mathematics* (1969–1971). He was a Sloan Fellow from 1956–1960 and was awarded the Veblen Prize in 1964. He is a member of the National Academy of Sciences.

Clifford H. Taubes of Harvard University was asked by the Editors of *Notices* to comment on Bott's contributions. He responded:

> Raoul Bott received the National Medal of Science for his pioneering studies in geometry and topology. One of the most influential mathematicians of recent decades, he has made fundamental contributions in these areas of mathematics.
>
> His most famous work is the "periodicity theorem," which bears his name. The periodicity theorem exemplifies the themes which characterize his career to date: where topology and geometry meet lie insights and visions of unusual clarity and depth.
>
> The Bott periodicity theorem was the culmination of a novel and enlightened application of Morse theory which culminated with the computation of the stable homotopy of the classical Lie groups. Using Morse theory, he also uncovered a great deal of the elegant topological and geometric structure of these groups and of their associated homogeneous spaces. The periodicity theorem and related work now form a cornerstone in K-theory and in the index theory for elliptic operators.

Raoul Bott and Michael Atiyah studied the effect of group actions on elliptic differential operators. The investigators revealed a new understanding of the geometry and topology of differential operators. The new understanding resulted in various surprising and powerful generalizations of the classical Lefschetz fixed point formula.

His exposition with Atiyah and V. K. Patodi on the relationship between the heat equation and the index theorem remains a fundamental reference on index theory for elliptic operators.

Raoul Bott was the first to recognize topological obstructions to the integrability of subbundles of the tangent bundles of smooth manifolds. This and related work on the geometry and topology of foliations is now considered foundational material.

More recently, he began an investigation of Morse theory in the equivariant context. With Michael Atiyah, the equivariant Morse theory was applied to the physicists' Yang-Mills equations. The result married geometric invariant theory with symplectic geometry and equivariant topology to provide a new understanding of the geometry of vector bundles over Riemann surfaces.

The theme here, as always, was to join topology with geometry to produce new and elegant insights.

Raoul Bott's current research appears aimed, in part, at understanding the geometry in the current physical theories of elementary particles. However, this interest in physics is not new, for his first published paper (with R. J. Duffin) was called "Impedance Synthesis Without the Use of Transformers," and it was published in the *Journal of Applied Physics.*

Raoul Bott's most lasting legacy will most likely not be the long and impressive list of theorems which bear his name. Rather, it could be his unique perspective on geometry and topology. His way of looking at mathematics is profoundly powerful; and profoundly sensitive. The power of this perspective stands revealed by the list of mathematical subjects which owe a debt to Raoul Bott, or to one of his many illustrious and distinguished students.

Michael Freedman was honored "for his proof of the Poincaré Conjecture in dimension four: a topological four-manifold is homeomorphic to S^4 if it is homotopy equivalent to S^4, one of the greatest achievements in mathematics in this century."

Michael H. Freedman was born April 21, 1951, in Los Angeles, California. He received his Ph.D. from Princeton University in 1973. He has held positions at the University of California at Berkeley (1973–1974), the Institute for Advanced Study (1975), and the University of California at San Diego (1976–present).

Professor Freedman gave addresses in AMS Special Sessions on algebraic and geometric topology at the Far Western Sectional Meeting in Hayward, California (April 1977) and on Dehn's lemma at the Annual Meeting in San Francisco, California (January 1981). He also gave Invited Addresses on Bing topology, infinite procedures, and the Poincaré conjecture in dimension four at the AMS Far Western Sectional Meeting in Bellingham, Washington (June 1982) and on four-dimensional manifolds at the AMS Annual Meeting in Denver, Colorado (January 1983).

He is an associate editor for *Annals of Mathematics*, *Journal of the AMS*, *Journal of Differential Geometry*, and *Topology.* Professor Freedman was awarded a Sloan Fellowship in 1980. In 1984, he was named the California Scientist of the Year and was elected to the National Academy of Sciences. In 1985, he was elected to the American Academy of Arts and Sciences, received a MacArthur Fellowship, and became the first Charles Lee Powell Professor in Mathematics at the University of California, San Diego. In 1986, he was the recipient of the Veblen Prize awarded by the AMS. At the 1986 International Congress of Mathematicians in Berkeley, he received a Fields Medal, in part for proving the Poincaré Conjecture in dimension four.

Robion C. Kirby, of the University of California, Berkeley, was asked by the Editors of *Notices* to comment on Freedman's contributions. He responded:

> Mike Freedman is a mathematician of great originality and depth. He is best known for his classification of 4-dimensional topological manifolds. Just as a closed 2-dimensional manifold is classified by its Euler number $(V-E+F)$, so Freedman proved that a simply connected, closed, topological 4-manifold is classified by an algebraic invariant, its intersection form on its second homology group. One corollary is a proof of the 4-dimensional Poincaré conjecture. Another consequence of his work plus Simon Donaldson's breakthrough is that ordinary 4-space, R^4, has many exotic differential structures.
>
> Smooth 4-manifold theory was known as a hard subject in which to make a living; topological 4-manifolds were thought to be untouchable until Freedman's stunning achievement. His proof took a beautiful construction of Andrew Casson in 1974, carried it much further with smooth techniques, and then blended in "Bing topology" under Bob Edward's supervision to obtain a result of unsurpassed originality.

New Director of Scientific Computing at DOE

David Nelson has been appointed Director of the Scientific Computing Staff at the Department of Energy's Office of Energy Research (OER). Nelson, who has a Ph.D. in mathematics from the Courant Institute of Mathematical Sciences at New York University, was previously director of the applied plasma physics program at the Department's Office of Fusion Energy. In his new post, Nelson will be in charge of the OER's Applied Mathematical Sciences Research program, as well as their supercomputer access program.

BMS Activities

In 1984, the National Academy of Sciences/ National Research Council (NAS/NRC) established the Board on Mathematical Sciences (BMS). The Board is charged with providing a unified voice for advising the government on pure and applied mathematics and statistics. Phillip Griffiths, Duke University, is Chairman of the BMS, and Ronald Pyke, University of Washington, is Chairman of the Board's Committee on Applied and Theoretical Statistics (CATS). The BMS is involved in a wide variety of projects, some of which are desribed below.

U.S. Survey Report. Begun when the BMS was first established, this extensive report covers pure and applied mathematics and statistics. The BMS is revising the report and has renamed it "Mathematical Sciences: Some Research Trends." The report is intended for the member agencies of the Interagency Committee on Extramural Mathematics Programs and should be released this fall.

MS2000. The BMS and the Mathematical Sciences Education Board (also a board of the NAS/NRC) are co-sponsoring this major undertaking, which will set an agenda and framework for college and university mathematics. The BMS has sought continued funding for fiscal year 1988 from the National Science Foundation. Bernard Madison of the University of Arkansas will provide primary staff and direction of the project. As part of MS2000, Lynn Arthur Steen, St. Olaf College, will be the primary author of "A Report to the Nation," which will assess U.S. mathematics education and present a national plan for reform. Steen and Ronald G. Douglas, State University of New York at Stony Brook, will serve on the MS2000 steering committee.

Reports on cross-disciplinary research. The BMS will issue a series of short reports on areas in which there have been fruitful interactions between mathematics and other disciplines. The reports are intended for policy use, but may be of interest to a wider audience. One of the reports will include a description of cross-disciplinary research pursued at the mathematics institutes sponsored by federal agencies.

Chairman's Colloquium. This annual meeting of chairmen of mathematical sciences departments seeks to promote discussion of issues of federal importance. In particular, it provides a forum for federal agencies to communicate information about their projects. Because of MS2000 and possible education initiatives at the agencies, as well as the trend toward funding research centers, this year's colloquium will focus on these topics. (See the second announcement of the colloquium in this section of *Notices*.)

Science Week Symposium. In 1987, this project focused on statistical sciences. The Board is now assessing the cost-benefit relation of the symposium. Funding is primarily from core grants.

National Security Agency Panel. The National Security Agency intends to expand its extramural mathematics program over the next several years. The BMS has agreed to assist the agency by forming an advisory panel for the program.

The board is conducting additional projects through CATS and panels for the various funding agencies.

On July 1, Frank Gilfeather left his position as staff director of the BMS to return to the University of Nebraska. His successor had not been named at the time of this writing. Seymour Selig and Robert Smythe are staff associates at the Board, and Rose Kopera is the staff assistant.

The Board staff can be contacted at Board on Mathematical Sciences, National Academy of Sciences, Room NAS311, 2101 Constitution Avenue N.W., Washington, DC 20418, 202-334-2421.

Calculus Teaching Reform Conference

On October 28-29, 1987, the National Research Council will hold a national conference on calculus teaching reform at the National Academy of Sciences in Washington, DC. Entitled "Calculus for a New Century," the conference will disseminate information on the problems and potential of calculus instruction in order to foster innovation in calculus teaching and to create a national environment receptive to calculus teaching reform.

The impetus to reform the teaching of calculus comes from many sources. The increasing utility of calculus in all fields of science, together with changes within those fields, have pointed to inadequacies in current teaching methods and curricula. The use of modern computers offers unprecedented opportunities in calculus instruction by replacing tedious drills with more sophisticated concepts that can impart a sense of wonder and discovery to the students.

Motivated by a conference in January of 1986, the MAA has led a discussion within the mathematical community on the subject of calculus teaching reform. This discussion has

prompted the NSF to include plans for pilot calculus teaching projects in its 1988 budget.

The Board on Mathematical Sciences and the Mathematical Sciences Education Board of the NRC are cosponsoring this conference as part of their joint comprehensive project, "The Mathematical Sciences in the Year 2000: Assessment for Renewal in U.S. Colleges and Universities" (MS2000). The conference proceedings and prospectus are being published through a cooperative arrangement with the MAA.

Registration for the conference is limited to 600 participants for day 1 (October 28), which will consist of general addresses and panel discussions, and to 150 participants for day 2 (October 29), which consists of discussion groups. A nonrefundable registration fee of $25 will be charged and includes lunch on day 1, a copy of the conference proceedings, and preconference copies of the background papers. The deadline for registration is **Monday, October 19**. For further information, contact MS2000, National Research Council, 202-334-3294.

National Chairmen's Colloquium 1987

This is the second announcement of this year's Board on Mathematical Sciences' Chairmen's Colloquium, to be held in Washington, D.C., on October 9–10, 1987. (The first announcement appeared in *Notices*, August 1987, page 743.) The board hopes to provide a dynamic program in order to maximize the benefits from this important forum.

One focus of this year's colloquium will be on the shift in federal agency funding to greater support of centers. The second focus will be on the national emphasis on post-secondary mathematics and structure. In addition, staff members of the federal funding agencies in mathematics will give current and detailed information about their programs to attending department chairmen.

The focus on the increased funding of centers will discuss the proper response of departments in the mathematical sciences to this shift. Both the National Science Board of the NSF and the NAS have recently prepared and issued reports on the funding of centers. The mathematical sciences community should prepare to respond in the most beneficial manner.

An important and informative discussion of centers relating to mathematical sciences departments is included in Allyn Jackson's article on the NSF Advisory Committee meeting in the June 1987 *Notices*, pages 603–606. The urgency of the discussion is underscored by Erich Bloch's statement in the April 3 issue of *Science*; "If all we are doing is the individual research grant approach to science, then I think this country is going down the drain."

The Board on Mathematical Sciences, in conjunction with the Mathematical Sciences Education Board, is undertaking a major study of post-secondary mathematical sciences, "Mathematical Sciences in the Year 2000: Assessment for Renewal in U.S. Colleges and Universities" (MS 2000). The study is projected to have an impact similar to that of the David report, but with a broad focus on talent, curriculum, and resources in the full range of post-secondary mathematics. An important part of MS 2000 is a project in cooperation with the MAA to prepare material and encourage a national dialogue concerning the renewal of calculus instruction in the U.S. It is anticipated that the NSF will have a university and collegiate issues.

This year the program will begin the afternoon of Friday, October 9, with three parallel programs being planned: federal issues in the statistical sciences, computational facilities and support in mathematical science departments, and background preparation for the calculus renewal. We would appreciate suggestions or volunteers for a panel concerning experiences and frustrations in developing computational facilities and support in mathematical sciences departments. There will be a banquet Friday evening, followed by a speaker and discussion.

The agenda on Saturday, October 10, will concentrate on federal issues and programs, especially the funding of centers, and will provide ample interaction with agency personnel. In addition, we will try to provide facilities for regional interaction and additional time for chairman to interact with each other.

Chairmen and their representatives are encouraged to attend this important event. Those who have not registered and wish to do so should contact the BMS office at 202-334-2421. Although the deadline for registration will have passed by the time this issue of *Notices* reaches its readers, every effort will be made to accommodate those who wish to attend.

Computing in Undergraduate Mathematics

Paul Zorn, St. Olaf College, Northfield, Minnesota

The following "issues paper" was prepared in conjunction with a conference organized by the Associated Colleges of the Midwest and held in Chicago last June. The conference, arranged by Lynn Arthur Steen, Past President of the Mathematical Association of America, examined the role of computing in undergraduate mathematics.

During the conference, a Planning Committee (listed below) met with participants from the NSF and with over one hundred midwest mathematicians and college mathematics teachers to discuss the ideas in the paper.

Funding for the conference was provided by the NSF, which is seeking to increase the impact of its College Science Instrumentation Program on undergraduate mathematics. The NSF views this "issues paper" as a means of stimulating interest within the mathematical community and encouraging participation in this program. The views expressed in this paper are those of the author and do not necessarily reflect the views of the National Science Foundation.

Modern computing raises unprecedented opportunities, needs, and issues for undergraduate mathematics. The relation between computing and mathematics is too young, and changing too quickly, to admit definitive positions. None are taken here. In mathematical language, this paper is not an authoritative monograph but a topical survey with many open questions.

We do not assert that computing serves every worthwhile purpose of undergraduate mathematics. The interesting issues are genuine questions: Where in the curriculum is computing appropriate, and why? What does computing cost—in time, money, and distraction from other purposes? If computers handle routine mathematical manipulations, what will students do instead? Will students' manipulative skills and intuition survive? Should we teach things machines do better?

So much said, it would be disingenuous to deny the viewpoint that motivates this paper, and is implicit throughout—that we can and should use modern computing more than we have done to improve mathematical learning and teaching. Although we will argue that the computing resource has scarcely been tapped, this paper is not simply a plea for computers in the classroom. Mathematical computing is educationally valuable only as it alters and serves curricular goals of undergraduate mathematics. It follows that curricular goals should guide teaching uses of computing, not the other way around.

What is Computing?

Until recently, computing in undergraduate mathematics usually meant writing or running programs (in Basic or Pascal) for floating point numerical operations. Much more is now possible: symbolic algebra, sophisticated graphics, interactive operating modes—all with little or no programming required of the user. Computing should be understood broadly, comprising hardware, software, and peripheral equipment.

Other forms of educational technology, such as videodiscs, might someday become important teaching tools. They are not addressed here. Covering everything that now exists would be difficult; anticipating what may exist is impossible. Our scope is comprehensive only in the sense that many kinds of educational technology, like computing, amount to new ways of representing and manipulating mathematical information.

Mathematics and Computing

Computing drives the modern mathematical revolution. As Gail Young puts it in [3],

> ... [W]e are participating in a revolution in mathematics as profound as the introduction of Arabic numerals into Europe, or the invention of the calculus. Those earlier revolutions had common features: hard problems became easy, and solvable not only by an intellectual elite but by a multitude of people without special mathematical talent; problems arose that had not been previously visualized, and their solutions changed the entire level of the field.

Like Arabic numerals and the calculus, computing is a sharper tool, but it is also more than that. Computers do more than help solve old problems. They lead to new problems, new approaches to old problems, and new notions of what it means to solve problems. They change fundamental balances that have defined the discipline of mathematics and how it is pursued: continuous and discrete, exact and approximate, abstract and concrete, theoretical and empirical, contemplative and experimental. Computers change what we

think possible, what we think worthwhile, and even what we think beautiful.

Computing is becoming commonplace (if not ubiquitous) in mathematical research, even on classical problems. Without computers, research in many new areas would stop. Computing figured, more or less fundamentally, on the way to several recent spectacular advances, including the four color theorem and the Bieberbach conjecture. With numerical, graphical, and symbol-manipulating abilities, computers check calculations, test conjectures, process large data sets, search for structure, and represent mathematical objects in new ways. They make possible entirely new viewpoints on problems in mathematical research—viewpoints that are more empirical than deductive, more experimental than theoretical.

Computing has changed how mathematics is *used* at least as much as it has changed how mathematics is created. The changes are broad and deep, touching areas from arithmetic to statistics to differential equations. This part of the computer revolution, moreover, is happening in public. Changes at the rarefied research level may affect only a few people; changes at the "user" level reach a much broader constituency. Already, undergraduates freely—if sometimes naively—use sophisticated numerical "packages" in science and social science courses. Seeing computing all around them, students naturally expect some in mathematics courses, too.

It seems axiomatic (certainly to students!) that the profound effects of computing on research and applied mathematics should be reflected in undergraduate mathematics education. Honesty to our discipline and our own best interests as mathematics teachers both dictate so. Honesty requires at least that we keep ourselves and our students abreast of important developments in our field. Self-interest says we should do more than report what happens outside: we should avail ourselves of the enormous opportunities computers offer for teaching and learning mathematics.

Despite all this, computing has not yet changed the daily work of undergraduate mathematics very much. The standard freshman calculus course, for example, still consists largely of paper and pencil performance of mechanical algorithms—differentiation, graph-sketching, antidifferentiation, series expansion, etc.—just what machines do best. Graphical and numerical methods are usually treated as side issues. With a little computing power, they could illuminate important interplays between discrete and continuous ideas, exact and approximate techniques, geometric and analytic viewpoints.

Statistical as well as anecdotal evidence shows that mathematics lags behind the other undergraduate sciences in teaching uses of computing. In 1985 and 1986, for example, only 32 of approximately 2,800 proposals to the NSF's College Science Instrumentation Program came from mathematics departments. Galling as it is to be elbowed from the trough, this paucity of mathematics proposals is only a symptom. Our real problem is not too few proposals, but the opportunities mathematicians miss to revitalize teaching and learning.

Problems of the Past

Reasons for the lag in undergraduate mathematical computing are easy to guess. The clearest difference between mathematics and the physical sciences is in the roles experiment and observations play in each. Although mathematics has an essential (if informal) experimental aspect, especially in research, mathematics is not a laboratory discipline in the formal, ritualistic sense that applies to the other sciences. The value of "instruments," whether computers or chemicals, to support the experimental side of the natural sciences is taken for granted, but there is no similar consensus about undergraduate mathematics. This may change, but for now, the idea of mathematical "instrumentation" is still a novelty. Machines to support undergraduate mathematical experimentation are just appearing, and we are just learning to use them. Unlike our colleagues in the natural sciences, we mathematicians must convince our departments and college administrators—and sometimes ourselves—not just that we need particular items of equipment, but that we need equipment at all.

Computing may reshape college mathematics slowly also because computers raise harder, more fundamental pedagogical questions in mathematics than in other disciplines. Computers can thoroughly transform activities in a chemistry laboratory, but they need not change the basic ideas studied there. By contrast, modern computers handle so much of what we mathematicians traditionally teach that we are forced to rethink not only *how* we teach, but also *what* and *why*. Ironically, computers may have contributed so little in undergraduate mathematics just because they can do so much.

The cost of computer programming, measured in time and distraction, has been another impediment to mathematical computing. Is the effort of implementing, say, a simple Riemann sum program in Basic worth the mathematical insight it offers? Similar questions might seem to apply in other sciences, but experimental data generated in natural science laboratories is well suited to routine numerical manipulations; a few programs go a long way. Mathematical computing, being less circumscribed, is harder to "package," and the programming overhead is correspondingly higher.

Prospects for the Future

Given this history, why should things change? The simplest reason might be called "manifest

destiny." Like it or not, computing is already changing undergraduates' views of and experience with mathematics, and the rate of change is increasing. In freshman calculus, symbol-manipulating and graph-sketching programs on *handheld* calculators already reduce a good share of canonical exam questions to button-pushing. (See [4] and [5]; note particularly their metaphorical titles.) We mathematicians can either applaud or condemn these changes, but we can't ignore them. We will either anticipate and use computing developments, or we will have to fend them off.

Good omens for computing in undergraduate mathematics can also be seen in hardware and software improvements. Mathematical computing is becoming more powerful, cheaper, and easier to use. For example, "computer algebra systems" (Macsyma, Maple, Reduce, SMP, and others) are starting to appear on student-type machines. These systems do much more than algebra; they are actually powerful ("awesome," in students-peak) and flexible mathematics packages that perform a host of routine operations—symbolic algebra, formal differentiation and integration, series expansions, graph-sketching, numerical computations, matrix manipulations, and much more. Because no programming is needed (one-line commands handle most operations), all this power costs virtually nothing in distraction. For good or ill, computing is changing the mix of "working" and "thinking" that determine what it is to know and do mathematics.

The possibilities and problems computing raises for teaching would be important even if undergraduate mathematics were thriving. On the contrary, too few students study mathematics; of those who do, too few learn it deeply or well. Freshman calculus is a squeaky wheel, but general complaints are heard up and down the curriculum: students can't figure, can't estimate, can't read, can't write, can't solve problems, can't handle theory and so on. Lacking computers didn't cause all these problems, and having computers won't solve them all. Nevertheless, the climate for change is favorable (see, e.g., [2]).

Benefits and Opportunities

Computing can benefit undergraduate mathematics teaching in many ways. Understanding the context is important: Our goal is not more computers, but better mathematical learning.

1. *To make undergraduate mathematics more like "real" mathematics.* Mathematics as it is really used has many parts: formal symbol manipulation, numerical calculation, conjectures and experiments, "pure" ideas, modeling, and applications. Undergraduate students, especially in beginning courses, see mainly the first two at the expense of the others. Another mixture of ingredients might give students a better sense of context, and help them calculate more knowledgeably and effectively. By handling routine operations, computing can free time and attention for other things.

2. *To illustrate mathematical ideas.* Analytic concepts such as the derivative have numerical, geometric, and dynamical (i.e., time-varying) as well as analytic meaning. Pursuing graphical, numerical, and dynamical viewpoints is tedious or impossible by hand techniques. Doing so is easy and helpful with computing, especially if algebraic, graphical, and numerical manipulation are all available. Given these, a student might compute difference quotients algebraically, tabulate numerical values as a parameter varies, and observe the geometric behavior of the associated secant lines at various scales.

3. *To help students work examples.* Mathematicians know the value of concrete examples for understanding theorems and their consequences. Students need examples, too, but the points examples make are often obscured by computational difficulties. With computers, students can work more and better examples. In matrix algebra and statistics, large-scale problems become feasible. In calculus, subtle points can be clarified. The fundamental theorem, for example, is often misunderstood because students have insufficient experience with the "left side"—the integral defined by Riemann sums. With a machine to crunch the numbers, the "left side" makes numerical and geometric sense. When the area-under-the-graph function can be tabulated, graphed, and geometrically differentiated, for several integrands, then the idea of the theorem is hard to miss.

4. *To study, not just perform, algorithms.* Algorithmic methods—for matrix operations, polynomial factorization, finding gcd's, and other operations—are now a way of mathematical life. Students continually perform algorithms, but seldom study them in their own right. Rudimentary algorithm analysis (e.g., the O-notation) could be an important and timely application of elementary calculus. Recursion, iteration, and list processing, viewed as general mathematical techniques, also deserve more attention than they get. Treating these topics efficiently means implementing them, or seeing them implemented, on computers.

5. *To support more varied, realistic, and illuminating applications.* Limited by hand computations, many applications of college mathematics are contrived and trite. There are too many farm animals, rivers, and exotic fencing schemes. Computing allows both larger-scale versions of traditional applications (e.g., larger matrices, larger data samples) and new applications altogether (e.g., ones requiring numerical methods.) More flexible, less circumscribed applications not only *do* more, they also *show* more of the mathematics underlying them. Physical applications, for example, should be part of the historical, mathematical, and intuitive fiber of

elementary calculus. Hand techniques restrict the scope of feasible physical problems to those few that can be solved in closed form, using elementary functions. Other conceptually simple applications, like many from economics, lead to high-order polynomial equations, and so are also taboo. Only simple numerical methods (root finding, numerical integration, etc.) are needed to make such applications tractable.

6. *To exploit and improve geometric intuition.* Graphs of all kinds give invaluable insight into mathematical phenomena. With computer graphics, attention can shift from the mechanics of obtaining graphs—a substantial topic in elementary calculus—to how graphs represent analytic information. Sophisticated graphics (surfaces in three dimensions, families of curves, fractals) practically require computing. They ease difficult learning transitions: from one variable to several, from function to family of functions, from real domain to complex domain, from pointwise to uniform convergence, from step to step in iterative constructions.

7. *To encourage mathematical experiments.* The polished theorem-proof-remark style of mathematical writing hides the fact that mathematics is created actively, by trial, error, and discovery. Students can learn the same way, if the labor of experimenting is not too great. With computing, students can discover that square matrices "usually" have full rank, that differentiable functions look straight at small scale, and that there is pattern to the coefficients of a binomial expansion.

Mathematical experimentation is good both as a teaching tool and as an active, engaged attitude toward mathematics. We mathematicians often try to inculcate this attitude in students, begging them to "try something." Interestingly, the opposite problem—an excessively experimental attitude, or "hacking"—plagues computer science. Will computers breed *mathematical* hackers? Would that be a bad thing?

8. *To facilitate statistical analysis and enrich probabilistic intuition.* Data analysis in mathematical statistics is highly computational. Machines allow larger samples, and thus greater reliability and verisimilitude. Students see more *analysis,* and more of its power, with less distraction. Computing in undergraduate statistics is already becoming routine. As *methods* of data analysis becomes easier, *choosing* methods and interpreting their results becomes harder. Informed statistical analysis requires sound probabilistic intuition. Probabilistic viewpoints are also essential, of course, in classical analysis and in modern physical applications. By simulating random phenomena, computers illustrate probabilistic viewpoints concretely. Monte Carlo integration methods, for example, combine ideas from elementary calculus and probability, and show relations between them.

Undergraduate Mathematics Curricula and Instrumentation Planning Committee

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9. *To teach approximation.* The idea of approximation is important throughout mathematics and its applications. When students use mathematics—in other courses and in careers—they will certainly use numerical methods. Yet students' learning experience, especially in beginning courses, is almost entirely based on exact, algebraic methods: explicit functions, closed-form solutions, elementary antiderivatives, and the like. Numerical and graphical illustrations of approximation ideas are computationally expensive, but essential for understanding. Machine computing makes them possible.

To use approximation effectively, students need some idea of error analysis. Error estimate formulas are especially intractable for hand computation because they usually involve higher derivatives, upper bounds, and other mysterious ingredients. High-level computing (symbolic differentiation, root-finding, numerical methods) helps students understand error estimation without foundering in distracting calculations.

10. *To prepare students to compute effectively—but skeptically—in careers.* Applied mathematics students who pursue technical professions (engineering, actuarial science, business, and industry) will use mathematical computing in many forms. Some kinds of software (e.g., differential equation solvers, statistical analysis packages) are standard; students should see some of them in advance. Even more important than working knowledge of particular programs is a sound *mathematical* understanding of how those—or any—programs address the problems they purport to solve. Arbitrary choices—estimates, simplifications, stopping rules—are always implicit in applications software. Duly skeptical users must understand these choices and how they affect computed results.

11. *To show the mathematical significance of the computer revolution.* The relation between mathematics and computer science offers excellent object lessons in the interconnectedness of knowledge. As a matter of general education, and for practical reasons, students should learn something about the mathematical foundations of computing, and about the mathematical problems computing raises.

12. *To make higher-level mathematics accessible to students.* Undergraduates in the natural sciences have always participated in serious research. Computing offers similar opportunities in mathematics as it strengthens the concrete, empirical side of mathematical research. With powerful graphics, students might investigate the fine structure of Mandelbrot sets, observe evolution of dynamical systems, and explore geodesics on complex surfaces.

Resource Requirements

No one doubts that educational uses of computing require hardware and software. It is less well understood that resource requirements only begin there. Chemistry departments require more than chemicals and equipment to support their laboratory courses. In the same way, more than hardware and software is needed if the benefits of having hardware and software are to be realized.

College mathematics teachers who use computing face common problems. Some problems are local (e.g., securing institutional support) and some are national. Many stem from the fact that computing is relatively new to mathematics. Mathematicians are just beginning the resource management tasks our scientific colleagues have worked at for decades: convincing administrators, purchasing and maintaining equipment, modifying time-hardened courses, developing curricular rationales, and articulating what we are doing. Undergraduate science departments write proposals, carry out supported projects, and administer grants as a matter of habit. In mathematics departments, these habits are less ingrained, and "machinery" to support them—administrative help, program and deadline information, accounting procedures—is usually primitive.

1. *Technical support.* Natural science departments maintain a complete apparatus of support services for their laboratory courses: equipment maintenance, classroom demonstration equipment, dedicated space, and paid student assistants. As mathematics departments develop and use their own versions of "instrumentation," the same support needs arise.

2. *Institutional support.* Most colleges have computers, but not necessarily the right ones, or in the right places, for mathematical use. Less tangible forms of institutional support are just as important: teaching loads that credit faculty time for developing and staffing mathematical laboratories, tenure and promotion procedures that reward such work, and administrative support for matching money for grant proposals.

3. *Time.* Realizing the mathematical benefits of computing, whatever they are, costs time—ours and our students'. Not all benefits will prove worth having, but for those we judge worthwhile, time should be provided, and accounted for honestly. Instructional computing, like other new things, often begins with a trail-blazing department zealot, for whom the work is its own reward. Eventually, ownership and responsibility should be shared. Unless time is made available, computing will remain the zealot's private province.

4. *Courseware.* It seems historically inevitable that computing will change mathematics courses and course materials. If we mathematicians are to manage the process, we need hard-

ware, software, and "courseware"—instructional material (manuals, exercises, tests, discursive material, and full textbooks) that thoughtfully integrates, rather than simply appends, the computing viewpoint into substantial mathematics courses. The necessary hardware and software exist, or will soon. The laggard, inevitably, is courseware. Robust courseware is expensive and time-consuming to develop, and it must find a precarious balance between being too specific to be portable and being too general to be useful.

5. *Technical information.* Hardware and software change rapidly. In order to choose equipment wisely and use it effectively, mathematicians need technical specifications for hardware and software, critical reviews of educational software, reliable price data, and (hardest of all) a sense of the future. Because hardware usually outruns software, the naive strategy (choose software, then hardware to run it) guarantees obsolete hardware. Should our professional societies marshal the expertise we need? How?

6. *Shared experience.* Who is doing what? Where? With what equipment? What worked? How was topic X treated? Undergraduate mathematical computing, like any quickly developing field, depends on communication if the wheel is not repeatedly to be reinvented. Several models exist: The Sloan Foundation supports several college projects and a newsletter on teaching uses of computer algebra systems, and occasional conferences on the subject. The Maple group at the University of Waterloo publishes a users' group newsletter and organizes electronic communications for an interest group in teaching uses of computer algebra. The *College Mathematics Journal* carries a regular column (see[1]) on instructional computing. The MAA and its Sections sponsor minicourses nationally and short courses regionally. More such efforts are needed.

Open Questions

Technical, financial, institutional, and logistical considerations notwithstanding, the most difficult and interesting questions computing raises are mathematical and pedagogical. Although few answers are hazarded here, most users face some of these questions, at least implicitly. As a discipline, we face them all regularly.

1. *Will computers reduce students' ability to calculate by hand? If so, is that a bad thing?* When computers do routine manipulations in mathematics courses, students must do something else. How will students who have never mastered routine calculation, or those who enjoy it, fare in such courses? Will seeing the results but not the process of calculations help them understand, or further mystify them? If hand computation builds algebraic intuition—"symbol sense"—will machine computation destroy it?

2. *How should analytic and numerical viewpoints be balanced?* To estimate $\int_{-1}^{1} \frac{1}{1+x^2}\,dx$ numerically as 1.57 is routine. To see analytically that the answer is $\frac{\pi}{2}$ is memorable. Both facts are worth knowing. Will students learn them both in the calculus course of the future? To paraphrase Richard Askey, exact solutions are precious *because* they are rare. Will students learn this? Will we remember it?

3. *How does computing change what students should know?* Traditional courses are full of methods and viewpoints that arose to compensate for the limitations of hand computation. Do new computational tools render these topics obsolete? More generally, should we teach mathematical techniques machines can do better? Some things, surely, but which, and why? Partial fraction decomposition? The square-root algorithm? For topics we keep, will we forbid computers? What will replace topics we discard?

4. *Will the mechanics of computing obscure the mathematics?* We teach mathematics, not computing, and mathematics syllabi are already full. How will we use computing to teach mathematics without distracting technical excursions? How will we gauge whether computing effort is commensurate with the mathematical insight it gives? Can computing *save* teaching time? Anecdotal evidence suggests that calculus students can use high-level programs without undue difficulty or distraction. Can pre-calculus students do the same?

5. *How will computing affect advanced courses?* Mathematical computing often occurs in lower-level courses, like calculus, which have other educational goals than preparation for advanced courses. Will alumni of such courses be better or worse prepared for advanced mathematics? Should advanced courses change along with introductory courses? Can computing improve advanced courses in their own right?

6. *Computing and remediation.* Remedial course emphasize mechanical operations. Will relegating routine operations to machines reduce the need for remediation? Or could deeper, more idea-oriented courses require *more* remediation for weaker students? In either case, how can computing help students in remedial courses? Can such students use advanced computing, or do they lack some necessary sophistication?

7. *CAI vs. tool-driven computing.* In some applications, computers act as intelligent tutors, leading students through carefully prescribed tasks. In others, computers are flexible tools: students decide where and how to use them. Where is each model useful?

8. *Equity and access to computing.* Sophisticated computing on powerful computers is still financially expensive and, for most people, not always on hand. Calculators, for the price of four books, already handle graphical, numerical, and algebraic (including matrix) calculations.

Sophisticated calculators might both radically "democratize" high-level computing, and make it as natural as handheld arithmetic computation. Will they? Should they?

9. *Will computing help students learn mathematical ideas more deeply, more easily, and more quickly?* Conjecturally, yes, but the conclusion is not foregone. For undergraduate mathematics, this is the bottom line.

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Letters to the Editor

Pure vs. Applied Mathematics and Federal Funding

Some recent discussions of federal mathematics funding willfully ignore the commonly recognized distinction between *pure* mathematics and *applied* mathematics. Applied mathematics is by definition useful; much of pure mathematics is utterly and totally useless. Those who would blur this distinction like to argue that the uselessness is only temporary, that much of pure mathematics will eventually "trickle down" to applications. This argument is at best questionable and at worst a deliberate fraud.

The trickle-down theorists like to use the barbarism "mathematical sciences." This ugly phrase suits their purposes in two ways:

1. It implies that pure mathematics and applied mathematics are happy partners in the same great enterprise, rather than bitter rivals for the same federal money.

2. It invokes the sacred name of science, thus tending to choke opposition by those who still regard (pure) mathematics as among the liberal arts (those arts befitting free men, rather than slaves).

The federal government clearly should support applied mathematics; whether it should also support pure mathematics is not so clear. Those who would confuse the issue by implying that mathematics is a science, in the same sense that chemistry and physics are sciences, are on shaky ground.

The issue is not merely academic. Taxpayers' money is at stake, and conspiracy to defraud the United States is a crime.

Steven H. Cullinane
Warren, Pennsylvania
(Received June 21, 1987)

Support for Refusniks

For almost eight years I strived for permission to leave the U.S.S.R. For all these years Soviet authorities refused my application without any legal grounds. These were very hard years for my family. My wife (also a mathematician) and I had no job and no access to scientific libraries. It was impossible for us to publish papers in Soviet scientific journals. Our children were faced with serious difficulties. Actually we were outcast.

For these hard years we were happy to feel the solidarity and support of many of our colleagues. Letters from the participants of scientific conferences, visits of colleagues, appeals to the Soviet authorities with the request to grant us permission to leave—all this was highly important for us (the latest letter was published in AMS *Notices*, no. 255). This helped us to survive and it was this solidarity that played the decisive role in permitting us to leave. In spite of some positive changes in the U.S.S.R. our problem would hardly have been solved if not for the persistent attention to the human rights problem as a whole, to the problem of refusniks and to our problem in particular. So many people helped us for these years that it is impossible to name all of them. With all my heart I want to thank my friends and colleagues for their support.

I also want to emphasize that the fact that myself and some other scientists refusniks were at last permitted to leave, shows the efficacy of the activity of our colleagues. I call on the mathematical community to continue supporting those of our colleagues in the Soviet Union who are still denied their right to leave the U.S.S.R.

Mark Freidlin
University of Maryland,
College Park
(Received June 29, 1987)

Request for Support Letters

I am a member of the Mathematical Association of America. I write you because I wish to relate to you the following facts:

• Last year I received an invitation, from Professor Richard K. Guy, to participate in the Eugene Strens Memorial Conference on Intuitive and Recreational Mathematics and its History (July 17–August 2, 1986; University of Calgary,

Policy on Letters to the Editor

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

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

The committee reserves the right to edit letters.

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

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.

Alberta, Canada) to present a 15–20 minute talk *Mathematical Fancies & Paradoxes*;

and another one, from Professor Andrew M. Gleason, to participate in the International Congress of Mathematicians (August 2–11, 1986; University of California, Berkeley, California, USA) to present a 10 minute short communication, *An infinity of unsolved problems concerning a function in number theory* in the Section 3 (Number Theory). I had already paid $125 as my preregistration fee.

But the Romanian authorities did not grant me a visa, although I had obtained the Canadian and American visas. Moreover, they have caused me to be unemployed since September 1986 and no office in Craiova will give me a job.

• This year I received another invitation, from Dr. B. Stankovic (Novi Sad), to participate in the International Conference on Generalized Functions, Convergence Structures and Their Applications (June 23–27, 1987; University of Dubrovnik, Yugoslavia) and to present a paper. But the Romanian authorities have told me that I may not participate in the Conference because I am unemployed!

In the future I should desire to obtain the Romanian visa so I may participate in international conferences. Hence, as the mathematician Radu Rosu did (see *Notices*, November 1985, page 795, "I appeal to the mathematical community, especially to former members of the IAS, to express concern for such cases by support letters to Nicolae Ceausescu, Honorary President of the Romanian Academy, Victoriei 125, Bucharest 1, Romania and Elena Ceausescu, Head of the Romanian Council for Sciences and Technology, Victoriei Sg. 1, Bucharest 1, Romania."

Thank you very much for your support.

Florentin Smarandache
Craiova, Romania
(Received May 26, 1987)

EDITOR'S NOTE: The grammatical construction of this letter was edited by the AMS office for the purpose of clarity.

Queries

Edited by Hans Samelson and Stuart Antman

QUESTIONS ARE WELCOMED from AMS members regarding mathematical matters such as details of, or references to, vaguely remembered theorems, sources of exposition of folk theorems, or the state of current knowledge concerning published or unpublished conjectures. This is not intended as a problem corner, except for occasional lists of problems collected at mathematical meetings.

REPLIES from readers will, when appropriate, be edited into a composite answer and published in a subsequent column. All answers received will be forwarded to the questioner.

QUERIES and RESPONSES should be typewritten if at all possible and sent to Queries Column, American Mathematical Society, P. O. Box 6248, Providence, Rhode Island 02940.

Queries

382. Kevin P. Walker (Engineering Science Software, Inc., P65 Log Road, Smithfield, RI 02917). Consider the principal value integral

$$F(x) = \int_{-1}^{1} (t-x)^{-1} dt = \log|(1-x)/(1+x)|$$

for $x \in (-1,1)$. If the given value of this integral is not known, then $F'(x) = (x-1)^{-1} - (x+1)^{-1}$ can be found by carefully accounting for the limits inherent in the notion of principal value. On the other hand, the following formal procedure also yields the correct $F'(x)$: the integrand $(t-x)^{-1}$ is replaced with its Fourier integral

$$\frac{i}{2}\int_{-\infty}^{\infty} \operatorname{sgn}(\xi)\exp[-i\xi(t-x)]d\xi,$$

and the integral of this expression with respect to t over $[-1,1]$ is replaced with the integral obtained by reversing the order of integration. The resulting representation for $F(x)$ can be differentiated with respect to x to yield the expression for $F'(x)$ given above. I have noticed that this procedure can be applied to many such integrals. Is this fact well known, and if so, where is it demonstrated?

383. Moshe Lotan (Aminadav St., 12/23, Tel Aviv (67066), Israel). The values of $q(n)$ [= number of partitions of the natural number n into unequal parts] seem to be mostly even. Only 36 of the first 500 values are odd, and in fact the odd values get rarer as n increases. This is not so for $p(n)$ [unrestricted partitions], with 275 odd values in the first 500. Is there an explanation for this phenomenon?

384. A. F. Badalamenti (Nathan S. Kline Institute, Orangeburg, New York 10962). For more than one decade I have been working with mathematical representations of psychoanalytic theory (both Freudian and Jungian). I am often told that there are others who have done similar work, yet no one has yet been able to give me a reference. Does anyone know of such references? The knowledge areas used in this research are mostly topology and algebra. The research is mathematical with applications (simultaneously) to psychiatry and artificial intelligence.

Responses

The editors would like to thank all those who sent in replies.

373. (vol. 34, p. 303, February 1987, Aldo Peretti) Solutions by radicals for solvable quintics. **Reply**: Explicit but rather unwieldy formulas for the solution of solvable quintic equations by radicals are given in E. McClintock, *Analysis of quintic equations*, Amer. J. Math. **8** (1886), 45–84. A feasible procedure that is not restricted to the case of degree five is outlined in my paper *Über die praktische Auflösung von Gleichungen höheren Grades*, to appear in Math. Semesterberichte, Institut für Mathematik, Universität Innsbruck (with numerical examples of degrees 5, 6). For teaching purposes, it seems to me more appropriate than McClintock's long proof of his formulas. (Contributed by K. Girstmair)

377. (vol. 34, p. 640, June 1987, Vasile Ion Istrăţescu) Early uses of the zeta-function. **Reply**: Charles Babbage, who was interested in prime numbers, developed a novel symbolic formula for $\varsigma(n)$ (see Query 226, vol. 27, p. 526, October 1980, Albert Mullin). (Contributed by A. A. Mullin)

379. (vol. 34, p. 758, August 1987, Aurel Spataru) Does $\frac{1}{n}\sum_0^{n-1}\{2^i x\}^i$ go to 0 a.e.? **Reply**: Since almost all x are normal with respect to base 2 the sequence $2^i x$, $i = 1, 2, \ldots$ is uniformly distributed mod 1 for almost all x and so for fixed $h = 1, 2, 3, \ldots$

$$\lim_{n\to\infty} \frac{1}{n}\sum_{i=0}^{n-1}\{2^i x\}^h = \frac{1}{h+1} \quad \text{a.e.}$$

Here $\{\cdot\}$ denotes the fractional part. Hence if $h > 1/\epsilon$,

$$\begin{aligned} 0 &\le \limsup_{n\to\infty} f_n(x) \\ &:= \limsup_{n\to\infty} \frac{1}{n}\sum_{i=0}^{n-1}\{2^i x\}^i \\ &\le \limsup_{n\to\infty} \frac{1}{n}\sum_{i=0}^{n-1}\{2^i x\}^h < \epsilon \quad \text{a.e.} \end{aligned}$$

(Contributed by W. Philipp and H. L. Montgomery)

380. (vol. 34, p. 758, August 1987, Seung Jin Bang) (a) Does $X \times Y \approx X \times Z$ imply $Y \approx Z$ (X nondiscrete)? (b) Does $X^2 \approx Y^2$ imply $X \approx Y$? **Reply**: Simple counterexamples to (a) exist. E.g., $X = \prod\{0,1\}$, $Y = \{0\}$, $Z = \{0,1\}$; or $X = I = [0,1]$, $Y =$ annulus A with two "whiskers" outside, $Z = A$ with one whisker outside, and one inside; see R. H. Fox, Fund. Math. **34** (1947), 278–287 (MR **10**, p. 316). The statement remains false for $X = \{0,1\}$. (b) is an old problem of S. Ulam, #56, Fund. Math. **20** (1933), 285, also #77 in the Scottish Book (see R. D. Mauldin's commentary and bibliography of 17 items in his edition of the latter). Fox gave the first counterexample (loc cit). The problem appears to be open for compact 3-manifolds or even polyhedra. More counterexamples available through this column. (Contributed by F. Galvin, J. J. Schäffer, N. Sivakumar, and K. Sundaresan)

381. (vol. 34, p. 758, August 1987, Seung Jin Bang) Rank of the adjunct of an $n \times n$ matrix A. **Reply**: This is elementary. If rk $A < n-1$, then of course adj $A = 0$. If rk $A = n-1$, then rk adj $A = 1$: Interpret adj A as the induced map in the $(n-1)$-fold exterior product; then the image space of adj A is spanned by $X_1 \wedge X_2 \wedge \cdots \wedge X_{n-1}$, if the X_i span the image space (column space) of A. (Generalizing this, if rk $A = k$, the induced map in the ith exterior product is 0 if $i > k$, and of rank $\binom{k}{i}$ if $i \leq k$.) In case rk $A = n-1$ one can show: If the column vector U (resp. the row vector V) is a nontrivial solution of $AU = 0$ (resp. of $VA = 0$, then adj $A = cVU$ with a suitable scalar c. Note also det(adj A) = (det $A)^{n-1}$. (Contributed by M. Newman, M. Ashbaugh, A. G. Azpeitia and H. Shank)

AMS Election 1987

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Lincoln, October 30 – November 1, University of Nebraska

Program for the 837th Meeting

The eight hundred and thirty-seventh meeting of the American Mathematical Society will be held at the University of Nebraska in Lincoln, Nebraska, on Friday afternoon, Saturday and Sunday morning, October 30 – November 1, 1987.

Invited Addresses

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

CAROLYN S. GORDON, University of Pennsylvania and Washington University, St. Louis, *When you can't hear the shape of a manifold.*

DAVID GRIFFEATH, University of Wisconsin, Madison, *Random cellular automata: A survey.*

DAVID W. MASSER, University of Michigan, Ann Arbor, *Transcendence without transcendental numbers.*

DAN VOICULESCU, University of California, Berkeley, *Hilbert space operators modulo normed ideals.*

Special Sessions

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

Operator algebras and operator theory, FRANK L. GILFEATHER, University of Nebraska, Lincoln. The speakers include William B. Arveson, Larry Baggett, Hari Bercovici, John W. Bunce, Rauúl E. Curto, Domingo A. Herrero, Palle E. T. Jorgensen, Victor Kaftal, Paul S. Muhly, C. Pearcy, Costel Peligrad, Justin Peters, Bernard Russo, Norberto Salinas, Albert J.-L. Sheu, Roger R. Smith, Harald Upmeier, Belisario A. Ventura, Bruce H. Wagner, Martin Walter, Gary Weiss, and Derek Westwood.

Transformation groups in geometry, CAROLYN S. GORDON and QUO-SHIN CHI, Washington University. The speakers include Chal Benson, B. E. Blank, Robert A. Blumenthal, Quo-Shin Chi, Josef Dorfmeister, Robert J. Fisher, Jr., Samuel I. Goldberg, James J. Hebda, Gary R. Jensen, H. Turner Laquer, Maung Min-oo, John Mitchell, Phillippe Tondeur, Kichoon Yang, and Yunbo Zheng.

Cellular automata and nonlinear dynamics, ERICA JEN, Los Alamos National Laboratory. Speakers are Karel Culik, Peter Gacs, Yu He, Howard Gutowitz, Erica Jen, and Stephen J. Willson.

Finite geometries and combinatorial designs, SPYROS S. MAGLIVERAS, EARL S. KRAMER, and DALE MESNER, University of Nebraska, Lincoln. The list of speakers includes Bruce A. Anderson, M. D. Atkinson, Ronald D. Baker, Eiichi Bannai, Lynn M. Batten, Frank E. Bennett, Albrecht Beutelspacher, Julia M. N. Brown, Aiden A. Bruen, A. R. Calderbank, William Cherowitzo, Charles J. Colbourn, Huw Davies, Marialuisa de Resmini, John F. Dillon, Jeffrey H. Dinitz, Jean Doyen, David A. Drake, Alan Hartman, Katherine Heinrich, J.W.P. Hirschfeld, Chat Yin Ho, Daniel R. Hughes, Norman W. Johnson, Dieter Jungnickel, David Klarner, Donald L. Kreher, E. Mendelsohn, N. S. Mendelsohn, R. Padmanabhan, Antonio Pasini, Stanley E. Payne, Vera S. Pless, D. K. Ray-Chaudhuri, Alexander Rosa, Paul J. Schellenberg, J. J. Seidel, Johannes Siemons, Edward Spence, Douglas R. Stinson, Luc Teirlinck, Joseph A. Thas, Vladimir D. Tonchev, Tran Van Trung, Scott A. Vanstone, Walter D. Wallis, and Michael A. Wertheimer.

Semi-groups and connections with automata and formal languages, JOHN C. MEAKIN and STUART W. MARGOLIS, University of Nebraska, Lincoln. Speakers are David Barrington, Jean Berstel, Jean-Camille Birget, Karl Byleen, Arthur Gerhard, Simon M. Goberstein, Karsten Henckell, Peter R. Jones, David Klarner, Michael Kunze, Robert McFadden, K.S.S. Nambooripad, Francis Pastijn, Dominique Perrin, J.-E. Pin, Mohan S. Putcha, Lex E. Renner, John Rhodes, Jacques Sakarovitch, Boris M. Schein, Imre Simon, Joseph B. Stephen, Howard Straubing, Denis Therien, and Pascal Weil.

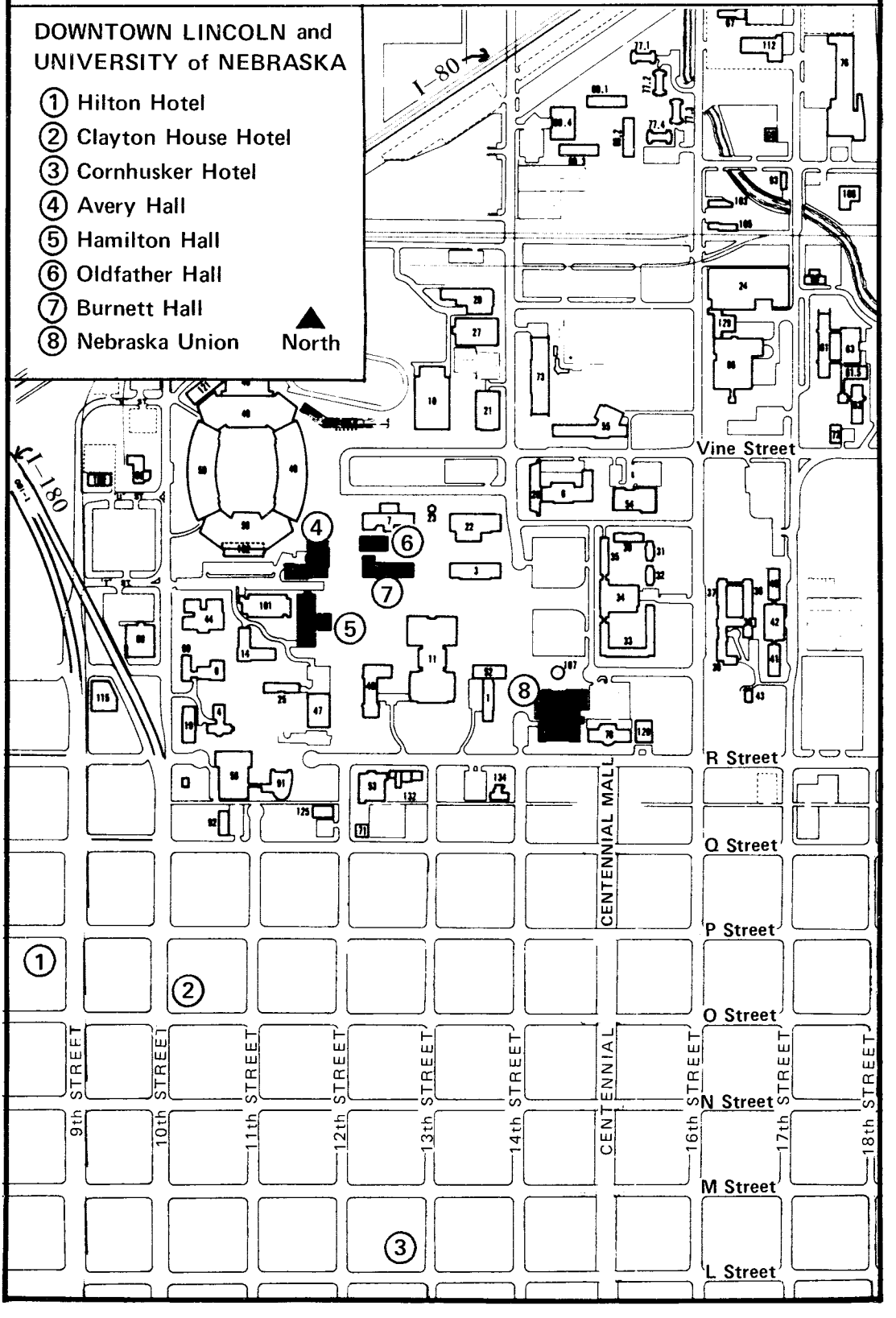
Diophantine problems, ROBERT E. TUBBS, University of Colorado, Boulder. Speakers are Richard T. Bumby, W. Dale Brownawell, T. W. Cusick, David Easton, James Fennell, Mike Fried, Andrew M. W. Glass, Julia Mueller, Cameron L. Stewart, Kenneth B. Stolarsky, Robert E. Tubbs, Jeffery D. Vaaler, Paul Vojta, and Jing Yu.

Commutative algebra and algebraic geometry, ROGER A. WIEGAND and BRIAN HARBOURNE, University of Nebraska, Lincoln. The speakers include D. D. Anderson, Susan Jane Colley, Bruce Crauder, Frank R. DeMeyer, S. P. Dutta, E. Graham Evans, Carl Faith, Robert Fossum, A. V. Geramita, Charles C. Hanna, William J. Heinzer, Melvin Hochster, Craig Huneke, Sheldon Katz, Pablo Lejarraga, Lawrence S. Levy, Rick Miranda, M. Pavaman Murthy, Ira J. Papick, Igor Reider, Christel Rotthaus, Judith D. Sally, David J. Saltman, Robert Speiser, Bernd Ulrich, Marie A. Vitulli, and David Wright.

Contributed Papers

There will also be one session for contributed ten-minute papers on Saturday afternoon.

CITY CAMPUS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Registration

The meeting registration desk will be located in Room 203, Oldfather Hall. The desk will be open from 2:30 p.m. to 5:00 p.m. on Friday and from 8:00 a.m. to 3:00 p.m. on Saturday. The registration fees are $30 for members, $45 for nonmembers, and $10 for students or unemployed mathematicians.

Social Event

All participants are invited to a no-host cocktail party at the Lincoln Hilton following the Invited Address on Friday evening, October 30. The party will begin at 9:00 pm. Please refer to the announcement board in the lobby of the Hilton for the room assigned to the AMS. There will be a cash bar and complimentary snacks.

Petition Table

A petition table will be set up in the registration area. Additional information can be found in a box in the Atlanta meeting announcement in this issue of *Notices*.

Accommodations

Rooms have been blocked at the following three downtown hotels. Participants should make their own reservations directly with the hotel of their choice and be sure to identify themselves as attending the AMS meeting at the University of Nebraska. The rates are subject to possible change and do not include applicable taxes. The deadline for reservations is **September 29**, after which reservations will be accepted on a space-available basis.

Clayton House
10th and "O" Streets, Lincoln 68508
Telephone: 402-476-0333 or
800-233-7778
(outside Nebraska)

Single	$34 (1 queen bed)
Double	$39 (1 queen bed)
Double	$42 (2 queen beds)

Cornhusker Hotel
333 South 13th Street, Lincoln 68508
Telephone: 402-474-7474 or
800-742-2226
(within Nebraska)
800-228-2676
(outside Nebraska)

Single $58 Double $68

NOTE: Participants employed at a state-supported institution should so indicate and show an I.D. to obtain the following rates:

Single $39 Double $49

Lincoln Hilton
141 North 9th Street, Lincoln 68508
Telephone: 402-475-4011 or 800-HILTONS
Single $34 Double $44

Food Service

A list of restaurants, grocery stores, and bakeries will be available at the meeting registration desk.

Travel

The University of Nebraska campus is four miles from the Lincoln Airport, which is served by Air Midwest, America West, Continental, Eastern, Northwest, TWA, and United Airlines. Although several car rental agencies have counters at the airport terminal, the three hotels listed above provide complimentary limousine service for their guests and can be summoned by the courtesy telephones in the terminal. It is also possible to fly to Omaha, rent a car, and drive the 55-mile distance to Lincoln. In addition to the airlines mentioned above, Omaha Airport is served by Air Wisconsin, American, Braniff, Delta, and Midway Airlines.

Lincoln is also served by AMTRAK trains, as well as Greyhound and Trailways Bus Lines, each of which has terminals near the campus.

Participants traveling by car may reach Lincoln via Interstate Route 80 from the east and west, or via U.S. Route 77 from the north or south. Either I-180 or "O" Street lead to downtown Lincoln and the campus.

Parking

Free parking will be available on campus during the meeting; however, participants should avoid reserved spaces and the lot by the Sheldon Art Gallery (marked "SGL"). Anyone arriving before 2:30 p.m. on Friday should obtain a free parking permit from Rhonda Bordeaux in the Mathematics and Statistics Department. The telephone number to call is 402-472-3731.

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 1987 issue of *Abstracts of papers presented to the American Mathematical Society*, ordered according to the numbers in parentheses following the listings below.

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

Friday, October 30, 1987, 2:30 p.m.

AMS Special Session on Finite Geometries and Combinatorial Designs, I Burnett Hall, Room 223

2:30– 2:50 (1) *Flocks of quadrics, maximal exterior sets and inversive planes.* Preliminary report. JOSEPH A. THAS, State University of Gent, Belgium (837-51-54) (Sponsored by Spyros S. Magliveras)

2:55– 3:15 (2) *Partial flocks of quadric sets and translation planes admitting Baer groups.* NORMAN L. JOHNSON, University of Iowa (837-51-142) (Sponsored by Spyros S. Magliveras)

3:20– 3:40 (3) *Oval designs in quadrics.* MICHAEL A. WERTHEIMER, Department of Defense, Fort George G. Meade, Maryland (837-05-112) (Sponsored by Spyros S. Magliveras)

3:45– 4:05 (4) *Hyperovals in translation planes.* Preliminary report. WILLIAM CHEROWITZO, University of Colorado, Denver (837-51-64)

4:10– 4:30 (5) *On the Dempwolff plane.* MARIALUISA J. DE RESMINI, Università di Roma, Italy (837-05-62) (Sponsored by Spyros S. Magliveras)

4:35– 4:55 (6) *Conjectured ovals and the ovoids of J. Tits.* Preliminary report. STANLEY E. PAYNE, University of Colorado, Denver (837-51-133)

5:00– 5:20 (7) *On the classification of finite C_n-geometries with thick lines.* Preliminary report. ANTONIO PASINI, University of Siena, Italy (837-51-11)

Friday, October 30, 1987, 2:30 p.m.

AMS Special Session on Finite Geometries and Combinatorial Designs, II Burnett Hall, Room 226

2:30– 2:50 (8) *Some applications of sequencings to combinatorial arrays.* Preliminary report. BRUCE A. ANDERSON, Arizona State University (837-05-27)

2:55– 3:15 (9) *Designs and approximation.* J. J. SEIDEL, Technical University Eindhoven, The Netherlands (837-05-21)

3:20– 3:40 (10) *Decomposing Steiner 2-designs into small configurations.* ALEXANDER ROSA, McMaster University (837-05-68)

3:45– 4:05 (11) *Constructing $6-(14,7,4)$ designs.* DONALD L. KREHER, Rochester Institute of Technology (837-05-29) (Sponsored by Paul Wilson)

4:10– 4:30 (12) *Room squares with subsquares.* Preliminary report. J. H. DINITZ*, University of Vermont, and D. R. STINSON, University of Manitoba (837-05-41)

5:00– 5:20 (13) *Difference sets in 2-groups.* Preliminary report. JOHN F. DILLON, Department of Defense, Fort George G. Meade, Maryland (837-05-148)

5:25– 5:45 (14) *Constructions of nonembeddable quasi-residual $2-(v,b,k+\lambda,k,\lambda)$ designs.* Preliminary report. TRAN VAN TRUNG, University of Heidelberg, Federal Republic of Germany (837-05-154) (Sponsored by Spyros S. Magliveras)

Friday, October 30, 1987, 3:00 p.m.

AMS Special Session on Commutative Algebra and Algebraic Geometry, I Oldfather Hall, Room 203

3:00– 3:20 (15) *Star-operations induced by overrings.* D. D. ANDERSON, University of Iowa (837-13-14)

3:25– 3:45 (16) *$(P+1)$-generated modules.* Preliminary report. CHARLES C. HANNA, United States Naval Academy (837-13-18)

3:50– 4:10 (17) *Valuation theory for commutative rings.* MARIE A. VITULLI, University of Oregon (837-13-42)

4:15– 4:35 (18) *Minimal models for degenerations of ruled surfaces.* Preliminary report. BRUCE CRAUDER, Oklahoma State University, Stillwater (847-14-136)

4:40– 5:00 (19) *On the ideal of Buchsbaum curve in three-dimensional projective space.* A. V. GERAMITA*, Queen's University, and J. MIGLIORE, Drew University (837-13-146) (Sponsored by Brian Harbourne)

5:05– 5:25 (20) *Polynomial rings over Hilbert rings.* CARL FAITH, Rutgers University, New Brunswick (837-13-09)

Friday, October 30, 1987, 3:30 p.m.

AMS Special Session on Semigroups and Connections with Automata and Formal Languages, I Oldfather Hall, Room 309

3:30– 3:50 (21) *Decidability problems in finite semigroups and automata.* Preliminary report. JOHN RHODES, University of California, Berkeley (837-20-140) (Sponsored by Stuart W. Margolis)

3:55– 4:15 (22) *An application of automata theory to a density problem—A generalization.* DAVID KLARNER, University of Nebraska, Lincoln (837-20-85) (Sponsored by Stuart W. Margolis)

4:20– 4:40 (23) *The semigroup of irreducible affine sets of matrices.* MOHAN S. PUTCHA, North Carolina State University (837-20-05)

4:45– 5:05 (24) *Completely regular algebraic monoids.* LEX E. RENNER, University of Western Ontario (837-20-38)

5:10– 5:30 (25) *Iterated morphisms, continued fractions and line drawing.* Preliminary report. JEAN BERSTEL, Université Pierre et Marie Curie, France (837-68-48) (Sponsored by Stuart W. Margolis)

5:35– 5:55 (26) *Factorization forests of finite height.* IMRE SIMON, Universidade de São Paulo, Brazil (837-20-105) (Sponsored by John C. Meakin)

Friday, October 30, 1987, 3:30 p.m.

AMS Special Session on Diophantine Problems, I Avery Hall, Room 135

3:30– 3:50 (27) *Maximum absolute value and distance to common zeros.* W. DALE BROWNAWELL, Pennsylvania State University, University Park (837-11-163)

4:00– 4:20 (28) *On the algebraic independence of two numbers.* ROBERT TUBBS, University of Colorado, Boulder (837-11-151)

4:30– 4:50 (29) *Constants for lower bounds for linear forms in the logarithms of algebraic numbers.* JOSEF BLASS, ANDREW M. W. GLASS*, DAVID B. MERONK and RAY P. STEINER, Bowling Green State University (837-11-72)

5:00– 5:20 (30) *A trancendence measure for the p-adic elliptic function.* JAMES FENNELL, Pennsylvania State University, Erie (837-11-118)

5:30– 5:50 (31) *An analogue of Baker's theorem in characteristic p.* JING YU, Academia Sinica, People's Republic of China (837-99-169) (Sponsored by Robert E. Tubbs)

Friday, October 30, 1987, 4:00 p.m.

AMS Special Session on Operator Algebras and Operator Theory, I Burnett Hall, Room 119

4:00– 4:20 (32) *On the structure of contraction operators, III.* B. CHEVREAU, Université de Bordeaux I, France, G. EXNER, Oberlin College, and C. PEARCY*, University of Michigan, Ann Arbor (837-47-121)

4:30– 4:50 (33) *C^*-algebras of singular foliations.* ALBERT JEU-LIANG SHEU, University of Kansas (837-46-97)

5:00– 5:20 (34) *Matrix norm inequalities and the relative Dixmier property.* GARY WEISS*, HERBERT HALPERN, VICTOR KAFTAL and KEN BERMAN, University of Cincinnati (837-47-155)

5:30– 5:50 (35) *Lie group actions on C^*-algebras.* PALLE E. T. JORGENSEN, University of Iowa (837-47-132)

6:00– 6:20 (36) *Group, groupoids and hypergroup duals.* Preliminary report. MARTIN WALTER, University of Colorado, Boulder (837-22-147)

Friday, October 30, 1987, 8:00 p.m.

AMS Invited Address Hamilton Hall, Room 104

8:00– 9:00 (37) *Random cellular automata: A survey.* DAVID GRIFFEATH, University of Wisconsin, Madison (837-60-88)

Saturday, October 31, 1987, 8:00 a.m.

AMS Special Session on Finite Geometries and Combinatorial Designs, III Oldfather Hall, Room 303

8:00– 8:20 (38) *On the order of a finite projective plane and its collineation group.* CHAT YIN HO, University of Florida (837-51-81) (Sponsored by Jean A. Larson)

9:00– 9:20 (39) *On finite projective planes constructed from groups.* JULIA M. N. BROWN, York University (837-99-170)

9:30– 9:50 (40) *Constructing translation planes.* RONALD D. BAKER, University of Delaware (837-51-130)

10:00–10:20 (41) *The characterization of elliptic curves over finite fields.* J. W. P. HIRSCHFELD*, University of Sussex, United Kingdom, and J. F. VOLOCH, Institute for Pure and Applied Mathematics, Brazil (837-51-93) (Sponsored by Spyros S. Magliveras)

10:30–10:50 (42) *Embedding linear spaces into finite projective planes.* ALBRECHT BEUTELSPACHER, Munich, Federal Republic of Germany (837-05-95) (Sponsored by Spyros S. Magliveras)

Saturday, October 31, 1987, 8:00 a.m.

AMS Special Session on Finite Geometries and Combinatorial Designs, IV — Oldfather Hall, Room 304

8:00 - 8:20 (43) *Steiner systems with certain transitivity properties.* LYNN MARGARET BATTEN, University of Winnipeg (837-51-153)

8:30 - 8:50 (44) *On the character tables of $GL(2n,q)/Sp(2n,q)$ and other association schemes.* Preliminary report. EIICHI BANNAI* and SUNG-YELL SONG, Ohio State University, Columbus (837-05-100)

9:00 - 9:20 (45) *Characters of automorphism groups.* JOHANNES SIEMONS, University of East Anglia, United Kingdom (837-20-12)

9:30 - 9:50 (46) *The classification of flag-transitive $2-(v,k,1)$ designs.* JEAN DOYEN, University of Brussels, Belgium (837-05-92)

10:30 - 10:50 (47) *Flag-transitive 2-designs.* HUW DAVIES, University of Edinburgh, Scotland (837-05-113) (Sponsored by Allan M. Sinclair)

Saturday, October 31, 1987, 8:00 a.m.

AMS Special Session on Commutative Algebra and Algebraic Geometry, II — Oldfather Hall, Room 203

8:00 - 8:20 (48) *Generalized equivalence of matrices over Dedekind and Prüfer domains.* Preliminary report. F. R. DEMEYER* and H. KAKAKHAIL, Colorado State University, and T. J. FORD, Florida Atlantic University (837-13-70)

8:25 - 8:45 (49) *Module presentations in dimension* 1. ROBERT M. GURALNICK, University of Southern California, and LAWRENCE S. LEVY*, University of Wisconsin, Madison (837-13-79)

8:50 - 9:10 (50) *Classification of cremona transformations with smooth irreducible fundamental locus.* SHELDON KATZ* and BRUCE CRAUDER, Oklahoma State University, Stillwater (837-14-137)

9:15 - 9:35 (51) *Coincidence formulas for line complexes.* SUSAN JANE COLLEY, Oberlin College (837-14-45)

9:40 - 10:00 (52) *Structure of the moduli of rational elliptic fibrations with section.* PABLO LEJARRAGA, Texas Tech University (837-14-145)

10:05 - 10:25 (53) *Canonical surfaces with $K^2 = 3\chi - 10 = 3p_g - 7$.* RICK MIRANDA, Colorado State University (837-14-125)

Saturday, October 31, 1987, 8:30 a.m.

AMS Special Session on Transformation Groups in Geometry, I — Oldfather Hall, Room 307

8:30 - 8:50 (54) *Nontangential maximal functions on compact Riemannian manifolds.* B. E. BLANK, Washington University (837-58-108)

9:00 - 9:20 (55) *An extra family of invariant affine connections on $SU(n)$.* H. TURNER LAQUER, Case Western Reserve University (837-53-111)

9:30 - 9:50 (56) *Characterizing $\mathbf{CP}_n$ and S^{2n+1} by Spec^p for any p.* SAMUEL I. GOLDBERG, University of Illinois, Urbana-Champaign (837-53-75)

10:00 - 10:20 (57) *Isoperimetric inequalities on nilpotent Lie groups.* Preliminary report. JOHN MITCHELL, University of Illinois, Urbana-Champaign (837-53-110)

10:30 - 10:50 (58) *Kähler and symplectic structures on nilmanifolds.* CHAL BENSON*, University of Missouri, St. Louis, and CAROLYN GORDON, Washington University (837-53-57)

Saturday, October 31, 1987, 8:30 a.m.

AMS Special Session on Operator Algebras and Operator Theory, II — Oldfather Hall, Room 209

8:30 - 8:50 (59) *Representations of triangular operator algebras.* Preliminary report. PAUL S. MUHLY, University of Iowa (837-47-30)

9:00 - 9:20 (60) *Computing Fourier coefficients.* DEREK WESTWOOD, Wright State University (837-47-156)

9:30 - 9:50 (61) *A factorization approach to quasisimilarity.* RAUL E. CURTO, University of Iowa (837-47-98)

10:00 - 10:20 (62) *AW^*-algebras are MF algebras.* Preliminary report. JOHN W. BUNCE, University of Kansas (837-46-83)

10:30 - 10:50 (63) *Infinite tensor products of commutative subspace lattices.* BRUCE H. WAGNER, Iowa State University (837-47-58)

Saturday, October 31, 1987, 8:30 a.m.

AMS Special Session on Cellular Automata and Nonlinear Dynamics, I Oldfather Hall, Room 205

8:30 - 8:50 (64) *Morphisms on additive cellular automata.* Preliminary report. STEPHEN J. WILLSON, Iowa State University (837-58-28)

9:00 - 9:20 (65) *Coherent nonstationary behavior in cellular automata.* YU HE, University of Illinois, Urbana-Champaign (837-82-165) (Sponsored by Erica Jen)

9:30 - 9:50 (66) *Statistical properties of cellular automata: Overview.* HOWARD GUTOWITZ, Rockefeller University (837-82-162)

10:00 - 10:20 Problem Session

10:30 - 10:50 (67) *On totalistic systolic networks.* KAREL CULIK, University of South Carolina, Columbia (837-93-166) (Sponsored by Erica Jen)

Saturday, October 31, 1987, 8:30 a.m.

AMS Special Session on Semigroups and Connections with Automata and Formal Languages, II Oldfather Hall, Room 309

8:30 - 8:50 (68) *Free objects in certain varieties of inverse semigroups.* Preliminary report. JOSEPH B. STEPHEN, Northern Illinois University (837-20-158)

8:55 - 9:15 (69) *Green's relations in finite transformation semigroups.* GERARD LALLEMENT, Pennsylvania State University, University Park, and ROBERT MCFADDEN*, Northern Illinois University (837-20-44)

9:20 - 9:40 (70) *Inverse monoids of dot-depth two.* PASCAL WEIL, University of Paris VI, France (837-20-06) (Sponsored by Stuart W. Margolis)

9:45 - 10:05 (71) *Some applications of the theory of cross-connections.* Preliminary report. K. S. S. NAMBOORIPAD, University of Kerala and University of Nebraska, Lincoln (837-20-86) (Sponsored by John C. Meakin)

10:10 - 10:30 (72) *Finitely generated congruence-free semigroups.* KARL BYLEEN, Marquette University (837-20-84)

10:35 - 10:55 (73) *Inverse semigroups admitting faithful transitive representations.* Preliminary report. BORIS M. SCHEIN, University of Arkansas, Fayetteville (837-20-87)

Saturday, October 31, 1987, 8:30 a.m.

AMS Special Session on Diophantine Problems, II Oldfather Hall, Room 207

8:30 - 8:50 (74) *Heights of algebraic subspaces.* Preliminary report. JEFFREY D. VAALER, University of Texas, Austin (837-11-73)

9:00 - 9:20 (75) *Arithmetic variation of fibers in families of curves.* MIKE FRIED*, University of Florida, and PIERRE DEBES, Institut Henri Poincaré, France (837-11-119)

9:30 - 9:50 (76) *Dyson's lemma for products of two curves of higher genus.* Preliminary report. PAUL VOJTA, University of California, Berkeley (837-11-134)

10:00 - 10:20 (77) *On S-unit equations in two variables.* CAMERON L. STEWART, University of Waterloo (837-11-71)

10:30 - 10:50 (78) *Bounding the solution set of* $| F(x,y) | \leq h$. Preliminary report. JULIA MUELLER, Fordham University (837-11-157)

Saturday, October 31, 1987, 11:00 a.m.

AMS Invited Address Hamilton Hall, Room 104

11:00 - 12:00 (79) *When you can't hear the shape of a manifold.* CAROLYN S. GORDON, Washington University (837-58-20)

Saturday, October 31, 1987, 1:30 p.m.

AMS Invited Address Hamilton Hall, Room 104

1:30 - 2:30 (80) *Transcendence without transcendental numbers.* DAVID W. MASSER, University of Michigan, Ann Arbor (837-99-171)

Saturday, October 31, 1987, 3:00 p.m.

AMS Special Session on Operator Algebras and Operator Theory, III — Oldfather Hall, Room 209

3:00– 3:20 (81) *C^*-dynamical semigroups.* WILLIAM B. ARVESON, University of California, Berkeley (837-99-167)

3:30– 3:50 (82) *Equivalence of cocycles for an irrational rotation.* L. BAGGETT*, University of Colorado, Boulder, and K. MERRILL, Colorado College (837-43-120)

4:00– 4:20 (83) *Topological stable rank of some nonselfadjoint operator algebras.* JUSTIN PETERS, Iowa State University (837-46-89)

4:30– 4:50 (84) *On some crossed products of the diagonal of an AF C^*-algebra by abelian groups.* Preliminary report. BELISARIO A. VENTURA, Texas A&M University, College Station (837-46-123)

5:00– 5:20 (85) *Variation of the point spectrum under compact perturbations.* DOMINGO A. HERRERO*, THOMAS J. TAYLOR and ZONG Y. WANG, Arizona State University (837-47-107)

5:30– 5:50 (86) *Finite weight projections in von Neumann algebras.* Preliminary report. HERBERT HALPERN and VICTOR KAFTAL*, University of Cincinnati, and LASZLO ZSIDO, University of Stuttgart, Federal Republic of Germany (837-46-82)

6:00– 6:20 (87) *Affine geometric aspects of operator algebras.* YAAKOV FRIEDMAN, Jerusalem College of Technology, Israel, and BERNARD RUSSO*, University of California, Irvine (837-46-26)

6:30– 6:50 (88) *A lifting theorem for C^*-algebras.* Preliminary report. A. G. ROBERTSON, University of Edinburgh, Scotland, and R. R. SMITH*, Texas A&M University, College Station (837-46-122)

Saturday, October 31, 1987, 3:00 p.m.

AMS Special Session on Transformation Groups in Geometry, II — Oldfather Hall, Room 307

3:00– 3:20 (89) *Isometry groups of Riemannian fibrations.* Preliminary report. ROBERT J. FISHER, JR.*, University of Oklahoma, and HANS R. FISCHER, University of Massachusetts, Amherst (837-53-77)

3:30– 3:50 (90) *Automorphisms of homogeneous Kähler manifolds.* Preliminary report. JOSEF DORFMEISTER, University of Georgia (837-22-102)

4:00– 4:20 (91) *The Plücker formulae for compact simple Lie groups.* KICHOON YANG, Arkansas State University (837-53-76)

4:30– 4:50 (92) *Transversal infinitesimal automorphisms of harmonic foliations on complete manifolds.* SEIKI NISHIKAWA, Kyushu University, Japan, and PHILIPPE TONDEUR*, University of Illinois, Urbana-Champaign (837-58-13)

5:00– 5:20 (93) *A sufficient condition for the leaves of a totally umbilic foliation to be conformally complete.* ROBERT A. BLUMENTHAL* and JAMES J. HEBDA, Saint Louis University (837-53-47)

Saturday, October 31, 1987, 3:00 p.m.

AMS Special Session on Cellular Automata and Nonlinear Dynamics, II — Oldfather Hall, Room 205

3:00– 3:20 Problem Session

3:30– 3:50 (94) *Cellular automata and recurring sequences in finite fields.* ERICA JEN, Los Alamos National Laboratory, Los Alamos, New Mexico (837-08-161)

4:00– 4:20 (95) *Self-correcting cellular arrays.* PETER GACS, Boston University (837-99-168)

4:30– 5:20 Problem Session

Saturday, October 31, 1987, 3:00 p.m.

AMS Special Session on Finite Geometries and Combinatorial Designs, V — Oldfather Hall, Room 303

3:00– 3:20 (96) *q-analogues of t-designs and their existence.* D. K. RAY-CHAUDHURI*, Ohio State University, Columbus, and N. M. SINGHI, Tata Institute of Fundamental Research, India (837-05-99)

3:30– 3:50 (97) *t-designs and related structures.* Preliminary report. LUC TEIRLINCK, Auburn University, Auburn (837-05-60)

4:00– 4:20 (98) *Kirkman triple systems with maximum subsystems.* ROLF REES, University of Waterloo, and D. R. STINSON*, University of Manitoba (837-05-80) (Sponsored by Hugh C. Williams)

4:30– 4:50 (99) *Cycles in block graphs of designs.* Preliminary report. BRIAN ALSPACH, KATHERINE HEINRICH* and BOJAN MOHAR, Simon Fraser University (837-05-67)

5:00– 5:20 (100) *Pairwise balanced designs with prime power block sizes.* Preliminary report. FRANK E. BENNETT, Mount Saint Vincent University (837-05-131)

5:30– 5:50 (101) *The neighbourhood problem.* CHARLES J. COLBOURN, University of Waterloo (837-05-15)

6:00– 6:20 (102) *Halving the complete design.* ALAN HARTMAN, University of Toronto (837-05-160) (Sponsored by Spyros S. Magliveras)

Saturday, October 31, 1987, 3:00 p.m.

AMS Special Session on Semigroups and Connections with Automata and Formal Languages, III
Oldfather Hall, Room 309

3:00– 3:20 (103) *Finite automata and circuit complexity.* DAVID MIX BARRINGTON, University of Massachusetts, Amherst (837-68-55)

3:30– 3:50 (104) *Programs over aperiodic monoids.* DENIS THERIEN, McGill University (837-94-40)

4:00– 4:20 (105) *Circuits and programs over finite groups.* Preliminary report. HOWARD STRAUBING, Boston College (837-68-56)

4:30– 4:50 (106) *Groups in syntactic monoids.* Preliminary report. DOMINIQUE PERRIN, Université Paris VII, France (837-20-96) (Sponsored by Stuart W. Margolis)

5:00– 5:20 (107) *Semigroups which are unions of abelian groups.* Preliminary report. FRANCIS PASTIJN, Marquette University (837-20-03)

5:30– 5:50 (108) *Varieties of bands revisited.* ARTHUR GERHARD* and MARIO PETRICH, University of Manitoba (837-20-08)

6:00– 6:20 (109) *On C-isomorphisms of Clifford semigroups and their generalizations.* Preliminary report. SIMON M. GOBERSTEIN, California State University, Chico, and Marquette University (837-20-141)

Saturday, October 31, 1987, 3:00 p.m.

AMS Special Session on Diophantine Problems, III Oldfather Hall, Room 207

3:00– 3:20 (110) *Fractional parts and semigroups.* Preliminary report. KENNETH B. STOLARSKY* and HORACIO PORTA, University of Illinois, Urbana-Champaign (837-11-74)

3:30– 3:50 (111) *Fractional parts of powers of certain rationals.* DAVID EASTON, California State University, San Bernardino (837-11-109)

4:00– 4:20 (112) *Rational approximation without rationals.* Preliminary report. RICHARD T. BUMBY, Rutgers University, New Brunswick (837-11-02)

4:30– 4:50 (113) *Simultaneous Diophantine approximation of rational numbers.* Preliminary report. T. W. CUSICK, State University of New York, Buffalo (837-11-50)

5:00– 5:45 Problem Session

Saturday, October 31, 1987, 3:00 p.m.

AMS Special Session on Commutative Algebra and Algebraic Geometry, III Oldfather Hall, Room 203

3:00– 3:20 (114) *Invariants of the additive group in characteristic $p > 0$.* Preliminary report. ROBERT FOSSUM, University of Illinois, Urbana-Champaign (837-13-51)

3:25– 3:45 (115) *Ideals generated by monomials and unions of Cohen-Macaulay schemes.* Preliminary report. MELVIN HOCHSTER, University of Michigan, Ann Arbor (837-13-124)

3:50– 4:10 (116) *Projective modules and zero cycles on singular varieties.* M. PAVAMAN MURTHY, University of Chicago (837-13-61) (Sponsored by Sanker Prasad Dutta)

4:15– 4:35 (117) *On Horrock's conjecture.* Preliminary report. E. GRAHAM EVANS* and PHILLIP A. GRIFFITH, University of Illinois, Urbana-Champaign (837-13-129) (Sponsored by Roger A. Wiegand)

4:40– 5:00 (118) *Residual intersections.* CRAIG HUNEKE*, Purdue University, West Lafayette, and BERND ULRICH, Michigan State University (837-13-127)

5:15– 5:35 (119) *General elements and joint reductions.* DAVID REES, Exeter, United Kingdom, and JUDITH D. SALLY*, Northwestern University (837-13-69)

5:40– 6:00 (120) *Unramifying transcendence basis.* CHRISTEL ROTTHAUS, Michigan State University (837-13-128)

6:05– 6:25 (121) *Sums of linked ideals.* Preliminary report. BERND ULRICH, Michigan State University (837-13-106)

6:30– 6:50 (122) *Asymptotic behaviour of cokernels.* S. P. DUTTA, University of Illinois, Urbana-Champaign (837-13-138)

Saturday, October 31, 1987, 3:00 p.m.

General Session Oldfather Hall, Room 208

3:00– 3:10 (123) *Bifurcations of Hamiltonian periodic orbits near an equilibrium in 1 : 1 resonance.* CHRISTOPHER COTTER, University of Northern Colorado (837-34-36)

3:15– 3:25 (124) *Constructive automata and semigroup theory.* Preliminary report. IRVING H. ANELLIS, Ames, Iowa (837-20-01)

3:30– 3:40 (125) *Diagrams for quotient geometries.* Preliminary report. CECIL ANDREW ELLARD, Kansas State University (837-51-19)

3:45- 3:55 (126) *Coherence in monoids.* Preliminary report. KENNETH MCDOWELL* and SYDNEY BULMAN-FLEMING, Wilfrid Laurier University (837-20-32)

4:00- 4:10 (127) *On V. Fleischer's characterization of absolutely flat monoids.* Preliminary report. SYDNEY BULMAN-FLEMING* and KENNETH MCDOWELL, Wilfrid Laurier University (837-20-33)

4:15- 4:25 (128) *On constructing a regular pentagon of a given edge length* λ. Preliminary report. SADANAND VERMA, LEWIS J. SIMONOFF* and SATISH C. BHATNAGAR, University of Nevada, Las Vegas (837-51-115)

4:30- 4:40 (129) *Massey K-fold products in the complement of a link* I. STEFANOS PANAGIOTIS GIALAMAS, Emporia State University (837-55-149)

4:45- 4:55 (130) *Automorphisms of semigroups of binary relations.* Preliminary report. INNESA LEVI, University of Louisville (837-20-22)

5:00- 5:10 (131) *An analog of the Frattini subgroup of a finite group.* PRABIR BHATTACHARYA*, University of Nebraska, Lincoln, and N. P. MUKHERJEE, Jawaharlal Nehru University, India (837-20-116)

Saturday, October 31, 1987, 3:30 p.m.

AMS Special Session on Finite Geometries and Cominatorial Designs, VI — Oldfather Hall, Room 304

3:30- 3:50 (132) *Eigenvalues of a class of* $(0, \pm 1)$*-symmetric matrices.* EDWARD SPENCE, University of Glasgow, Scotland (837-05-65) (Sponsored by Spyros S. Magliveras)

4:00- 4:20 (133) *Partitions in matrices and graphs.* D. R. HUGHES*, Queen Mary College, England, and NAVIN SINGHI, Tata Institute of Fundamental Research, India (837-05-52) (Sponsored by Spyros S. Magliveras)

4:30- 4:50 (134) *Plausible collineations for finite projective planes.* Preliminary report. DAVID KLARNER, University of Nebraska, Lincoln (837-51-66) (Sponsored by Spyros S. Magliveras)

5:30- 5:50 (135) *Finite geometrics and clique partitions.* W. D. WALLIS, Southern Illinois University, Carbondale (837-05-114)

6:00- 6:20 (136) *A geometric approach to root finding in* $GF(q^n)$. SCOTT A. VANSTONE* and PAUL C. VAN OORSCHOT, University of Waterloo (837-05-94) (Sponsored by Spyros S. Magliveras)

6:30- 6:50 (137) *Recent results on blocking sets.* DIETER JUNGNICKEL, Universität Giessen, West Germany (837-05-59)

Sunday, November 1, 1987, 8:00 a.m.

AMS Special Session on Finite Geometries and Combinatorial Designs, VII — Oldfather Hall, Room 303

8:00- 8:20 (138) *Self-orthogonal designs.* VLADIMIR D. TONCHEV, Bulgarian Academy of Sciences, Bulgaria (837-05-53) (Sponsored by Spyros S. Magliveras)

8:30- 8:50 (139) *The Oberwolfach problem and factors of uniform odd length cycles.* B. ALSPACH, Simon Fraser University, P. J. SCHELLENBERG*, University of Waterloo, D. R. STINSON, University of Manitoba, and D. WAGNER, Simon Fraser University (837-05-152)

9:00- 9:20 (140) *Extended triple systems and straight edge constructions on cubic curves.* N. S. MENDELSOHN*, R. PADMANABHAN and B. WOLK, University of Manitoba (837-51-35)

9:30- 9:50 (141) *On the spectrum of imbrical designs.* E. MENDELSOHN*, University of Toronto, and A. ASSAF, Auburn University, Auburn (837-05-17)

Sunday, November 1, 1987, 8:00 a.m.

AMS Special Session on Finite Geometries and Combinatorial Designs, VIII — Oldfather Hall, Room 304

8:00- 8:20 (142) *Representations of Desargues and Pappus like designs.* N. S. MENDELSOHN, R. PADMANABHAN* and B. WOLK, University of Manitoba (837-51-37)

8:30- 8:50 (143) *On the width of an orientation of a tree.* M. D. ATKINSON, Carleton University (837-05-164) (Sponsored by Spyros S. Magliveras)

9:00- 9:20 (144) *Cyclic designs and cyclic codes.* Preliminary report. VERA PLESS, University of Illinois, Chicago (837-05-43)

9:30- 9:50 (145) *Linear codes and quasi-symmetric designs.* A. R. CALDERBANK, AT&T Bell Laboratories, Murray Hill, New Jersey (837-05-10)

10:00-10:20 (146) *Some new results on codes associated with designs.* Preliminary report. A. A. BRUEN*, University of Western Ontario, and W. OTT, Technical University of Braunschweig, Federal Republic of Germany (837-05-63)

10:30-10:50 (147) *A bound on the size of a blocking set in a finite projective plane.* Preliminary report. DAVID A. DRAKE, University of Florida (837-05-49)

Sunday, November 1, 1987, 8:00 a.m.

AMS Special Session on Semigroups and Connections with Automata and Formal Languages, IV
Oldfather Hall, Room 309

8:00 - 8:20 (148) *Aperiodic transformation semigroups and products of semilattices.* MICHAEL KUNZE, University of Arkansas, Fayetteville (837-20-04)

8:30 - 8:50 (149) *On free products of completely regular semigroups.* PETER R. JONES, Marquette University (837-20-31)

9:00 - 9:20 (150) *On rational sets of free inverse semigroups.* JACQUES SAKAROVITCH, Centre Nationale de la Recherche Scientifique, France (837-20-144) (Sponsored by John C. Meakin)

9:30 - 9:50 (151) *Pointlike sets: The finest aperiodic cover of a finite semigroup.* KARSTEN HENCKELL, University of South Florida (837-20-07)

10:00 - 10:20 (152) *Two-way automata and semigroups.* JEAN-CAMILLE BIRGET, University of Nebraska, Lincoln (837-20-101) (Sponsored by Stuart W. Margolis)

10:30 - 10:50 (153) *Some consequences of the theorem of Ash in language theory.* Preliminary report. J. E. PIN, University Paris VI, France (837-20-39) (Sponsored by Stuart W. Margolis)

Sunday, November 1, 1987, 8:00 a.m.

AMS Special Session on Commutative Algebra and Algebraic Geometry, IV Oldfather Hall, Room 203

8:00 - 8:20 (154) *Remarks on a remark of Kaplansky.* Preliminary report. WILLIAM HEINZER, Purdue University, West Lafayette, and IRA J. PAPICK*, University of Missouri, Columbia (837-13-24)

8:30 - 8:50 (155) *Bounds for the number of moduli for irregular varieties of general type.* IGOR REIDER, University of Oklahoma (837-14-126) (Sponsored by Stanley B. Eliason)

9:00 - 9:20 (156) *Invariant fields of groups and division algebras.* DAVID J. SALTMAN, University of Texas, Austin (837-12-139)

9:30 - 9:50 (157) *Transversality theorems for families of maps.* Preliminary report. ROBERT SPEISER, Brigham Young University (837-14-143)

10:00 - 10:20 (158) *Rees valuations and normalized blowing-up in two-dimensional domains.* Preliminary report. WILLIAM J. HEINZER*, Purdue University, West Lafayette, and DAVID C. LANTZ, Colgate University (837-13-135)

10:30 - 10:50 (159) *Cremona groups acting on models.* Preliminary report. DAVID WRIGHT, Washington University (837-14-25)

Sunday, November 1, 1987, 8:30 a.m.

AMS Special Session on Transformation Groups in Geometry, III Oldfather Hall, Room 307

8:30 - 8:50 (160) *Quaternionic Kaehler manifolds.* QUO-SHIN CHI, Washington University (837-53-23)

9:00 - 9:20 (161) *Scalar curvature rigidity of asymptotically hyperbolic spaces.* MAUNG MIN-OO, McMaster University (837-53-103)

9:30 - 9:50 (162) *The generalized Cartan-Ambrose-Hicks theorem.* ROBERT A. BLUMENTHAL and JAMES J. HEBDA*, St. Louis University (837-53-16)

10:00 - 10:20 (163) *Harmonic maps in Grassmann manifolds.* Preliminary report. YUNBO ZHENG, Rice University (837-53-78)

10:30 - 10:50 (164) *Harmonically immersed surfaces in* $\mathbf{R}^n$. GARY R. JENSEN*, Washington University, and MARCO RIGOLI, International Center for Theoretical Physics, Italy (837-53-104)

Sunday, November 1, 1987, 9:00 a.m.

AMS Special Session on Operator Algebras and Operator Theory, IV Oldfather Hall, Room 209

9:00 - 9:20 (165) *Solvable* C^**-algebras in geometry and analysis.* HARALD UPMEIER, University of Kansas (837-47-90)

9:30 - 9:50 (166) *Duality principles for ergodic actions of simple Lie groups on operator algebras.* COSTEL PELIGRAD, University of Cincinnati (837-46-150)

10:00 - 10:20 (167) *Operator algebras isomorphic to* H^∞. HARI BERCOVICI, Indiana University, Bloomington (837-47-91)

10:30 - 10:50 Problem Session

Sunday, November 1, 1987, 11:00 a.m.

AMS Invited Address Hamilton Hall, Room 104

11:00 - 12:00 (168) *Hilbert space operators modulo normed ideals.* DAN VOICULESCU, University of California, Berkeley (837-47-117)

Urbana, Illinois

Robert M. Fossum
Associate Secretary

Presenters of Papers

Numbers following the names indicate the speakers' positions on the program.
•AMS Invited lecturer *Special session speaker

Los Angeles, November 14 – 15, University of California, Los Angeles

Program for the 838th Meeting

The eight hundred and thirty-eighth meeting of the American Mathematical Society will be held at the University of California on Saturday and Sunday, November 14 – 15, 1987. This meeting will be held in conjunction with the Southern California section of the Mathematical Association of America. All sessions will take place in the Mathematical Sciences Building.

Invited Addresses

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meeftings, there will be three invited one-hour addresses including:

BJORN ENQUIST, University of California, Los Angeles, *Computation of oscillatory solutions to hyperbolic differential equations.*

HENRYK HECHT, University of Utah, *Harish-Chandra modules, globalizations, and geometry of the flag variety*

PAUL C. YANG, University of Southern California, *Conformal deformations of metrics*

Special Sessions

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

Differential geometry, ROBERT GREENE, University of California, Los Angeles, S.-Y. CHENG, University of California, Los Angeles, and H.-Y. CHOI, University of Utah. Speakers are Robert Brooks, Shaoping Chang, Shiu-Yuen Cheng, S. S. Chern, Kevin Corlette, Dennis DeTurck, T. Duchamp, Wei-Qui Gao, Peter B. Gilkey, C. Robin Graham, Robert E. Greene, Detlef Gromol, David Hoffman, Ralph Jenne, Gary R. Jensen, Kang Tae Kim, Nicholas J. Korevaar, Rob Kusner, Gary Lawlor, Guojun Liao, E. B. Lin, Alan Michael Nadel, Vladimir Oliker, R. C. Penner, Mark Pinsky, Y. S. Poon, Martin Ross, Leslie Saper, Bruce Solomon, Mark Stern, Johan Tysk, S. Walter Wei, Howard Weiss, Brian White, Jon G. Wolfson, Pit-Mann Wong, Youyu Xu, Kichoon Yang, Chi-Ming Yau, and Stephen S. T. Yau.

Geometric methods in representation theory, HENRYK HECHT. Speakers include Dan Barbasch, Mladen Bozicevic, Luis Casian, Jen-Tseh Chang, Devra Garfinkle, Joseph F. Johnson, Lisa Mantini, Dragan Milicic, Tomasz Przebinda, Brad Shelton and Joseph A. Wolf.

Game theory, WILLIAM LUCAS, Claremont Graduate School. Speakers are Harrison H. C. Cheng, Irinel Dragan, Thomas S. Ferguson, William Geller, Johannes G. C. Heijmans, Dov Monderer, T. E. S. Raghavan, Eric Rasmusen, and L. S. Shapley.

Stochastic processes, SIDNEY PORT, University of California, Los Angeles, and RUTH WILLIAMS, University of California, San Diego. Speakers include Kenneth Alexander, P. J. Fitzsimmons, Dick Holley, Thomas S. Mountford, Charles M. Newman, and Thomas S. Salisbury.

Geometric topology, JOHN WALSH, University of California, Riverside. Speakers are Stephen Brick, Robert Edwards, Dennis J. Garrity, Jim Hoste, W. Kazez, D. D. Long, Darryl McCullough, Andy Miller, K. C. Millett, Ulrich Oertel, James T. Rogers, Dale M. Rohm, Martin Scharlemann, Michael Starbird, Morwen B. Thistlethwaite, F. C. Tinsley, Keith Wolcott and Raymond Y. Wong.

Contributed Papers

There will also be sessions for contributed ten-minute papers on Saturday morning, November 14.

Joint Invited Addresses

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, and the Mathematical Association of America, there will be two joint invited address as follows:

THEODORE E. HARRIS, University of California, Los Angeles, *Stochastic flows of mappings*

LLOYD S. SHAPLEY, University of California, Los Angeles, *Utility categories and applications*

MAA Program

The MAA program will begin on Saturday, November 14 with a minicourse by GUILLERMO OWENS titled *Value theories and applications to economics and politics, I.* Registration for the minicourse is $7.50. The MAA Business meeting will begin at 9:00 am. In addition to the jointly sponsored Invited Addresses, two MAA Invited Addresses are scheduled:

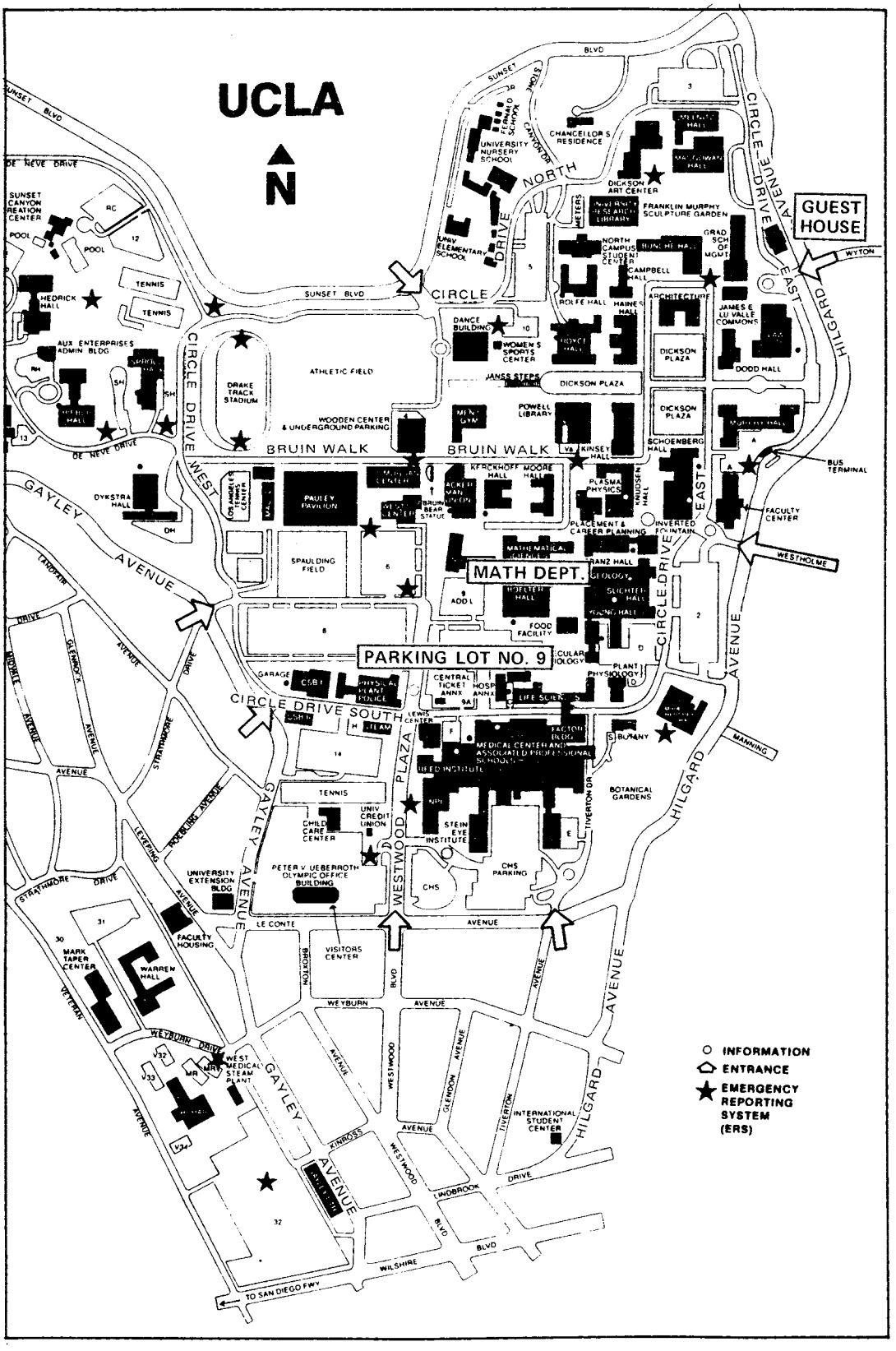
JOSEPH M. GANI, University of California, Santa Barbara, *The many faces of statistics*

JAMES H. WHITE, University of California, Los Angeles, *Wrapping DNA on surfaces: solving knotty problems in recombination*

A luncheon is scheduled at noon featuring an address by JOHN W. GREEN of the University of California, Los Angeles, title to be announced. The fee for the luncheon is $12.50.

Registration

The meeting registration desk will be located in the Faculty Lounge in the Mathematical Sciences Building. The desk will be open from 8:00 a.m. until 4:00 p.m. on Saturday, and from 8:30 a.m.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KINSEY HALL
BUS TERMINAL
FACULTY CENTER
INVERTED FOUNTAIN
PLACEMENT & CAREER PLANNING
PLASMA PHYSICS
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KERCKHOFF HALL
MOORE HALL
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PAULEY PAVILION
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FACTOR BLDG
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TENNIS
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FACULTY HOUSING
MARK TAPER CENTER
WARREN HALL
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to noon on Sunday. The registration fees are $10 for members of the AMS or MAA, $16 for nonmembers, and $5 for students or unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information can be found in a box in the Atlanta meeting announcement found in this issue of *Notices*.

Accommodations

Blocks of rooms are being held at the following locations. Participants should make their own arrangements directly with the hotel of their choice and be sure to mention the joint AMS-MAA meeting at UCLA. Note that the rates do not include applicable taxes. The Claremont and Royal Palace hotels are located in Westwood Village within walking distance, adjacent to the south side of campus. The UCLA Guest House is on the campus.

Claremont Hotel
1044 Tiverton Avenue, Westwood 90024
Telephone: 213-208-5957
Single $33.50 Double $39.50

Royal Palace Westwood
1052 Tiverton Avenue, Westwood 90024
Telephone: 213-208-6677 or
800-248-6955 (California)
800-631-0100 (Outside California)
Single $49, 56, 62, 65, 75
Double $55, 62, 68, 71, 81

UCLA Guest House
(on UCLA campus)
Telephone: 213-825-2923

Standard room	$57 single or double
Parlor room	$55 single or double
Suite	$78 2 queen-size beds (sleeps up to 4 people)

Tax is included in rates.

Food Service

Information will be provided at the meeting registration desk regarding availability of food service within walking distance.

Travel

The UCLA campus is located approximately 12 miles north of Los Angeles International Airport (LAX), which is served by all of the major airlines. The taxi fare from the airport to the UCLA campus is approximately $20 plus tip. There is no extra charge for additional passengers going to the same destination. The Super Shuttle, which provides door-to-door service, can be summoned by dialing number 35 from the courtesy phones in the baggage claim area. The bus should arrive within 15 minutes; the fare is $15 for one passenger and $6 for each additional person, plus tip. For information or advance reservations call 213-777-8000.

The most economical transportation is via public bus from the LAX Transit Center at 96th Street and Vicksburg Avenue (1/4 mile northeast of the main airport exit). To reach the Transit Center from the terminal, wait next to the lower level roadway under a SHUTTLE BUS sign, which lists buses as A, B, C, etc. Board the free C or Lot C bus and exit the airport, getting off at its first stop outside of the airport just after it enters Parking Lot C. Walk 100 yards east to the LAX Transit Center. The fastest and most frequent service to UCLA is by the RTD #560 bus, which takes approximately 30 minutes to reach the campus and costs $1.20. (NOTE: exact change in **coins** is required; no bills accepted!) Direct service to UCLA is also available Monday through Friday on the Culver City #6 bus, which takes approximately 50 minutes; the fare is 50 cents. All buses approach the campus from the south, up Westwood Boulevard, turning right (east) at LeConte Avenue. Exit the bus at that corner and walk north up Westwood to the Mathematical Sciences Building (Boelter Hall, approximately 3/4 mile on the right, beyond parking structure #9.) Participants planning to stay at the UCLA Guest House should stay on the bus to end of the line.

Parking

Permits costing $3 per day are required for any cars parking on campus between the hours of 7:00 a.m. and 9:00 p.m. daily, and may be obtained at any of the several parking kiosks around the campus. Visitors with permits from other University of California campuses may use these to park at UCLA, but must check in at a kiosk. The parking area closest to the Mathematical Sciences Building is Structure #9 on Westwood Boulevard; its kiosk is in the center of the Boulevard.

Program of the Sessions

The time limit for each contributed paper in the AMS sessions is ten minutes. In AMS 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 AMS sessions at this meeting will be found in the October issue of *Abstracts of papers presented to the American Mathematical Society*, ordered according to the numbers in parentheses following the listings below.

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

All sessions will take place in the Mathematical Sciences Building, unless otherwise indicated.

Saturday, November 14, 1987, 8:30 a.m.

MAA Minicourse — Room 6227

8:30 - 9:50 *Value theories and applications to economics and politics*, I. GUILLERMO OWENS

Saturday, November 14, 1987, 8:30 a.m.

General Session, I — Room 5138

8:30 - 8:40 (1) *3-manifolds which are end 1-movable.* MATTHEW G. BRIN, State University of New York, Binghamton, and T. L. THICKSTUN*, Southwest Texas State University (838-57-29)

8:45 - 8:55 (2) *The effect of an isotopy of a knot in $S^2 \times S^1$ on the surgery 3-manifold groups.* Preliminary report. FRANCIS D. LONERGAN, Webster, Massachusetts (838-55-30)

9:00 - 9:10 (3) *Chromaticity of certain regular graphs.* GREGORY M. CONSTANTINE and EARL GLEN WHITEHEAD, JR.*, University of Pittsburgh (838-05-47)

9:15 - 9:25 (4) *Operations on generators of unitary amicable pairs.* RUDOLPH M. NAJAR, University of Wisconsin, Whitewater (838-11-52)

9:30 - 9:40 (5) *A note on $n(x,y)$-reflected lattice paths.* A. K. AGARWAL, Pennsylvania State University, Mont Alto Campus (838-11-03)

9:45 - 9:55 (6) *Diophantine hyperbolic functions and Fermat's last theorem (FLT).* C. MUSÈS, Mathematics Research Centre, Albany, California (838-11-11) (Sponsored by K. Demys)

10:00 - 10:10 (7) *Commutativity of rings satisfying certain polynomial identities.* YASUYUKI HIRANO, Okayama University, Japan, and ADIL YAQUB*, University of California, Santa Barbara (838-16-62)

10:15 - 10:25 (8) *Semigroups of approximately differentiable functions.* Preliminary report. KRZYSZTOF OSTASZEWSKI, University of Louisville (838-26-28)

10:30 - 10:40 (9) *Spontaneous oscillations in neural networks.* Preliminary report. STANLEY R. LENIHAN, U. S. Army, Yuma Proving Ground (838-34-20)

10:45 - 10:55 (10) *Nonlinear boundary value problems with signum function.* SHOUCHUAN HU, Southwest Missouri State University (838-34-110)

Saturday, November 14, 1987, 8:30 a.m.

AMS Special Session on Game Theory, I — Room 5137

8:30 - 9:00 (11) *A new version of the Folk theorem.* ERIC RASMUSEN, University of California, Los Angeles (838-90-88) (Sponsored by William F. Lucas)

9:05 - 9:35 (12) *The principal of equivalence.* HARRISON H. C. CHENG, University of Southern California (838-90-86) (Sponsored by William F. Lucas)

9:40 - 10:10 (13) *Almost quartic core convergence.* WILLIAM GELLER, University of California, Berkeley (838-90-34)

10:15 - 10:45 (14) *On the rate of convergence of the strong $\in$-core to the core.* Preliminary report. LLOYD SHAPLEY, University of California, Los Angeles (838-90-71)

Saturday, November 14, 1987, 9:00 a.m.

MAA Business Meeting — Location to be announced

Saturday, November 14, 1987, 9:00 a.m.

AMS Special Session on Differential Geometry, AI — Room 5117

9:00 - 9:20 (15) *Harmonic Gauss maps.* GARY R. JENSEN*, Washington University, and MARCO RIGOLI, International Center for Theoretical Physics, Italy (838-53-67)

9:30 - 9:50 (16) *Variational problems connected with convex bodies.* Preliminary report. VLADIMIR OLIKER, Emory University (838-53-91)

10:00 - 10:20 (17) *Metrics of rapid curvature decay.* Preliminary report. ROBERT E. GREENE, University of California, Los Angeles (838-53-65)

10:30 - 10:50 (18) *Asymptotics of the heat equation.* PETER B. GILKEY, University of Oregon (838-58-45)

Saturday, November 14, 1987, 9:00 a.m.

AMS Special Session on Differential Geometry, BI — Room 5118

9:00 - 9:20 (19) *Rational automorphism group of a domain in* $\mathbf{C}^n$. Preliminary report. STEPHEN S. T. YAU, University of Illinois, Chicago (838-32-80)

9:30 - 9:50 (20) *Finite dimensionality of the space generated by positive harmonic functions.* SHIU-YUEN CHENG, University of California, Los Angeles (838-53-75)

10:00 - 10:20 (21) *First order asymptotics of the principal eigenvalue of tubular neighborhoods.* MARK PINSKY*, Northwestern University, and LEON KARP, Herbert H. Lehman College, City University of New York (838-58-09)

10:30 - 10:50 (22) *Moduli of flat unitary bundles.* Preliminary report. ALAN MICHAEL NADEL, Harvard University (838-53-33)

Saturday, November 14, 1987, 9:00 a.m.

AMS Special Session on Geometric Topology, I — Room 5128

9:00 - 9:20 (23) *Thin cellular decompositions of the Hilbert cube.* Preliminary report. DENNIS J. GARITY, Oregon State University (838-57-49)

9:25 - 9:45 (24) *Products of infinite-dimensional spaces.* Preliminary report. DALE M. ROHM, Oregon State University (838-54-37)

9:50 - 10:10 (25) *On spaces of Lipschitz homeomorphisms of compact manifolds.* KATSURO SAKAI and RAYMOND Y. WONG*, University of California, Santa Barbara (838-57-16)

10:15 - 10:35 (26) *Local product structures on homogeneous continua.* MICHAEL W. MISLOVE and JAMES T. ROGERS, JR.*, Tulane University (838-54-27)

Saturday, November 14, 1987, 10:00 a.m.

MAA Invited Address — Room 4000A

10:00 - 10:50 (27) *Wrapping DNA on surfaces: Solving knotty problems in recombination.* JAMES H. WHITE, University of California, Los Angeles

Saturday, November 14, 1987, 11:00 a.m.

AMS Invited Address — Room 4000A

11:00 - 11:50 (28) *Conformal deformation of metrics.* PAUL C. YANG, University of Southern California (838-53-92)

Saturday, November 14, 1987, Noon

Luncheon — Location to be announced

Saturday, November 14, 1987, 1:30 p.m.

MAA Minicourse — Room 6227

1:30 - 2:50 *Value theories and applications to Economics and Politics,* II. GUILLERMO OWENS

Saturday, November 14, 1987, 1:30 p.m.

AMS Special Session on Differential Geometry, AII — Room 5117

1:30 - 1:50 (29) *Periodic minimal surfaces with an infinite number of ends.* MICHAEL CALLAHAN, DAVID HOFFMAN* and WILLIAM MEEKS, University of Massachusetts, Amherst (838-53-41)

2:00 - 2:20 (30) *Spec* (Δ) *on cubic minimal isoparametric hypersurfaces.* BRUCE SOLOMON, Indiana University, Bloomington (838-53-23)

2:30 - 2:50 (31) *Minimal surfaces in Kähler surfaces and Ricci curvature.* JON G. WOLFSON, Tulane University (838-53-18)

3:00 - 3:20 (32) *On removability of a singular submanifold for weakly harmonic maps.* DAVID COSTA and GUOJUN LIAO*, University of Utah (838-58-59) (Sponsored by Peter Li)

3:30 - 3:50 (33) *An index characterization of the catenoid and index bounds for minimal surfaces in* S^3. S. Y. CHENG, University of California, Los Angeles, and JOHAN TYSK*, Columbia University (838-53-08)

4:00 - 4:20 (34) *A differential geometric approach to nonlinear partial differential equations.* S. WALTER WEI, University of Oklahoma (838-53-22)

Saturday, November 14, 1987, 1:30 p.m.

AMS Special Session on Differential Geometry, BII — Room 5118

1:30 - 1:50 (35) *Conformal invariant theory.* Preliminary report. C. ROBIN GRAHAM, University of Washington (838-53-78)

2:00 - 2:20 (36) *L^2-cohomology of arithmetic varieties.* MARK STERN, Duke University (838-53-56)

2:30 - 2:50 (37) *Harmonic maps and rigidity in Kähler geometry.* KEVIN CORLETTE, University of Chicago (838-53-43)

3:00 - 3:20 (38) *Low dimensional quaternionic Kähler manifolds.* Preliminary report. Y. S. POON, Rice University (838-53-98)

3:30 - 3:50 (39) *L^2-cohomology of arithmetic varieties.* LESLIE SAPER* and MARK STERN, Duke University (838-53-102)

4:00 - 4:20 (40) *Domains with noncompact automorphism group.* Preliminary report. KANG TAE KIM, University of California, Los Angeles (838-53-46)

Saturday, November 14, 1987, 1:30 p.m.

AMS Special Session on Geometric Topology, II — Room 5128

1:30 - 1:50 (41) *Virtual cohomological dimension of 3-manifold mapping class groups.* DARRYL MCCULLOUGH, University of Oklahoma (838-57-21)

1:55 - 2:15 (42) *Acyclic maps which are homotopic to homeomorphisms.* Preliminary report. F. C. TINSLEY, Colorado College (838-57-31)

2:20 - 2:40 (43) *Cut-and-paste of incompressible surfaces.* Preliminary report. ULRICH OERTEL, University of Oklahoma (838-57-13)

2:45 - 3:05 (44) *Dichromatic link invariants.* Preliminary report. JIM HOSTE*, Oregon State University, and MARK KIDWELL, United States Naval Academy (838-57-81)

3:10 - 3:30 (45) *Stable genus increments for finite group actions on surfaces.* Preliminary report. DARRYL MCCULLOUGH and ANDY MILLER*, University of Oklahoma (838-57-35)

3:35 - 3:55 (46) *Kervaire complexes.* Preliminary report. STEPHEN BRICK, University of California, Riverside (838-20-100)

4:00 - 4:20 (47) *Planarity of locally planar graphs.* Preliminary report. KEITH WOLCOTT, University of California, Santa Barbara (838-57-39)

4:25 - 4:45 (48) *Applications of the plane theorem to wild topology.* Preliminary report. WILLIAM T. EATON and MICHAEL STARBIRD*, University of Texas, Austin (838-57-40)

4:50 - 5:10 (49) *Surgery on fibered two bridge knots.* Preliminary report. D. GABAI and W. KAZEZ*, California Institute of Technology (838-57-107)

Saturday, November 14, 1987, 1:30 p.m.

General Session, II — Room 5138

1:30 - 1:40 (50) *A new theory on mean values.* Preliminary report. HIROSHI HARUKI, University of Waterloo (838-39-07)

1:45 - 1:55 (51) *Convergence theorems for Bernstein type operators.* Preliminary report. C. JAYASRI, University of Kerala, India, and Y. SITARAMAN*, University of Louisville (838-41-104)

2:00 - 2:10 (52) *On convergence of certain series via Fourier analysis.* Preliminary report. SADANAND VERMA, University of Nevada, Las Vegas, and PRABHA VARMA*, Bankipur Girl's High School, India (838-42-72) (Sponsored by L. J. Simonoff)

2:15– 2:25 (53) *Fubini products of liminal C^*-algebras with Hausdorff spectra.* SEUNG-HYEOK KYE, University of California, Berkeley (838-46-54)

2:30– 2:40 (54) *Self-circumference of polygons in the Minkowski plane.* Preliminary report. MOSTAFA GHANDEHARI*, Santa Clara University, and RICHARD PFIEFER, San Jose State University (838-52-25)

2:45– 2:55 (55) *Approximately invertible maps preserve small-weak-infinite-dimensionality.* RICHARD MILLSPAUGH, University of Oklahoma (838-54-105)

3:00– 3:10 (56) *Computing Massey product invariants of links and an improved formulation.* DAVID STEIN, Texas A & M University, College Station (838-57-12)

3:15– 3:25 (57) *Fourier integrals.* Preliminary report. KRISHNANAND VERMA, University of Nevada, Las Vegas, and PUNESHWAR PRASAD SINHA*, H. R. College, India (838-65-42) (Sponsored by L. J. Simonoff)

3:30– 3:40 (58) *On some numerical schemes for transonic flow problems.* MARCO MOSCHE MOSTREL, University of California, Los Angeles (838-76-57)

3:45– 3:55 (59) *Diffraction by a dielectric wedge of arbitrary angle.* MICHAEL PAPADOPOULOS, University of Redlands (838-78-73)

4:00– 4:10 (60) *Some notes on the Stokes phenomenon relating to the equation $x^n y^{(n)}(x) - x^m y(x) = 0$.* Preliminary report. SHARON KUNOFF, Long Island University, C. W. Post Center (838-01-66)

Saturday, November 14, 1987, 1:45 p.m.

MAA Invited Address Room 4000A

1:45– 2:35 (61) *The many faces of statistics.* JOSEPH M. GANI, University of California, Santa Barbara

Saturday, November 14, 1987, 2:00 p.m.

AMS Special Session on Game Theory, II Room 5137

2:00– 2:30 (62) *A new algorithm for discounted switching control stochastic games terminating in finite steps and some computational results.* T.E.S. RAGHAVAN, University of Illinois, Chicago (838-90-85) (Sponsored by William F. Lucas)

2:35– 3:05 (63) *Measure-based values of nonatomic games.* DOV MONDERER, University of California, Los Angeles (838-90-89) (Sponsored by William F. Lucas)

3:10– 3:40 (64) *An existence theorem for the modified bargaining set of cooperative n-person games with side payments.* IRINEL DRAGAN, University of Texas, Arlington (838-90-83)

3:45– 4:15 (65) *Minimal blocking coalitions and symmetric von Neumann-Morgenstern solutions.* Preliminary report. JOHANNES G. C. HEIJMANS*, University of Texas, Arlington, and WILLIAM F. LUCAS, The Claremont Graduate School (838-90-87)

4:20– 4:50 (66) *Models for the game of liar's dice.* CHRISTOPHER P. FERGUSON and THOMAS S. FERGUSON*, University of California, Los Angeles (838-90-84)

Saturday, November 14, 1987, 2:45 p.m.

MAA Invited Address Room 4000A

2:45– 3:35 (67) *Probability methods in potential theory.* SIDNEY C. PORT, University of California, Los Angeles

Saturday, November 14, 1987, 3:45 p.m.

MAA Executive Committee Meeting Location to be announced

Saturday, November 14, 1987, 4:30 p.m.

AMS Special Session on Differential Geometry, III Franz Hall 1198

4:30– 4:50 (68) *Lie sphere geometry and Dupin submanifolds.* Preliminary report. S. S. CHERN, University of California, Berkeley (838-53-99)

Saturday, November 14, 1987, 5:00 p.m.

AMS-MAA Invited Address Room 4000A

5:00– 5:50 (69) *Utility categories and applications.* LLOYD SHAPLEY, University of California, Los Angeles

Sunday, November 15, 1987, 8:15 a.m.

AMS Special Session on Geometric Topology, III Room 5128

8:15 - 8:35 (70) *Evaluation of the F-polynomial of a link.* W.B.R. LICKORISH, Cambridge University, England, and K. C. MILLETT*, University of California, Santa Barbara (838-57-53)

8:40 - 9:00 (71) *Some applications of the Kauffman polynomial.* Preliminary report. MORWEN B. THISTLETHWAITE, University of California, Santa Barbara (838-57-14) (Sponsored by John J. Walsh)

9:05 - 9:25 (72) *Link genus and crossing changes.* MICHEL BOILEAU, University of Paris-Sud, France, and MARTIN SCHARLEMANN*, University of California, Santa Barbara (838-57-50)

9:30 - 9:50 (73) *On the linear representation of braid groups.* Preliminary report. D. D. LONG, University of California, Santa Barbara (838-57-15)

9:55 - 10:15 (74) *Free A_p actions on cell-like compacta.* Preliminary report. MLADEN BESTVINA and ROBERT EDWARDS*, University of California, Los Angeles (838-57-17)

Sunday, November 15, 1987, 8:30 a.m.

AMS Special Session on Differential Geometry, AIV Room 5117

8:30 - 8:50 (75) *On complete manifolds with nonnegative Ricci curvature.* UWE ABRESCH, Mathematisches Institut der Universität, Federal Republic of Germany, and DETLEF GROMOLL*, State University of New York, Stony Brook (838-53-90)

9:00 - 9:20 (76) *A construction of conformally invariant differential operators.* Preliminary report. RALPH JENNE, University of Washington (838-53-79) (Sponsored by C. Robin Graham)

9:30 - 9:50 (77) *Affine conormal of convex hypersurfaces.* CHI-MING YAU, University of Oklahoma (838-53-68) (Sponsored by Robert E. Greene)

10:00 - 10:20 (78) *Complete unoriented area minimizing surfaces in R^n.* MARTIN ROSS, Stanford University (838-53-108)

Sunday, November 15, 1987, 8:30 a.m.

AMS Special Session on Differential Geometry, BIV Room 5118

8:30 - 8:50 (79) *Dynamical systems on loop spaces.* E. B. LIN, University of Toledo (838-53-44)

9:00 - 9:20 (80) *A construction of metrics of negative Ricci curvature.* ROBERT BROOKS, University of Southern California (838-53-10)

9:30 - 9:50 (81) *On analysis of inverse scattering transformation solution to generalized KDV equation.* YOUYU XU, University of California, Los Angeles (838-53-76) (Sponsored by Shiu-Yuen Cheng)

10:00 - 10:20 (82) *Regularity of entropy of the geodesic flow on a negatively curved surface under smooth perturbations.* Preliminary report. GERHARD KNIEPER, California Institute of Technology and Institute for Advanced Study, and HOWARD WEISS*, California Institute of Technology (838-58-48)

Sunday, November 15, 1987, 8:30 a.m.

AMS Special Session on Geometric Methods in Representation Theory, I Room 5137

8:30 - 8:50 (83) *Extensions of generalized Verma modules.* BRAD SHELTON, University of Oregon (838-22-82) (Sponsored by Robert S. Freeman)

9:00 - 9:20 (84) *Geometric constructions of representations.* JOSEPH A. WOLF, Mathematical Sciences Research Institute and University of California, Berkeley (838-22-64)

9:30 - 9:50 (85) *The unitary dual of F^4.* Preliminary report. DAN BARBASCH, Mathematical Sciences Research Institute, Berkeley, and Rutgers University, New Brunswick (838-22-51)

10:00 - 10:20 (86) *Localization of Harish-Chandra modules.* DRAGAN MILICIC, University of Utah (838-22-94)

Sunday, November 15, 1987, 8:30 a.m.

AMS Special Session on Stochastic Processes, I Room 5138

8:30 - 8:50 (87) *Possible cluster sets for the LIL sequence in Banach space.* Preliminary report. KENNETH ALEXANDER, University of Southern California (838-60-19) (Sponsored by Ronald E. Bruck)

9:00 - 9:20 (88) *The asymptotic number of crossings from a circle to a tangential line by planar Brownian motion.* THOMAS S. MOUNTFORD, University of California, Los Angeles (838-60-63)

9:30 - 9:50 (89) *Gibbs distributions and percolation models.* CHARLES M. NEWMAN, University of Arizona (838-60-05)

10:00 - 10:20 (90) *Simulated annealing via Sobolev inequalities.* DICK HOLLEY*, University of Colorado, Boulder, and DAN STROOCK, Massachusetts Institute of Technology (838-60-06)

Sunday, November 15, 1987, 10:30 a.m.

AMS Invited Address Room 4000A

10:30 - 11:20 (91) *Computation of oscillatory solutions to hyperbolic differential equations.* BJORN ENQUIST, University of California, Los Angeles (838-99-106)

Sunday, November 15, 1987, 11:30 a.m.

AMS Invited Address Room 4000A

11:30 - 12:20 (92) *Harish-Chandra modules, globalizations, and geometry of the flag variety.* HENRYK HECHT, University of Utah (838-22-93)

Sunday, November 15, 1987, 1:30 p.m.

AMS-MAA Invited Address Room 4000A

1:30 - 2:20 (93) *Stochastic flows of mappings.* THEODORE E. HARRIS, University of Southern California

Sunday, November 15, 1987, 2:30 p.m.

AMS Special Session on Differential Geometry, AV Room 5117

2:30 - 2:50 (94) *A new proof of the compactness theorem for integral currents.* BRIAN WHITE, Stanford University (838-53-109)

3:00 - 3:20 (95) *The structure of complete embedded surfaces with constant mean curvature.* NICHOLAS J. KOREVAAR*, University of Kentucky, ROB KUSNER, University of California, Berkeley, and BRUCE SOLOMON, Indiana University, Bloomington (838-53-26)

3:30 - 3:50 (96) *New examples of singularities in area-minimizing surfaces.* Preliminary report. GARY LAWLOR, Stanford University (838-51-77)

4:00 - 4:20 (97) *On complete minimal immersion* $X : \mathbf{R}P^2\backslash\{a,b\} \to \mathbf{R}^3$ *with total curvature* -10π. SHAOPING CHANG, University of California, Los Angeles (838-53-74) (Sponsored by Shiu-Yuen Cheng)

4:30 - 4:50 (98) *Comparison surfaces for the Willmore problem.* ROB KUSNER, University of California, Berkeley (838-53-24)

Sunday, November 15, 1987, 2:30 p.m.

AMS Special Session on Differential Geometry, BV Room 5118

2:30 - 2:50 (99) *Second main theorems in Nevanlinna theory.* Preliminary report. PIT-MANN WONG, University of Notre Dame (838-32-60)

3:00 - 3:20 (100) *On the unimodular Monge-Ampère equation.* Preliminary report. WEI-QUI GAO* and PIT-MANN WONG, University of Notre Dame (838-53-61)

3:30 - 3:50 (101) *Complex foliations.* T. DUCHAMP*, University of Washington, and M. KALKA, Tulane University (838-32-38)

4:00 - 4:20 (102) *The Gauss-Frenet map of a horizontal curve in the G-flag manifold.* KICHOON YANG, Arkansas State University (838-53-58)

4:30 - 4:50 (103) *Connections with prescribed curvature.* Preliminary report. DENNIS DETURCK* and JANET TALVACCHIA, University of Pennsylvania (838-53-101)

5:00 - 5:20 (104) *Some problems in two-dimensional conformal geometry.* R. C. PENNER, University of Southern California (838-53-103)

Sunday, November 15, 1987, 2:30 p.m.

AMS Special Session on Geometric Methods in Representation Theory, II Room 5137

2:30 - 2:50 (105) *Classification of principal series modules for real reductive groups.* Preliminary report. LUIS CASIAN, Massachusetts Institute of Technology (838-22-55)

3:00 - 3:20 (106) *Unstable base change* $\mathbf{C}/\mathbf{R}$. Preliminary report. JOSEPH F. JOHNSON, University of Utah (838-22-96)

3:30 - 3:50 (107) *On Enright-Varadarajan modules.* Preliminary report. MLADEN BOZICEVIC, University of Utah (838-22-69)

4:00 - 4:20 (108) *Twisted sheaf of differential operators.* Preliminary report. JEN-TSEH CHANG, Mathematical Sciences Research Institute, Berkeley (838-22-32)

4:30 - 4:50 (109) *Primitive ideals in universal enveloping algebras.* Preliminary report. DEVRA GARFINKLE, University of Utah (838-22-95)

5:00 - 5:20 (110) *The duality correspondence of infinitesimal characters.* TOMASZ PRZEBINDA, University of Utah (838-43-70)

5:30 - 5:50 (111) *A geometric construction of unitary highest weight modules for* $U(p,q)$. Preliminary report. LISA MANTINI, Oklahoma State University, Stillwater (838-22-97)

Sunday, November 15, 1987, 2:30 p.m.

AMS Special Session on Stochastic Processes, II Room 5138

2:30– 2:50 (112) *On Fukushima's version of the Chacon-Ornstein theorem.* P. J. FITZSIMMONS, University of California at San Diego, La Jolla (838-60-01)

3:00– 3:20 (113) *Pathologies of conditioned Brownian motion.* THOMAS S. SALISBURY, York University (838-60-02)

Salt Lake City, Utah

Hugo Rossi
AMS Associate Secretary

Eugene, Oregon

Kenneth A. Ross
MAA Secretary

Presenters of Papers

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Atlanta Meetings, January 6 – 9, 1988

Preliminary Announcement

The January 1988 Joint Mathematics Meetings, including the 94th Annual Meeting of the AMS, the 71st Annual Meeting of the Mathematical Association of America, and the 1988 annual meetings of the Association for Women in Mathematics and the National Association for Mathematicians will be held January 6 – 9 (Wednesday – Saturday), 1988, in Atlanta, Georgia. Sessions will take place in the Hyatt Regency Atlanta and the Atlanta Marriott Marquis.

The members of the Local Arrangements Committee are Jean H. Bevis, Sylvia T. Bozeman, W. Wistar Comfort (ex-officio), Frank J. Hall, Ray A. Kunze, Stephen L. Langston, Robert A. Leslie, William J. LeVeque (ex-officio), Fred A. Massey (Chairman), John D. Neff, Mary Neff, Kenneth A. Ross (ex-officio), Charles R. Stone, and Thomas R. Thomson.

IMPORTANT DEADLINES

AMS Abstracts	
For consideration for special sessions	**Expired**
Of contributed papers	**October 8**
MAA Abstracts	
Of contributed papers	**Expired**
Employment Register (Applicants & Employers)	**November 6**
EARLY Preregistration and Housing	**October 26**
Preregistration and Housing	**November 6**
MAA Minicourse Preregistration	**November 6**
Motions for AMS Business Meeting	**December 7**
Preregistration cancellations (50% refund)	**December 23**

94th Annual Meeting of the AMS
January 6 – 9, 1988

Sixty-First Josiah Willard Gibbs Lecture

The 1988 Gibbs lecture will be presented at 8:30 p.m. on Wednesday, January 6, by DAVID P. RUELLE of Institut des Hautes Etudes Scientifiques. The title of his lecture is *How natural is our mathematics? The example of equilibrium statistical mechanics.*

Colloquium Lectures

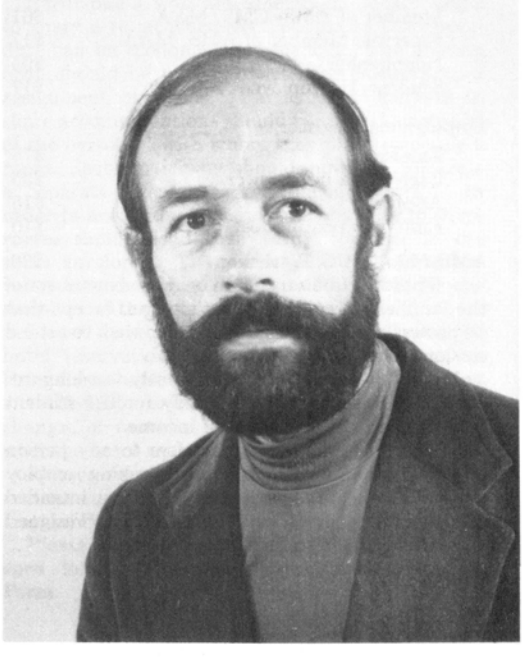
There will be a series of four Colloquium Lectures presented by VICTOR W. GUILLEMIN of the Massachusetts Institute of Technology. The title of this lecture series is *Spectral properties of Riemannian manifolds.* The lectures will be given at 1:00 p.m. daily, Wednesday through Saturday, January 6 – 9.

Prizes

The 1988 George David Birkhoff Prize in Applied Mathematics will be awarded at 4:25 p.m. on Thursday, January 7.

Invited Addresses

By invitation of the Program Committee, there will be eight fifty-minute invited addresses. The names of the speakers, their affiliations, the dates



David P. Ruelle, Gibbs Lecturer

Preregistration

Preregistration for these meetings and the Mathematical Sciences Employment Register **must be completed by November 6, 1987.** Those wishing to preregister must complete the form(s) which appear(s) at the back of this issue and submit it (them) together with the appropriate preregistration fee(s) to the Mathematics Meetings Housing Bureau in Providence by **November 6**. Please note that a space has been provided on the Preregistration/Housing Form if one wishes to have his/her nickname printed on the meeting badge.

Preregistration fees do not represent an advance deposit for lodgings. One must, however, preregister for the meetings in order to obtain hotel accommodations through the Mathematics Meetings Housing Bureau, as outlined on the facing page.

Preregistration fees may be paid by check payable to the American Mathematical Society (Canadian checks must be marked for payment in U.S. funds), or by providing a VISA or MASTERCARD credit card number on the Preregistration/Housing Form. **Please be sure to give the name and number exactly as they appear on the credit card, and to include the expiration date.**

The registration fees at the meeting will be 30 percent higher than the preregistration fees listed below.

AMS Short Course	
Student/Unemployed	$10
All Others	$35
Joint Mathematics Meetings	
Member of AMS, CMS, MAA	$61
Emeritus Member of AMS, MAA	$17
Nonmember	$94
Student/Unemployed	$17
Employment Register	
Employer	$75
Each extra interviewer	$35
Applicant	$15
Employer posting fee	$10
AMS-MAA-TUG Workshop	$60

There will be 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 employ ment, and who is not a student. It is not intended to include any person who has voluntarily resigned or retired from his or her latest position.

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 from his or her latest position.

A $5 charge will be imposed for all invoices prepared when Preregistration/Housing Forms are submitted without accompanying payment for the preregistration fee(s) and room deposits, or are accompanied by an amount insufficient to cover the total due. Preregistration/Housing Forms received well before the deadline of **November 6** which are not accompanied by correct payment will be returned to the participant with a request for resubmission and full payment. **This will, of course, delay the processing of any housing request so that it will be unlikely that the participant's first choices will still be available.**

A 50 percent refund of the preregistration fee(s) will be made for all cancellations received in Providence no later than December 23. **No refunds will be granted for cancellations received after that date,** or to persons who do not attend the meetings.

The only exception to this rule is someone who preregisters for the Joint Mathematics Meetings only in order to attend an MAA Minicourse, and is too late to obtain a slot in the Minicourse. In this case, full refund will be made of the Joint Mathematics Meetings preregistration fee, **provided the preregistrant has checked the box** on the MAA Minicourse Preregistration Form that this was his or her intent. Individuals who preregister for both the Joint Meetings and an MAA Minicourse and who intend to participate in the Joint Meetings, even if the MAA Minicourse is not available, should **not**, of course, check the box on the MAA Minicourse Preregistration Form. In this case the Joint Meetings preregistration will be processed.

Please note that a separate preregistration form for MAA Minicourses must be sent to Jane Heckler at the address given on the form.

Those who wish to preregister for the Employment Register should read carefully the special article titled "Mathematical Sciences Employment Register" which follows this announcement of the Atlanta meetings. The attention of applicants is particularly directed to the section regarding the December issue of *Employment Information in the Mathematical Sciences.*

Please read the facing page titled **Housing** carefully before completing the Preregistration/Housing Form.

Housing

Special Bonus for Early Preregistrants!

Participants who preregister before the *early* preregistration deadline of **October 26** will be eligible for a complimentary room in Atlanta. (Multiple occupancy of these rooms is permissible.) Winners will be randomly selected from the names of all who preregister by October 26 and these lucky individuals will be notified by mail by December 23. **So, preregister early!** (A list of the winners in San Antonio appears in the section on Hotels.)

Acknowledgment Form

Participants will receive an acknowledgement of their preregistration, room deposit, and hotel assignment from the Mathematics Meetings Housing Bureau, which will be followed by a confirmation of the room reservation from the hotel to which they have been assigned.

The Preregistration/Housing Form for requesting hotel accommodations will be found at the back of this issue. Use of the services offered by the Mathematics Meetings Housing Bureau requires preregistration for the meetings. Persons desiring confirmed hotel accommodations should complete the form, or a reasonable facsimile, and send it to the Mathematics Meetings Housing Bureau, Post Office Box 6887, Providence, Rhode Island 02940, **so that it will arrive no later than November 6, 1987. Housing requests received after the deadline of November 6 most surely cannot be honored.**

All reservation requests must be received in writing and will be processed through the Housing Bureau in Providence. Telephone requests will not be accepted. **Please do not contact the hotels directly.** Blocks of rooms and special rates have been set aside for the Housing Bureau, and the hotel will either refer you back to the Housing Bureau, or give you a room outside of the block, which may be at a higher rate. Please note that the room occupancy tax in Atlanta is 11 percent.

Please read carefully the section on **Hotels** before completing the form. Forms sent to the wrong address and thus incurring delay in delivery to the Housing Bureau until after the deadline cannot be accepted and will, therefore, be returned.

Participants requesting hotel accommodations in Atlanta are required to submit housing deposits or credit card information when preregistering. Deposits may be paid by check payable to the AMS (Canadian checks must be marked for payment in U.S. funds), or by providing a VISA, MASTERCARD or American Express (**for housing only**) credit card number on the Preregistration/Housing Form. Please be sure to give the name and number **exactly** as they appear on the credit card, and to include the expiration date. Please note that when you provide a credit card number in lieu of a $50 check as a guarantee, no charge against your account will be processed by the hotel **unless you fail to claim the reserved room on your given arrival date, or if you fail to cancel your reservation directly with the hotel/motel 48 hours in advance of your given arrival date.** If either of the latter two circumstances apply, the hotel will then charge your credit card account for one night's occupancy. **Please read the section on Hotels carefully regarding deposits.**

Housing assignments are made on a first-come, first-served basis, so participants desiring low-cost accommodations are urged to submit their housing requests in as early as possible. Participants should also be aware that the special rates being offered in the section titled **Hotels** may not be available **after December 14**.

Participants are strongly urged to rank **each** hotel on the housing form in the order of preference, and circle the type of room and the rate desired. Reservations will be made in accordance with preferences indicated on the reservation form insofar as this is possible. 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 lowest rate.

Participants who are able to do so are urged to share a room whenever possible as this procedure can be economically beneficial. The housing form should be fully completed to ensure proper assignment of rooms. Participants planning to share accommodations should provide the name(s) of the person(s) with whom they plan to occupy a room. Each participant should, however, complete a separate Preregistration/Housing Form. **In order to avoid confusion, parties planning to share rooms should send their forms together in the same envelope. The participant requesting the room should submit the deposit and will be the recipient of the hotel confirmation.**

Please make all changes to or cancellations of hotel reservations with the Housing Bureau in Providence **before December 23, 1987, by calling 401-272-9500, extension 290.** After that date, changes or cancellations should be made directly with the hotel assigned.

Please read the facing page titled **Preregistration** carefully before completing the Preregistration/Housing Form.

Please be sure to send housing deposit or credit card information with Preregistration/Housing Form.

American Mathematical Society Short Course Series

Introductory Survey Lectures on

Computational Complexity Theory

Atlanta, Georgia, January 5–6, 1988

The American Mathematical Society, in conjunction with its ninety-fourth Annual Meeting, will present a short course entitled *Computational Complexity Theory* on Tuesday and Wednesday, January 5–6, 1988, in Atlanta at the Hyatt Regency Atlanta. The program is under the direction of JURIS HARTMANIS of Cornell University. Six lectures are planned and it is anticipated that proceedings will be published in the series *Proceedings of Symposia in Applied Mathematics*. **Please note that this is not an MAA Minicourse.**

The systematic study of computational complexity theory was initiated in the early sixties and during the following twenty-five years it has developed into one of the central and most active research areas of computer science. It has grown into a rich and exciting mathematical theory whose development is motivated and guided by computer science needs and technological advances. At the same time, it is clear that complexity theory, dealing with the quantitative laws of computation and reasoning, is concerned with issues and problems of direct interest to many other disciplines as well. In particular, complexity theory is of considerable interest to mathematics and some of the key open problems in complexity theory are basic questions about the quantitative nature of mathematics.

This course is intended to provide a quick introduction to computational complexity theory followed by five lectures on related, current research topics in complexity theory. Titles, speakers and schedule for the talks are as follows:

January 5, morning:

Overview of Computational Complexity Theory, JURIS HARTMANIS, Cornell University.

The Isomorphism Conjecture and Sparse Sets, STEPHEN R. MAHANEY, AT&T Bell Laboratories.

January 5, afternoon:

Restricted Relativizations of Complexity Classes, *Ronald V. Book*, University of California, Santa Barbara.

Descriptive and Computational Complexity, Neil Immerman, Yale University.

January 6, morning:

Complexity Issues in Cryptography, ALAN L. SELMAN, Northeastern University.

Interactive Proof Systems, SHAFI GOLDWASSER, Massachusetts Institute of Technology.

While no specialized background is required of participants, a familiarity with basic notions about Turing machines and computability will generally be assumed. Those who wish to get the most benefit from the course should consult M. Garey and D. S. Johnson, *Computers and Intractability: A Guide to the Theory of NP-Completeness*, Freeman, 1979, Chapters 1 and 2; J. E. Hopcroft and J. D. Ullman, *Introduction to Automata Theory, Languages, and Computation*, Addison-Wesley, 1979, Chapters 7, 12 and 13. Synopses of the talks and accompanying reading lists appear in this issue of the *Notices*. Complete lecture notes will be mailed to those who preregister for the course, and will be available at the Short Course registration desk for those registering for the course on site.

Those who also plan to register for the Joint Mathematics Meetings should take note of an AMS special session entitled *Structural Complexity Theory*, organized by STEPHEN R. MAHANEY of AT&T Bell Laboratories. For more information, see the Special Session section of the Atlanta meeting announcement in this issue of the *Notices*.

All who wish to participate in the Short Course may do so upon payment of a $35 advance registration fee ($45 on site). There are reduced fees for students and unemployed individuals. Please refer to the sections titled **Preregistration, Housing and Registration at the Meetings** for details.

The Short Course was recommended by the AMS-MAA Committee on Employment and Educational Policy (CEEP), whose members are Morton Brown, Stefan A. Burr, Edward A. Connors (chair), Philip C. Curtis, Jr., David J. Lutzer, Donald C. Rung, and Audrey A. Terras. The Short Course series is under the direction of the CEEP Short Course Subcommittee, whose members are Stefan A. Burr (chair), Lisl Novak Gaal, Robert P. Kurshan, Barbara L. Osofsky, and Marjorie L. Stein.

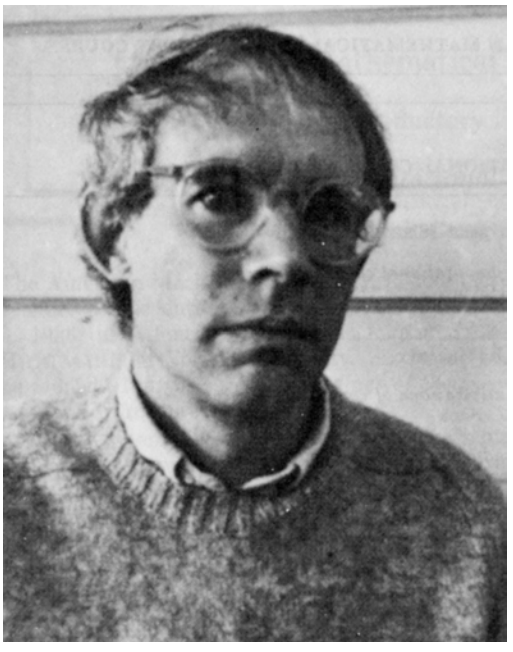
TUESDAY, JANUARY 5

COMPUTATIONAL COMPLEXITY THEORY

8:00 p.m. - 2:30 p.m.	Registration (Short Course Only)
9:00 a.m. - 10:15 a.m.	*Overview of computational complexity theory* Juris Hartmanis
10:45 p.m. - noon	*The isomorphism conjecture and sparse sets* Stephen R. Mahaney
1:45 p.m. - 3:00 p.m.	*Restricted relativizations of complexity classes* Ronald V. Book
3:15 p.m. - 4:30 p.m.	*Descriptive and computational complexity* Neil Immerman
4:30 p.m. - 5:00 p.m.	Discussion period

WEDNESDAY, JANUARY 6

8:00 a.m. - 9:15 a.m.	*Complexity issues in cryptography* Alan L. Selman
9:30 a.m. - 10:55 a.m.	*Interactive proof systems* Shafi Goldwasser



Victor W. Guillemin, Colloquium Lecturer

and times of their talks, and some of the titles follow:

CONSTANTINE M. DAFERMOS, Brown University, title to be announced, 2:15 p.m. Thursday;

R. MARK GORESKY, Northeastern University, title to be announced, 3:20 p.m. Thursday;

PHILIP J. HANLON, University of Michigan, *The Macdonald root system conjectures and their significance*, 10:05 a.m. Wednesday;

H. W. LENSTRA, JR., University of California, Berkeley, title to be announced, 3:20 p.m. Saturday;

DUSA MCDUFF, SUNY at Stony Brook, title to be announced, 10:05 a.m. Friday;

ROGER D. NUSSBAUM, Rutgers University, *Means and their iterations*, 9:00 a.m. Wednesday;

PETER CLIVE SARNAK, Stanford University, *Determinants of Laplacians, heights and finiteness*, 2:15 p.m. Saturday;

STEPHEN WILLIAM SEMMES, Yale University, *Nonlinear Fourier analysis*, 9:00 a.m. Friday.

Special Sessions

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

Ordered algebraic systems, MARLOW ANDERSON, The Colorado College, and TODD FEIL, Denison University. Friday 1:00 p.m., Saturday 8:00 a.m.

Banach space theory, ALFRED D. ANDREW, and JOHN H. ELTON, Georgia Institute of Technology. Wednesday 2:15 p.m., Thursday 8:00 a.m.

Modern trends in matrix analysis and applications, JEAN BEVIS, GEORGE DAVIS, FRANK HALL, FRED A. MASSEY and VALERIE MILLER, Georgia State University. Wednesday 2:15 p.m., Thursday 8:00 a.m.

Measure theory and descriptive set theory, JACK B. BROWN, Auburn University, and R. DANIEL MAULDIN, North Texas State University. Wednesday 2:15 p.m., Thursday 8:00 a.m.

Nonlinear differential delay equations, SHUINEE CHOW, Michigan State University, and ROGER D. NUSSBAUM, Rutgers University. Wednesday 2:15 p.m., Thursday 8:00 a.m.

Toeplitz operators and geometry, LEWIS A. COBURN, SUNY at Buffalo. Friday 1:00 p.m., Saturday 8:00 a.m.

Algebraic number theory and algorithms, GARY CORNELL, University of Connecticut, Storrs, and H. W. LENSTRA, JR., University of California, Berkeley. Friday 1:00 p.m., Saturday 8:00 a.m.

Stability of differential and integro-differential equations, SABER ELAYDI, University of Colorado at Colorado Springs. Friday 1:00 p.m., Saturday 8:00 a.m.

Applications of differential equations to population ecology, HERBERT FREEDMAN, University of Alberta, and PAUL WALTMAN, Emory University. Friday 1:00 p.m., Saturday 8:00 a.m.

Geometry of nonlinear control systems, ROBERT B. GARDNER, University of North Carolina at Chapel Hill, and CLYDE MARTIN, Texas Tech University. Friday 1:00 p.m., Saturday 8:00 a.m.

Graph theory, RONALD GOULD, Emory University, and MICHAEL S. JACOBSON, University of Louisville. Friday 1:00 p.m., Saturday 8:00 a.m.

Total positivity and applications, JOHNNY HENDERSON and R. A. ZALIK, Auburn University. Wednesday 2:15 p.m., Thursday 8:00 a.m.

Abelian groups, PAUL HILL, Baylor University. Wednesday 2:15 p.m., Thursday 8:00 a.m.

Discrete-time optimal stopping theory, THEODORE P. HILL and ROBERT KERTZ, Georgia Institute of Technology. Friday 1:00 p.m., Saturday 8:00 a.m.

Structural complexity theory, STEPHEN R. MAHANEY, AT&T Bell Laboratories, Murray Hill. Wednesday 2:15 p.m., Thursday 8:00 a.m.

Optimization, LYNN MCLINDEN, University of Illinois, and JAY S. TREIMAN, Western Michigan University. Wednesday 2:15 p.m., Thursday 8:00 a.m.

Multidimensional inverse problems, related problems in analysis and applications, A. G.

RAMM, Kansas State University. Friday 1:00 p.m., Saturday 8:00 a.m.

Combinatorics and group representations, DENNIS STANTON, University of Minnesota. Wednesday 2:15 p.m., Thursday 8:00 a.m.

Most of the papers to be presented at these special sessions will be by invitation; however, anyone contributing an abstract for the meeting who felt that his or her paper would be particularly appropriate for one of these sessions should have indicated this clearly on the abstract, **and should have submitted it by September 17, 1987, three weeks earlier than the normal deadline for contributed papers,** in order that it be considered for inclusion.

Contributed Papers

There will be sessions for contributed papers Wednesday afternoon, Thursday morning, Friday afternoon, and Saturday morning.

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 8, 1987.** A charge of $16 is imposed for retyping abstracts that are not in camera-ready form.

Late papers will not be accepted.

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, Everett Pitcher (chairman), and Carol L. Walker.

In order that a motion for the Business Meeting of January 7, 1988, receive the service offered by the committee in the most effective manner, it should be in the hands of the secretary by December 7, 1987.

Everett Pitcher, Secretary

Other AMS Sessions

Committee on Employment and Educational Policy

The Committee on Employment and Educational Policy will sponsor a panel discussion on Saturday, January 9 at 4:25 p.m. tentatively titled *Recruiting U.S. mathematical talent for graduate programs.*

Council Meeting

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

Business Meeting

The Business Meeting of the Society will take place immediately following the award of the Birkhoff Prize at 4:25 p.m. on Thursday, January 7. The secretary notes the following resolution of the Council: Each person who attends a Business Meeting of the Society shall be willing and able to identify himself as a member of the Society. In further explanation, it is noted that *each person who is to vote at a meeting is thereby identifying himself as and claiming to be a member of the American Mathematical Society.* For additional information on the Business Meeting, please refer to the box titled Committee on the Agenda for Business Meetings.

Joint AMS–MAA Sessions

AMS-MAA Invited Addresses

By invitation of the AMS-MAA Joint Program Committee (H. W. Lenstra, Jr., Carl Pomerance, Paul H. Rabinowitz, and James W. Vick, chairman), four speakers will address the AMS and MAA on the history and development of mathematics. The names of the speakers, their affiliations, the titles, dates, and times of their talks follow:

LIPMAN BERS, Columbia University, *The European mathematicans' migration to America*, 11:10 a.m. Friday.

JOSEPH W. DAUBEN, Graduate School and University Center, CUNY, *Georg Cantor - the battle for transfinite set theory*, 11:10 a.m. Saturday.

JOHN G. KEMENY, Dartmouth College, *How computers have changed the way I teach*, 11:10 a.m. Wednesday.

DAVID MUMFORD, Harvard University, *Oscar Zariski and his work*, 11:10 a.m. Thursday.

100 Years of American Mathematics

In Atlanta, Thursday evening, January 7, will be devoted to a Special Banquet, co-hosted by the Presidents of AMS and MAA, launching *100 Years of American Mathematics*, a year-long expansion of the Society's Centennial linking ten major events in 1988. A letter of invitation from President Mostow and further details on the banquet appear elsewhere in this announcement.

On Friday evening, January 8, the AMS and MAA, in cooperation with the Society for

YEARS OF AMERICAN MATHEMATICS

Dear AMS Member:

1988 is the centennial year of the American Mathematical Society. I want to tell you about some of the events we have planned and urge you to catch the centennial spirit.

Since the early planning stages it has been my concern, and the concern of our Centennial Committee, that the festivities we undertake involve the broader mathematics community, not just AMS, and that they incorporate serious discussion looking toward the future.

To these ends, we have joined with the Mathematical Association of America and the Society for Industrial and Applied Mathematics to create a year-long celebration and dialogue called '100 Years of American Mathematics'. This has been done by linking the AMS Centennial Celebratio next August to nine other special events taking place throughout 1988, to create a future-oriented 'centennial of American mathematics'.

I want to extend to you a personal invitation to participate in these events, especially to attend the January 7 banquet at the up-coming Joint Mathematics Meetings in Atlanta. This banquet, together with a unique session the following evening called 'Forces for Change in Mathematics Education', will launch the year-long '100 Years of American Mathematics'.

By attending the banquet you can be a part of the kick-off of our special year, and you can take advantage of a once in a lifetime offer made by Hewlett-Packard to acquire for $60 the $235 HP 28C calculator. It will be a specially-inscribed, enhanced model of this state-of-the-art machine which Hewlett-Packard is producing for the occasion. Our purposes in making this offer available are to help heighten your interest in coming to the banquet and put into your hands one of the forces for change in mathematics education which we all need to think about.

Please join us at Atlanta, and in the other Centennial events.

Sincerely,

G. D. Mostow

George Daniel Mostow
President

100 Years of American Mathematics

Special Banquet

Thursday, January 7, 7:00 p.m.

Presidents Leonard Gillman (MAA) and G. D. Mostow (AMS) will co-host a festive Thursday evening banquet to launch *100 Years of American Mathematics*, a year-long expansion of the AMS Centennial linking ten major events in 1988. A description of *100 Years* and a special banquet invitation from G. D. Mostow are found elsewhere in this announcement

The Banquet (cost to you $30) will feature the Dollar-a-Year Centennial Package for all registrants who attend. This package includes a banquet ticket for $30, and for an additional $60 a specially-inscribed HP 28C calculator (list price $235), plus an optional $10 contribution to the support of *100 Years of American Mathematics*. The HP 28C offered to you will be an enhanced model of this state-of-the-art machine produced by Hewlett-Packard solely for *100 Years* and will be available for $60 only on this banquet occasion.

Brief ceremonies to launch *100 Years* and entertainment will follow dinner. Emcee for the evening will be A. B. "Al" Willcox, MAA Executive Director.

Don't Miss This Special Evening!

Tickets will be available through preregistration **ONLY**. To purchase a ticket for the banquet or banquet/calculator, please fill in the appropriate box(es) on the Preregistration/Housing Form and enclose the necessary total amount along with your preregistration payment.

AMS-MAA Special Program on

Forces for Change in Mathematics Education

Friday, January 8, 7:30 p.m.

The American Mathematical Society and the Mathematical Association of America – in cooperation with the Society for Industrial and Applied Mathematics, the Board of Mathematical Sciences and the Mathematical Sciences Education Board – have organized a program of three concurrent sessions involving national leaders in education in dialogue about impending major changes of which all mathematicians should be aware.

The proceedings of the October 1987 symposium at the National Academy of Sciences on the reform of the teaching of calculus, the rapidly changing picture of where the talent must come from in mathematics, and the new patterns of educating and certifying mathematics teachers which are developing will form the basis for informative presentations, brief prepared responses and general discussions.

The program will be preceded by a 6:15 p.m. Reception hosted by the exhibitors, free to registrants at the Joint Mathematics Meetings. The following sessions will run concurrently from 7:30 p.m. to 9:00 p.m.:

Calculus for a New Century

The views of a perceptive and witty mathematician turned provost on the current reform movement in the teaching of calculus.
Speaker: TIMOTHY O'MEARA, Provost, University of Notre Dame
Respondent: RONALD G. DOUGLAS, SUNY at Stony Brook
Moderator: LYNN A. STEEN, St. Olaf College

The beauty of fractals: A force for reaching the public

A compelling lecture to illustrate the effectiveness of fractals in creating understanding in a nonmathematical audience.
Speaker: HEINZ-OTTO PEITGEN, University of California, Santa Cruz, and University of Bremen
Moderator: HYMAN BASS, Columbia University

Who will teach mathematics?

A compelling description of the issues involved in attracting, educating and certifying tomorrow's teachers.
Speaker: MARC TUCKER, Executive Director, Carnegie Forum on Education and the Economy
Respondent: F. JOE CROSSWHITE, Northern Arizona University and Chairman, Conference Board of the Mathematical Sciences
Moderator: JOHN A. DOSSEY, Chairman, Mathematics Department, Illinois State University, and President, National Council of Teachers of Mathematics

100 YEARS OF AMERICAN MATHEMATICS

A Year-long Celebration of a Century of Mathematical Achievement

A Year-long Preview of the Future with Mathematics

1988 Events

January	**Banquet:** *100 Years of American Mathematics* **AMS-MAA Special Program:** *Forces for Change in Mathematics Education*–**Joint Mathematics Meetings, Atlanta, GA**
February	*American Mathematics Entering its Second Century*– American Association for the Advancement of Science Annual Meeting, Boston, MA
April	National Mathematics Awareness Week–JPBM Annual Event
April	*A Century of American Mathematics*–National Academy of Sciences Annual Meeting, Washington, DC
April	*The Impact of Mathematics*–Board on Mathematical Sciences Event Washington, DC
May	*Mathematics Education: Wellspring of U.S. Industrial Strength*– Mathematical Sciences Education Board Symposium, Irvine, CA
June	*The Legacy of John von Neumann*–Hofstra-AMS-SIAM International Symposium, Hempstead, NY
July	*Applied Mathematics: Foundations for Science & Technology*– SIAM Annual Meeting, Minneapolis, MN
August	Mathematics into the 21st Century–AMS Centennial Celebration, Providence, RI
October	*The Future of Mathematics Education in the U.S.*–MSEB-BMS Report to the Nation

For a detailed calendar of events, write: JPBM–*100 Years*, 1529 18th Street, NW, Washington, DC 20036, and watch for details in upcoming mathematics' society publications or call Kirsten Sampson at the JPBM office: (202) 387-5200.

Sponsored by the Joint Policy Board for Mathematics:

American Mathematical Society, Mathematial Association of America, Society for Industrial and Applied Mathematics

In cooperation with:

Board on Mathematical Sciences, Mathematical Sciences Education Board of the National Research Council

Industrial and Applied Mathematics, the Board of Mathematical Sciences, and the Mathematical Sciences Education Board, have organized a Special Program on *Forces for Change in Mathematics Education*. This program begins at 6:15 p.m. with an exhibitor-hosted open reception and light supper, followed at 7:30 p.m. by three concurrent sessions to help launch The Mathematical Sciences in the Year 2000 (MS 2000), a joint BMS/MSEB project for the revitalization of collegiate mathematics, undertaken at the request of AMS, MAA, and SIAM. Again, further details on this Special Program appear elsewhere in this announcement.

Ethno-mathematics Panel Discussion

The AAAS-AMS-MAA Committee on Opportunities in Mathematics for Disadvantaged Groups is sponsoring a panel discussion on *How does ethnomathematics make sense at the college level?* This panel is scheduled from 1:00 p.m. to 3:00 p.m. on Saturday, January 9. The organizer is GLORIA GILMER, Math-Tech, Inc. The participants are the organizer; UBIRATAN D'AMBROSIO, Universidade Estadual de Campinas (Brazil); SOLOMON A. GARFUNKEL, COMAP; MARCIA ASCHER, Ithaca College; and ARTHUR B. POWELL, JR., Rutgers University.

AMS-MAA-TUG Workshop

This workshop is being cosponsored by the AMS and MAA and will be presented by the TEX Users Group.

TEX is a series of programs for preparation of scientific papers for publication. It was developed by Donald Knuth, Stanford University, Computer Science Department. This workshop is designed to familiarize the participant with TEX and also give basic instruction in how to use TEX. An opportunity for hands-on experimentation using the IBM PC will be available.

The AMS-TEX macro package, which was written by Michael Spivak to simplify using TEX for inputting mathematical material, will be discussed also.

This workshop will be presented in three two-hour sessions on Tuesday, January 5: 9:00 a.m. to 11:00 a.m., 2:00 p.m. to 4:00 p.m., and 7:00 p.m. to 9:00 p.m. A fee of $60 will be charged through preregistration. The fee at the meeting is $80.

71st Annual Meeting of the MAA
January 6–9, 1988

Retiring Presidential Address

The Retiring Presidential Address will be given by LYNN A. STEEN, St. Olaf College, at 3:50 p.m. on Friday, January 8. The title of his address is *Celebrating mathematics.*

Invited Addresses

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

LAWRENCE COUVILLON, Southern University, *What does it mean to understand the function concept?*, 9:00 a.m. Thursday;

RONALD G. DOUGLAS, SUNY at Stony Brook, *Calculus: Past, present, and future*, 2:45 p.m. Friday;

DONALD L. KREIDER, Dartmouth College, title to be announced, 10:05 a.m. Saturday;

JEFFREY C. LAGARIAS, AT&T Bell Laboratories, title to be announced, 10:05 a.m. Thursday;

CHARLES C. LINDNER, Auburn University, *Perpendicular arrays and graph decompositions*, 3:20 p.m. Wednesday;

VERA S. PLESS, University of Illinois at Chicago, *Codes and designs – existence and uniqueness*, 9:00 a.m. Saturday;

JANE CRONIN SCANLON, Rutgers University, *Singularly perturbed equations – theory vs. applications*, 2:15 p.m. Wednesday.

Minicourses

Thirteen 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: *Using computer graphing to enhance the teaching and learning of calculus and precalculus mathematics* is being organized by FRANKLIN D. DEMANA and BERT K. WAITS of Ohio State University. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Tuesday, January 5, and Part B from 4:30 p.m. to 6:30 p.m. on Wednesday, January 6. Enrollment is limited to 30.

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

Minicourse #2: *Computer software for differential equations* is being organized by HOWARD LEWIS PENN and JAMES BUCHANAN of the U.S. Naval Academy. Part A is scheduled from 9:00 a.m. to 10:55 a.m. on Wednesday, January 6, and Part B from 2:15 p.m. to 4:15 p.m. on Thursday, January 7. Enrollment is limited to 30.

In this Minicourse, the participants will have a chance to see demonstrations of and use several computer packages which are useful in the teaching of differential equations. The Minicourse is limited to 30 people so as to allow hands on experience with each participant. There will be available at least 10 IBM PC's for the students to use. The Minicourse will consist of two two-hour sessions with about half of each session devoted to demonstrations by the instructors and the other half devoted to use of the programs by those taking the Minicourse. The programs will cover numerical and graphical uses of the computers as well as applications of differential equations.

Minicourse #3: *Teaching mathematical modeling* is being organized by FRANK R. GIORDANO, U. S. Military Academy and MAURICE D. WEIR, Naval Postgraduate School. Part A is scheduled from 9:00 a.m. to 10:55 a.m. on Wednesday, January 6, and Part B from 2:15 p.m. to 4:15 p.m. on Thursday, January 7. An optional third session, Part C, will use the microcomputer facility and is scheduled from 7:00 p.m. to 9:00 p.m. on Thursday, January 7. Enrollment is limited to 40.

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

This Minicourse provides an introduction to the modeling process, to several topics underlying the construction of mathematical models and addresses issues related to the design of an undergraduate course in modeling.

The optional third session will consist of demonstrations and "hands-on" running of models on microcomputers.

Minicourse #4: *Teaching calculus with an HP-28C symbol manipulating calculator* is being organized by JOHN W. KENELLY, Clemson University. Part A is scheduled from 9:00 a.m. to 10:55 a.m. on Wednesday, January 6 and Part B from 2:15 p.m. to 4:15 p.m. on Thursday, January 7. Enrollment is limited to 30.

After briefly surveying the capabilities of currently available graphic calculators, the Minicourse will introduce participants, hands on, to the HP-28C. Graphing, symbol manipulating, differentiation, equation solving, Taylor polynomials and (time permitting) matrix operations will be viewed.

There will be a discussion of the use of the HP-28C in calculus instruction of how its use will change current topics and will make possible the introduction of new topics in calculus.

Minicourse #5: *Logo and problem solving* is being organized by CHARLES A. JONES, Grinnell College. Part A is scheduled from 2:15 p.m. to 4:15 p.m. on Wednesday, January 6, and Part B from 9:00 a.m. to 10:55 a.m. on Thursday, January 7. Enrollment is limited to 30.

Logo is a powerful computer language which includes commands for graphics and list processing. Logo has been an excellent language to teach to nonscience oriented undergraduates in the course "Problem Solving and Computing" at Grinnell College. The goal of this Minicourse is to provide an introduction to Logo that illustrates how Logo can be used to teach problem solving concepts and techniques.

This Minicourse will provide a hands-on introduction to a selection of Logo commands and programming techniques. The emphasis will be on the use of procedures, especially recursive procedures, to produce graphical displays and to obtain elegant solutions to list processing problems. The Logo instruction will consist of handouts which provide a wide variety of problems and which describe the particulars of Logo syntax.

Some previous programming experience (using any programming language) is assumed.

Minicourse #6: *Coloring and path following algorithms for approximating roots and fixed points* is being organized by WILLIAM F. LUCAS, Claremont Graduate School. Part A is scheduled from 4:30 p.m. to 6:30 p.m. on Wednesday, January 6, and Part B from 7:00 p.m. to 9:00 p.m. on Thursday, January 7. Enrollment is limited to 80.

Cayley (1879) found that Newton's method for approximating *complex* roots of a polynomial equation could lead to complications. (See *Science News*, February 28, 1987, regarding regions with chaotic boundaries.) H. W. Kuhn (1974) has provided an elementary path following algorithm in the plane for finding such roots. The roots are triple points in a simple three coloring of the plane as was already evident in a geometric view provided in Gauss' thesis (1799).

The fundamental combinatorial lemmas by E. Sperner (1928) and A. W. Tucker (1946) for labeling (or coloring) the vertices of an n-simplex or n-octahedron are the discrete analogues of the Brouwer fixed point theorem and Borsuk-Ulum antipodal points theorems, respectively. These provide the basis for the path following algorithms of Scarf (1967) and others for finding approximate fixed points. Applications include the computing of equilibrium points or prices in game theory and economics.

These topics can be included at various levels in undergraduate courses on discrete mathematics, and do not assume any specialized prerequisites.

Minicourse #7: *Computer based discrete mathematics* is being organized by NANCY BAXTER, Dickinson College and ED DUBINSKY, Purdue University. Part A is scheduled from 9:00 a.m. to 10:55 a.m. on Friday, January 8, and Part B from 3:30 p.m. to 5:30 p.m. on Saturday, January 9. An optional open-ended hands-on lab is scheduled from 11:15 a.m. to 12:45 p.m. on Saturday. Enrollment is limited to 30.

This Minicourse is about a new way of teaching Discrete Mathematics. The content agrees with what is generally recommended. The method is based on contemporary research in learning abstract mathematics and makes use of a very high level programming language ISETL.

ISETL is interactive and its syntax is close to mathematical notation. Participants will learn to understand several mathematical programs that express complicated mathematical ideas and will write their own. The point for teaching is that students learn to use important mathematical constructs (such as set formers, quantifiers, function definitions) in the context of getting their programs to do the right thing. The syntax is sufficiently simple that most of their mental energy is devoted to understanding mathematical processes that become realities for them.

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

Minicourse #8: *Laboratory projects for first year calculus* is being organized by L. CARL LEINBACH, Gettysburg College. Part A is scheduled from 9:00 a.m. to 10:55 a.m. on Friday, January 8, and Part B from 3:30 p.m. to 5:30 p.m. on Saturday, January 9. Enrollment is limited to 80.

The presentation of the First Year Calculus course differs from that of any other course we offer to mathematics majors. Instead of the presentation of theorems and proofs in the standard format, much of our effort is spent on motivation of results and application of technique. The course is more mathematical engineering than it is mathematics.

The format for presenting a Calculus course suggested in this Minicourse is to use the existence of inexpensive software and hardware to create a laboratory component for the standard calculus course. The laboratory is to be conducted in the same way a physics, chemistry, or biology laboratory is conducted. Students run experiments, observe results, write reports, and make conjectures. Some experiments are to motivate results to be presented in lecture. Others are to apply the material of the lecture to a specific situation. In an ideal situation, student conjectures may be used to motivate a lecture presentation.

Minicourse #9: *Constructing placement examinations* is being organized by JOHN G. HARVEY, University of Wisconsin at Madison, and sponsored by the Committee on Placement Examinations. Part A is scheduled from 9:00 a.m. to 10:55 a.m. on Friday, January 8, and Part B from 3:30 p.m. to 5:30 p.m. on Saturday, January 9. Enrollment is limited to 40.

Lectures and workshops will take participants, step-by-step, through the entire process of constructing and implementing placement exams, including: preliminary planning, writing test items, designing a test for establishing cut-off scores, and evaluating the test. Placement testing problems of participants' own institutions will be discussed during question and answer periods.

Minicourse #10: *Computer graphics in elementary statistics* is being organized by FLORENCE S. GORDON, New York Institute of Technology and SHELDON P. GORDON, Suffolk County Community College. Part A is scheduled from 1:30 p.m. to 3:30 p.m. on Friday, January 8, and Part B from 9:00 a.m. to 10:55 a.m. on Saturday, January 9. Enrollment is limited to 30.

This Minicourse is intended to provide a hands-on introduction to the use of microcomputer graphics for an elementary, non-calculus-based, statistics couse. All participants will have the opportunity to work with a graphics software package developed by the presenters which covers virtually all of the topics normally encountered in elementary statistics including data analysis and descriptive statistics, probability simulations, the normal and t-distributions, sampling and the Central Limit Theorem, estimation, hypothesis testing, linear regression analysis, etc. The Minicourse is designed for individuals who have taught such an introductory statistics course, though no previous computer experience is assumed.

Minicourse #11: *The use of computing in teaching linear algebra* is being organized by EUGENE HERMAN and CHARLES JEPSEN, Grinnell College. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Friday, January 8, and Part B from 1:00 p.m. to 3:00 p.m. on Saturday, January 9. Enrollment is limited to 30.

The goal of this course is to discuss the changes that can or should occur in a linear algebra course in which students have access to a powerful matrix computation package. Participants will get hands-on experience in using such a package to better prepare them for the discussion.

A major reason that linear algebra is now taught to so many students so early in their education is that the computer has made linear algebra much more useful to scientists than it was 35 years ago. Yet computing has not had a significant effect on how undergraduate linear algebra is usually taught. This Minicourse explores the possibilities and consequences of putting powerful

matrix computation packages in the hands of beginning linear algebra students. Participants will get to use one such package and will get information on others. Topics discussed will include the new kinds of problems that can be assigned to students, the changes that might be warranted in course, the background needed by instructors and students, the effects of the changed course on students, and the mathematical algorithms incorporated into the software. The packages we discuss have at least the following computational capabilities: Finding all the solutions of a consistent system of equations, finding matrix inverses, LU-factoring, QR-factoring, finding complete sets of eigenvectors and associated eigenvalues for arbitrary square matrices, and finding least-squares solutions.

Minicourse #12: *Using computer algebra systems in undergraduate mathematics* is being organized by PAUL ZORN, St. Olaf College. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Friday, January 8, and Part B from 1:00 p.m. to 3:00 p.m. on Saturday, January 9. Enrollment is limited to 80.

Computer algebra system (Macsyma, Maple, SMP, etc.) which handle many standard mathematical operations, are emerging as powerful tools for teaching, learning, and doing mathematics. In freshman calculus, for example, a CAS facilitates *combining* algebraic, numerical, and graphical viewpoints on limits, derivatives, integrals, antiderivatives, Taylor series, differential equations, and other objects. Because CAS's operate in calculator-like interactive mode, without programming, distraction from mathematical content is minimized.

The course will include a detailed demonstration (on-line or simulated) of an introduction to a particular CAS, description (with examples) of a freshman calculus project using CAS at St. Olaf College, and remarks on use of CAS in other courses. Because CAS hardware and software are changing rapidly and teaching experiencce is limited, the course will raise questions, not give definitive answers. Discussion time will be reserved.

Minicourse #13: *Learning mathematics through discrete dynamical systems* is being organized by JAMES T. SANDEFUR, Georgetown University. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Friday, January 8, and Part B from 1:00 p.m. to 3:00 p.m. on Saturday, January 9. Enrollment is limited to 60.

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

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 6 deadline. DO NOT SEND THIS FORM TO PROVIDENCE. Please note that these MAA Minicourses are NOT the AMS Short Course.**

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

The MAA Minicourses are open only to persons who register for the Joint Mathematics Meetings and pay the Joint Meetings registration fee.

If the only reason for registering for the Joint Meetings is to gain admission to a MAA Minicourse, this should be indicated by checking the appropriate box on the MAA Minicourse Preregistration Form. Then, if the Minicourse is fully subscribed, full refund can be made of the Joint Mathematics Meetings preregistration fee. Otherwise, the Joint Meetings preregistration will be processed, and then be subject to the 50 percent refund rule. PREREGISTRATION FORMS FOR THE JOINT MEETINGS SHOULD BE MAILED TO PROVIDENCE PRIOR TO THE DEADLINE OF NOVEMBER 6.

The registration fee for MAA Minicourses #1, #2, #5, #7, #10, and #11 is $40 each. The registration fee for the other MAA Minicourses is $30 each.

Contributed Papers

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

- *Teaching mathematical modeling*, JEANNE AGNEW, Oklahoma State University, 1:00 p.m. Saturday.
- *History of contemporary mathematics*, FLORENCE D. FASANELLI, Sidwell Friends School, Washington, DC, VICTOR J. KATZ, University of District of Columbia, and V. FREDERICK RICKEY, Bowling Green State University, Wednesday morning.
- *Strategies for teaching geometry*, DORIS SCHATTSCHNEIDER, Moravian College, 1:00 p.m. Saturday.

- *Writing as part of the mathematics curriculum*, ANDREW STERRETT, Denison College, 2:15 p.m. Thursday.

The deadline for submitting papers for these sessions was **September 15. Late papers will not be accepted.**

Other MAA Sessions

Software Session

A panel discussion on *Software issues - pricing, copy protection, copyright* is being sponsored by the Committee on Computers in Mathematics Education (CCIME) and is scheduled from 8:30 a.m. to 10:55 a.m. on Wednesday, January 6. The moderator is HOWARD ANTON, Drexel University. The participants are MICHAEL C. GEMIGNANI, University of Maine; WILLIAM H. GRAVES, University of North Carolina, KEVIN HOWAT, Wadsworth Publishing; ALAN JACOBS, Addison-Wesley Publishing; and PETER TROTTER, CONDUIT and University of Iowa.

First Two Years Panel Discussion

The CUPM subcommittee on the First Two Years of College Mathematics is sponsoring a panel discussion titled *Compressing five into four: How can we streamline the first two years of college mathematics?* The session is scheduled from 9:00 a.m. to 10:55 a.m. on Wednesday, January 6, and will be moderated by RICHARD D. ANDERSON, Louisiana State University.

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 6.

ICME-6 Panel Discussion

A panel discussion titled *What can mathematicians contribute to mathematics education?* is scheduled from 2:15 p.m. to 4:15 p.m. on Thursday, January 7. The moderator is EILEEN L. POIANI, St. Peter's College, and the lead speaker is JEREMY KILPATRICK, University of Georgia. The other participants are GEORGE BERZSENYI, Lamar University; THOMAS J. COONEY, University of Georgia; DONALD M. HILL, Florida A&M University; WARREN PAGE, New York City Technical College; and LYNN A. STEEN, St. Olaf College.

Task Force on Minorities Panel Discussion

The Task Force on Minorities in Mathematics is sponsoring a panel discussion titled *Mathematics, minorities and the MAA - How do they fit together?* It is scheduled from 2:15 p.m. to 4:15 p.m. on Thursday, January 7. The moderator is REUBEN HERSH, University of New Mexico. The presenters are MANUEL P. BERRIOZABAL, University of Texas at San Antonio; ROGERS J. NEWMAN, Southern University; and PAUL J. SALLY, JR., University of Chicago. The responders are LIDA K. BARRETT, Mississippi State University; WADE ELLIS, JR., West Valley College; and KENNETH A. ROSS, University of Oregon. About an hour will be available for open discussion.

Computer Algebra Systems Symposium

The Committee on Computers in Mathematics Education (CCIME) is sponsoring a symposium on *Applications and implications of computer algebra systems in mathematics instruction.* The symposium is being organized by WARREN PAGE, New York City Technical College, and will run from 8:30 a.m. to 10:55 a.m. on Friday, January 8. The program follows:

8:30 a.m. - 8:55 a.m. *Technology at the high end of the low end: the HP-28C calculator*, JOHN W. KENELLY, Clemson University

9:00 a.m. - 9:25 a.m. *Symbolic computation without a computer algebra system*, DAVID A. SMITH, Duke University.

9:30 a.m. - 9:55 a.m. *The Colby experience: two classroom examples*, DONALD SMALL, Colby College

10:00 a.m. - 10:25 a.m. Title to be announced, BRUCE W. CHAR, University of Tennessee at Knoxville

10:30 a.m. - 10:55 a.m. *New perspectives, current concerns, future directions*, WARREN PAGE

NAM-MAA Panel Discussion

The National Association of Mathematicians and the Mathematical Association of America are cosponsoring a panel discussion on the *Impact of computer science on the mathematics program*, scheduled from 9:30 a.m. to 10:55 a.m. on Friday, January 8. The moderator is DAVID W. BALLEW, Western Illinois University.

TA/PTI Panel Discussion

The CTUM Subcommittee on Teaching Assistants and Part-Time Instructors is sponsoring a panel discussion scheduled from 10:00 a.m. to 10:55 a.m. on Friday, January 8. The organizer of the panel is BETTYE ANNE CASE, Florida State University. The participants are the organizer; THOMAS F. BANCHOFF, Brown University; ANNETTE BLACKWELDER, Florida State University; and JOHN PHILIP HUNEKE, Ohio State University. Most of the time will be an informal exchange between the panel and the audience.

Presentation on Participation of Women

The Committee on the Participation of Women is sponsoring an address on *Academic structure and women faculty* by DONNA SHAVLIK, Director of the American Council on Education, Office of Women in Higher Education. The talk is scheduled from 1:30 p.m. to 2:20 p.m. on Friday, January 8.

Teaching experiences in Soweto

There will be a special presentation on Saturday, January 9, from 3:15 p.m. to 3:45 p.m. on *Teaching experiences in Soweto*, given by TERRY LLOYD JENKINS, University of Wyoming.

Audio-Visual Equipment

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

Upon written request, the following projection equipment will be made available: one additional overhead projector/screen, 35 mm carousel slide projector, 16 mm film projector, or VHS video cassette recorder with one color monitor. Speakers requiring any of the equipment listed in this paragraph are required to submit their needs **in writing prior to November 1.**

No other equipment can be made available for these sessions without approval of the MAA Secretary. Requests for equipment not listed above should also be addressed to the Audio-Visual Coordinator in Providence (again, prior to November 1), who will forward them to the Secretary for possible approval.

Prize Session and Business Meeting

The MAA Prize Session and Business Meeting is scheduled from 5:00 p.m. to 6:00 p.m. on Friday, January 8. The Chauvenet Prize and the Award for Distinguished Service to Mathematics will be presented. Some bylaw changes allowing the creation of an Associate Secretary will be submitted to the membership. This meeting is open to all members of the Association.

Board of Governors

The MAA Board of Governors will meet at 9:00 a.m. on Tuesday, January 5. 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 5.

Activities of Other Organizations

The **Association for Women in Mathematics** (AWM) will sponsor a panel discussion on *Is the climate for women in mathematics changing?* on Wednesday, January 6 at 3:20 p.m. The moderator is JUDITH ROITMAN, University of Kansas. Panelists include LOUISE HAY, University of Illinois at Chicago; MARY ELLEN RUDIN, University of Wisconsin; NANCY K. STANTON, University of Michigan, Ann Arbor; and KAREN UHLENBECK, University of Chicago.

The AWM Business Meeting will be held at 4:20 p.m. on Wednesday, January 6.

An open reception is being planned by AWM at 9:30 p.m. on Wednesday, January 6.

The AWM will also sponsor the eighth annual Emmy Noether Lecture at 9:00 a.m. on Thursday, January 7. The speaker is KAREN UHLENBECK, University of Chicago. The title of her lecture will be announced.

The **Interagency Commission for Extramural Mathematics Programs** (ICEMAP) will present a session at 7:15 p.m. on Wednesday, January 6. ICEMAP is a coordinating group of all federal funding agencies which sponsor basic and applied research in mathematical sciences. This includes NSF, DOE and DOD agencies such as AFOSR, ARO, DARPA, NSA and ONR. This forum will provide presentations by the key members of this group about the research opportunities and program trends at their respective agencies. The panel will be chaired/moderated by JAGDISH CHANDRA, Director, Mathematical Sciences Division, U.S. Army Research Office, who is the current chairman of ICEMAP. Members will be available for informal discussion after the panel.

The **Joint Policy Board for Mathematics** (JPBM) Committee for Mathematics Department Heads has organized a National Meeting of Department Heads at 8:45 p.m. on Friday, January 8.

Information on a number of special events being planned for the Atlanta meetings in connection with *100 Years of American Mathematics* can be found elsewhere in this announcement.

The **National Association of Mathematicians** (NAM) will receive the William W. S. Claytor Session of Invited Presentations at 1:00 p.m. on Saturday, January 9.

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

The NAM Business Meeting will take place at 10:00 a.m. on Saturday, January 9.

A panel discussion sponsored by MAA and NAM will be held on Friday, January 8. Further information can be found in the MAA section of this announcement.

The **National Science Foundation** (NSF) will sponsor a session at 5:45 p.m. on Wednesday, January 6.

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 Thursday, January 7, from 2:15 p.m. to 4:15 p.m.

Other Events of Interest

Book Sales

Books published by the AMS and MAA will be sold at discounted prices somewhat below the cost for the same books purchased by mail. **These discounts will be available only to registered**

Petition Table

At the request of the AMS Committee on Human Rights of Mathematicians, a table will be made available in the meeting registration area at which petitions on behalf of named individual mathematicians suffering from human rights violations may be displayed and signed by meeting 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 meeting to the Meetings Department in Providence (telephone 401-272-9500). 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.**

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 and are located in Ivy Hall, Hyatt Regency Atlanta.

Exhibits

The book and educational media exhibits will be located in Ivy Hall, Hyatt Regency Atlanta, and will be open Wednesday through Saturday, January 6–9. The hours they will be open are 1:00 p.m. to 5:00 p.m. on Wednesday, 9:00 a.m. to 5:00 p.m. Thursday and Friday, and 9:00 a.m. to noon on Saturday. All participants are encouraged to visit the exhibits during the meeting. **Participants visiting the exhibits will be asked to display their meeting badge or acknowledgment of preregistration from the Mathematics Meetings Housing Bureau in order to enter the exhibit area.**

Mathematical Sciences Employment Register

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

Accommodations

Hotels

The rates listed below are subject to an 11 percent sales/occupancy tax. The estimated walking distance from the hotel to the headquarters hotel is given in parentheses following the telephone number. Checkout time for all hotels is 12:00 noon.

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

Reservations at these hotels cannot be made by calling the hotel directly until after December 9, 1987. After December 14, 1987, the rates below may not apply. It is imperative that all hotels listed on the back of the preregistration form be numbered in order of preference to insure accurate hotel assignments.

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

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

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

Please make all changes to or cancellations of hotel reservations with the Mathematics Meetings Housing Bureau in Providence **before December 23, 1987**. The telephone number in Providence is 401-272-9500 (extension 290). After that date, changes should be made directly with the hotel. **Cancellations must be made directly with the hotel 48 hours prior to date of arrival in order to receive refunds or deposits. A deposit of $50 is required for each room reservation and may be paid by check**, VISA, MASTERCARD, **or** American Express (**for housing only**) **credit cards.** (Canadian checks should be marked "In U.S. funds".)

The following hotels accept American Express, MasterCard, Visa, Carte Blanche, and Diners' Club credit cards, personal checks with identification, and travelers' checks as payment for room charges.

Hyatt Regency Atlanta
Headquarters Hotel
265 Peachtree Street Northeast
Atlanta, Georgia 30303
Telephone: 404-577-1234

Singles	$69
Doubles	$80 (1 or 2 beds)
Triples	$89
Quads	$98

There is no charge for children 17 years of age and younger. The Hyatt is a full-service hotel equipped with restaurants, lounge, and outdoor pool. Parking is $8 per day. Rates for suites vary upon request. There is also a small health club including free weights, Universal Paramount machine, sauna and steam room.

Marriott Marquis
265 Peachtree Center Avenue
Atlanta, Georgia 30303
Telephone: 404-586-6045 (1 block)

Singles	$71
Doubles	$81 (1 or 2 beds)
Additional person	$20 extra

There is no charge for children 17 years of age and younger. The Marriott is a full-service hotel equipped with restaurants, lounge, and indoor pool. Parking is $8 per day. Rates for suites vary upon request.

Radisson
Courtland & International Blvds.
Atlanta, Georgia 30303
Telephone: 404-659-6500 (2 blocks)

Singles	$60
Doubles	$65 (1 or 2 beds)
Triples	$70
Triples	$86 (with cot)
Quads	$75
Quads	$91 (with cot)

There is no charge for children 12 years and younger. The Radisson is a full-service hotel equipped with restaurant, lounge, and indoor pool. Parking is $4 per day. Rates for suites vary upon request.

American
Spring Street at International
Atlanta, Georgia 30303
Telephone: 800-621-7885 (2 blocks)

Singles	$55
Doubles	$60 (1 or 2 beds)
Triples	$65
Triples	$70 (with cot)
Quads	$65
Quads	$70 (with cot)

There is no charge for children 17 years and younger. The American is a full-service hotel equipped with restaurant, coffee shop, outdoor pool, and lounge. Parking is $2 per day. Rates for suites vary upon request.

Days Inn Downtown
300 Spring Street
Atlanta, Georgia 30308
Telephone: 800-325-2525 (1 block)

Singles	$55
Doubles	$65 (1 or 2 beds)
Triples	$65
Quads	$65

The Days Inn Downtown is a full-service hotel equipped with a restaurant and outdoor pool. Parking is $3 per day. Rates for suites vary upon request.

Most hotel facilities are accessible to the handicapped. People with special requirements should contact the Mathematics Meetings Housing Bureau. The Hyatt has two specially equipped rooms for handicapped.

San Antonio Room Lottery Winners

The following participants received a complimentary hotel room during the San Antonio 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 Atlanta meetings are urged to consider the **early deadline of October 26** in order to qualify for the Atlanta Room Lottery.

Hyatt Regency
- John E. Sasser
- Norman R. Howes
- Robert L. Devaney
- Ronald E. Bruck
- Michael W. Ecker
- Gerald L. Norword

Travelodge
- Michael J. Evans
- Charles R. Grissom, Jr.

Holiday Inn
- Ronald D. Jamison

La Quinta Market Square
- Greg A. Kirmayer

Mitsuhiro Okada
Crockett
Donald E. Sarason
George Crocker
Edmond Nadler
La Quinta Convention Center
Edwin E. Moise
David F. Dawson

Registration at the Meetings

Meeting preregistration and registration fees only partially cover expenses of holding meetings. All mathematicians who wish to attend sessions are expected to register, and should be prepared to show their meeting badge, if so requested. **Badges are required to enter the exhibit area, to obtain discounts at the AMS and MAA Book Sales, to cash a check with the meeting cashier, and to attend all sessions scheduled in the Regency Ballroom in the Hyatt Regency Atlanta. (If a preregistrant should arrive too late in the day to pick up his/her badge, he/she may show the acknowledgment of preregistration received from the Mathematics Meetings Housing Bureau as proof of registration.)** The fees for Joint Meetings registration at the meeting listed below are 30 percent more than the preregistration fees.

Participants wishing to attend sessions for one day only may take advantage of the one-day fees listed below. These special fees are effective daily January 6 through 9, and are available at the meeting to members and nonmembers only. These one-day fees are not applicable to student, unemployed, or emeritus participants, whose fees for registration at the meetings are listed below.

Joint Mathematics Meetings

Member of AMS, CMS, MAA	$ 79
Emeritus Member of AMS, MAA	$ 22
Nonmember	$122
Student/Unemployed	$ 22

Joint Mathematics Meetings One-Day

Member of AMS, CMS, MAA	$ 41
Nonmember	$ 63

Employment Register

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

AMS Short Course

Student/Unemployed	$ 15
All Other Participants	$ 45

MAA Minicourses
(if openings available)

Minicourses # 1, 2, 5, 7, 10, or 11	$ 40
Minicourses # 3, 4, 6, 8, 9, 12, or 13	$ 30

AMS-MAA-TUG Workshop $ 80

Registration fees may be paid at the meetings in cash, by personal or travelers' check, or by VISA or MASTERCARD credit card. Canadian checks must be marked for payment in U.S. funds. Although American Express is being accepted by hotels for housing payments, unfortunately, only VISA or MASTERCARD can be accepted for registration.

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

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

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

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

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

Registration Dates, Times, and Locations

AMS Short Course
Outside Lancaster A & B, Hyatt Regency Atlanta
Tuesday, January 5 8:00 a.m. to 2:30 p.m.

Joint Mathematics Meetings
[and MAA Minicourses (until filled)]
Ivy Hall, Hyatt Regency Atlanta
Tuesday, January 5 4:00 p.m. to 8:00 p.m.
Wednesday, January 6 through Friday, January 8 7:30 a.m. to 4:00 p.m.
Saturday, January 24 7:30 a.m. to 3:00 p.m.

AMS-MAA-TUG Workshop
Outside English Suite, Hyatt Regency Atlanta
Tuesday, January 5 8:00 a.m. to 9:30 a.m.

Registration Desk Services

Assistance, Comments, and Complaints

A log for registering participants' comments or complaints about the meeting is kept at the Transparencies section of the registration desk. All

participants are encouraged to use this method of helping to improve future meetings. Comments on all phases of the meeting are welcome. If a written reply is desired, participants should furnish their name and address.

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

Audio-Visual Assistance

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

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

Baggage and Coat Check

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

Check Cashing

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

Local Information

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

Lost and Found

See the Joint Meetings cashier.

Mail

All mail and telegrams for persons attending the meetings should be addressed as follows: Name of Participant, c/o Joint Mathematics Meetings, Atlanta Convention and Visitors Bureau, 233 Peachtree Street NE, Suite 200, Peachtree Harris Building, Atlanta, GA 30043. Mail and telegrams so addressed may be picked up at the mailbox in the registration area during the hours the registration desk is open. U.S. mail not picked up will be forwarded after the meeting to the mailing address given on the participant's registration record.

Information Table

The information table at Joint Meetings of the AMS and MAA is set up in the registration area for the dissemination of information of a nonmathematical nature of possible interest to the members. The administration of the information table is in the hands of the AMS-MAA Joint Meetings Committee, as are all arrangements for such joint 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 the table is to be sent to the Director of Meetings, American Mathematical Society, Post Office Box 6248, 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 the 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, the table will be swept clean. A proponent who wishes the return of extra copies should remove them.

Personal Messages

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

Telephone Messages

A telephone message center is located in the registration area to receive incoming calls for participants. The center is open from January 5 through 9, 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. The telephone number of the message center will be announced later.

RECEIVE A FREE
ARRIVAL TRANSFER

WIN A FREE
AIRLINE TICKET

SPECIAL AIRFARES
1-800-888-MICA

MICA, Inc., the official travel management firm for the Joint Mathematics Meetings to be held in Atlanta, January 6-9, 1988, has arranged for special discounts aboard Eastern and American Airlines.

Save 5% off all published promotional fares, meeting all restrictions, or 35% off regular roundtrip coach fares, with a 7-day advance purchase. It may be possible to receive an even lower airfare depending on your individual circumstances.

Win a free airline ticket... simply make your reservations through MICA's toll-free number and your name will be entered into a drawing for a free roundtrip ticket good for travel throughout the Continental U.S.

Additional savings... with all tickets purchased through MICA, you will receive a free transfer from the airport to the hotel.

Sample Airfares to Atlanta
(Quoted 8/21/87 and subject to change)

Originating City	Coach Fares	Discounted Coach Fares	Discounted Promotional Fares	Non-Refundable Fares
New York	$ 632.00	$410.80	$264.10	$278.00
Chicago	$ 630.00	$409.50	$283.10	$278.00
San Francisco	$1,022.00	$664.30	$311.60	$288.00

Please Note: The lowest published promotional fares require a Saturday night stay, are subject to an airline change/cancellation penalty, and must be purchased at least 30 days prior to departure. The airlines limit the number of promotional fares for each flight; therefore, we recommend that you make your reservations as early as possible.

Make your reservations today! MICA reservationists can obtain the lowest available fare on any airline. You may pay by credit card or ask to be invoiced. We urge you to purchase your airline tickets without delay using your credit card. This will confirm your reservation, the current airfare and protect you against later fare increases.

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EASTERN

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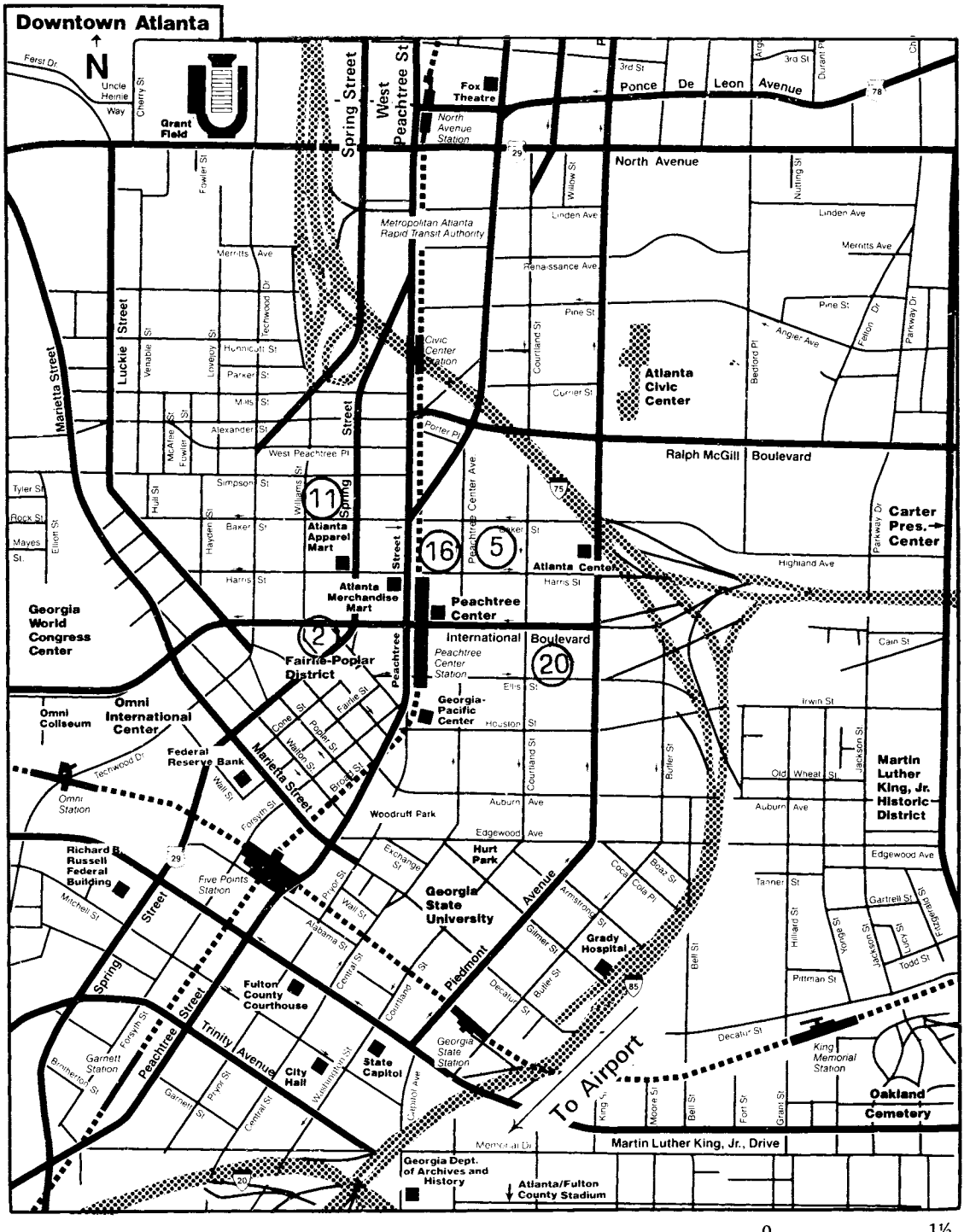
Suite 303, 195 Farmington Avenue, Farmington, CT 06032
(203) 678-1040



0 1½ MILES

DOWNTOWN ATLANTA

(2) American Hotel

(5) Atlanta Marriott Marquis

(11) Days Inn Downtown

(16) Hyatt Regency Atlanta (Headquarters)

(20) Radisson Hotel Atlanta

Transparencies

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

Visual Index

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

Miscellaneous Information

Child Care

There are two state-licensed child care facilities that are available. Reservations should be made directly with the facility of your choice.

ABC Atlanta Best Care, 404-451-2884-5, 3154 Shallowford Road, Atlanta 30341. Contact Wendy. All ages. In the Hyatt Regency Atlanta. Rates: $4 per hour, 4 hour minimum, $7.50 booking fee. Maximum $12. Please make reservations by December 1.

The Wonderful World of Children, 404-881-6668, 1316 West Peachtree, Atlanta 30309. Located near the Arts Center MARTA Station (See Local Information). Contact Melanie. Ages 6 weeks to 11 years. Hours: 24 hours per day, 7 days a week. Rates: $3.50 per hour under 30 months old; $3 per hour over 30 months old. One time insurance fee $10. Please make reservations at least one week in advance.

In addition, a Parent-Child Lounge will be located adjacent to the Joint Meetings registration area in Ivy Hall of the Hyatt. It will be furnished with casual furniture, cribs, 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.

The Hyatt Regency Atlanta has a limited number of cribs. Reservations should be made by December 1 directly through the Mathematics Meetings Housing Bureau. Metal portacribs can be rented from Aaron Rents, 1853 Piedmont Road, Atlanta 30324, 404-873-1455. Reservations should be made by December 1. The cost is approximately $12.50 per week. Tax is 5 percent. Aaron Rents is about three miles from the Hyatt. They will deliver to the Hyatt for $31.50. Contact the manager, Scott Boswell.

Local Information

Atlanta, the state capitol, is located in the northwest part of Georgia. Since its inception, Atlanta has been a transportation hub, first with the railways and now with the airlines. Hartsfield Airport is the busiest in the world. Atlanta is a major commercial center and the home of Coca Cola.

Bus and rapid rail service are available by MARTA, Metropolitan Atlanta Rapid Transit Authority, 404-522-4711, where 152 bus routes feed into 26 rail stations. The Peachtree Center Station is one block from the Hyatt. Passengers can ride anywhere MARTA serves for 75 cents, exact change required. Tokens are 8 for $5 and 10 for $6. Tokens are available at the main Five Points station and from machines ($5 only) in all MARTA stations. The downtown Atlanta map shows rapid rail stations (see dotted line along Peachtree Street).

Downtown sights include:

Carter Presidential Center, (about three miles from Hyatt), 1 Copen Hill, 404-331-3942. President Jimmy Carter's life and administration and the office of the presidency itself are portrayed. Accessible by MARTA bus #16 from the Five Points station.

Federal Reserve Bank, (about one mile from Hyatt), Monetary Museum, 104 Marietta Street, NW, 404-521-8747. The Monetary Museum traces the evolution of currency through the ages, and is located a few blocks from the Five Points station.

Fox Theater, (about one mile from Hyatt), 660 Peachtree Street, NE, 404-881-1977. The Fox is fancy outside with its minarets, onion domes and parapets and inside with Egyptian-Art Deco trappings. Hosts a wide range of live performance, and is adjacent to the North Avenue station.

Georgia State Capitol, (about one and one half miles from Hyatt), Capitol Hill at Washington Street, 404-656-2844. Besides the state offices included are natural science displays, A Hall of Flags and a Hall of Fame honoring outstanding Georgians; located one block south of the Georgia State station.

High Museum of Art, (about two miles from Hyatt), 1280 Peachtree Street, NE, 404-892-3600, 24-hour information line 892-HIGH. Contains collections of European and American paintings, sculpture and decorative arts, photography, prints and graphics and international traveling exhibits. Covered walk leads from adjacent Arts Center station.

High Museum at Georgia-Pacific Center, (about four blocks from Hyatt) 133 Peachtree Street, NE, 404-577-6940. Contains works from the "uptown" High Museum along with rotating traveling exhibits, adjacent to the Peachtree Center station.

Martin Luther King, Jr. Historical Site, Auburn Avenue between Jackson and Randolph Streets, two blocks associated with Martin Luther

King, Jr., the Nobel Peace Prize winner and civil rights leader. The birth home: 507 Auburn Avenue, 404-331-5190. Ebenezer Baptist Church: 407 Auburn Avenue, 404-688-7263. Gravesite: 449 Auburn Avenue, 404-524-1956. MARTA bus #3 (Auburn Avenue) from Five Points and #3 (MLK) from Edgewood/Candler Park station.

Metropolitan highlights include:

Atlanta Historical Society, 3101 Andrews Drive, 404-261-1837. Rotating exhibits, archives and library. Swan House, 1928 Anglo-Palladian showstopper and 1830 middle-class Tullie Smith House, Swan House Coach House contains a restaurant, art gallery and gift shop. Take MARTA bus #40 (West Paces Ferry) from Lenox station.

Cyclorama, Grant Park, Georgia and Cherokee Avenues, SE, 404-658-7625. Immense painting in the round of the Civil War Battle of Atlanta, also a film and exhibits. Take Marta bus #31 (Grant Park), #97 (Atlanta Avenue/Georgia Avenue), #32 (Eastland) from Five Points station.

Georgia's Stone Mountain Park, (about fifteen miles from Hyatt), Highway 78, Stone Mountain, GA, 404-498-5600. The world's largest bas-relief sculpture on the world's largest mass of granite, a 3200 acre park with skating, camping, swimming, fishing, tennis and golf. Take MARTA bus #120 from Avondale station, limited return bus service on weekdays.

Lenox Square, (about seven miles from Hyatt), 3393 Peachtree Road, NE, 404-233-6767. The South's oldest and largest shopping center. Rich's, Macy's, Neiman-Marcus and over 100 shops, restaurants and boutiques; adjacent to Lenox station.

Tours are available from the following firms:

Atlanta Tours and Sightseeing, 255 Peachtree Center Avenue, Suite M42, Atlanta, 30303, 404-522-4299

Gray Line of Atlanta, 3745 Zip Industrial Boulevard, SE, Atlanta 30354, 404-767-0594

Smoking

Please note that smoking is not allowed in any of the session rooms in the Hyatt Regency Atlanta or the Atlanta Marriott Marquis.

Travel

In January, Atlanta is on Eastern Standard Time. The city is served by most major U.S. airlines. The airport lies about ten miles south of the Hyatt. The airport shuttle runs every half hour to the Hyatt. It costs $7.50 one way. Cab fare to the Hyatt should cost $14.

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

If you drive to Atlanta, you will approach the Hyatt from the North on I-75 and I-85. Exit the interstate onto Courtland Street, proceed south about three blocks and turn right onto International Boulevard. Proceed west two blocks and turn right onto Peachtree Center Avenue. The Hyatt parking entrance is about two blocks north on Peachtree Center Avenue. See map of downtown Atlanta.

If you approach the Hyatt from the south on I-75 and I-85, exit the interstate onto International Boulevard. Now follow the directions in the proceeding paragraph.

The interstate near the Courtland Street exit and the International Boulevard exit is being widened. Markers are temporary and are subject to change.

Weather

In January the normal high is 52 degrees F and the normal low is 37 degrees F. Rain is common and sleet is not uncommon. It rarely snows. Weather conditions may be variable, mild one day and cold the next.

W. Wistar Comfort
Middletown, Connecticut Associate Secretary

TIMETABLE

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 available at press time.

JOINT MATHEMATICS MEETINGS

TUESDAY, JANUARY 5	American Mathematical Society	Mathematical Association of America
8:00 a.m. – 9:30 a.m.	REGISTRATION FOR TUG WORKSHOP **ONLY**	
9:00 a.m. – 4:00 p.m.		MAA BOARD OF GOVERNORS' MEETING
9:00 a.m. – 9:00 p.m.	AMS-MAA-TUG WORKSHOP	
4:00 p.m. – 8:00 p.m.	JOINT MEETINGS REGISTRATION	
5:00 p.m. – 10:00 p.m.	COUNCIL MEETING	
7:00 p.m. – 9:00 p.m.		MAA SECTION OFFICERS' MEETING
7:00 p.m. – 9:00 p.m.		MAA MINICOURSE #1 (Part A) *Using computer graphing to enhance the teaching and learning of calculus and precalculus mathematics* Franklin D. Demana Bert K. Waits

WEDNESDAY, JANUARY 6	AMS	MAA
7:30 a.m. – 4:00 p.m.	REGISTRATION	
morning		MAA CONTRIBUTED PAPER SESSION *History of contemporary mathematics* Florence D. Fasanelli Victor J. Katz V. Frederick Rickey
8:30 a.m. – 10:55 a.m.		MAA COMMITTEE ON COMPUTERS IN MATHEMATICS EDUCATION PANEL DISCUSSION *Software issues – pricing, copy protection, copyright* Howard Anton (moderator) Michael C. Gemignani William H. Graves Kevin Howat Alan Jacobs Peter Trotter
9:00 a.m. – 9:50 a.m.	INVITED ADDRESS *Means and their iterations* Roger D. Nussbaum	

WEDNESDAY, JANUARY 6 (cont'd)	American Mathematical Society	Mathematical Association of America
9:00 a.m. – 10:55 a.m.		MAA CUPM SUBCOMMITTEE ON THE FIRST TWO YEARS OF COLLEGE MATHEMATICS PANEL DISCUSSION *Compressing five into four: How can we streamline the first two years of college mathematics?* Richard D. Anderson (moderator)
9:00 a.m. – 10:55 a.m.		MAA MINICOURSE #2 (Part A) *Computer software for differential equations* Howard Lewis Penn James Buchanan
9:00 a.m. – 10:55 a.m.		MAA MINICOURSE #3 (Part A) *Teaching mathematical modeling* Frank R. Giordano Maurice D. Weir
9:00 a.m. – 10:55 a.m.		MAA MINICOURSE #4 (Part A) *Teaching calculus with an HP-28C symbol manipulating calculator* John W. Kenelly
9:00 a.m. – 9:30 a.m.	EMPLOYMENT REGISTER ORIENTATION SESSION	
9:30 a.m. – 4:00 p.m.	EMPLOYMENT REGISTER REGISTRATION	
10:05 a.m. – 10:55 a.m.	INVITED ADDRESS *The Macdonald root system conjectures and their significance* Philip J. Hanlon	
11:10 a.m. – noon	AMS-MAA INVITED ADDRESS *How computers have changed the way I teach* John G. Kemeny	
1:00 p.m. – 2:00 p.m.	COLLOQUIUM LECTURE I *Spectral properties of Riemannian manifolds* Victor W. Guillemin	
1:00 p.m. – 5:00 p.m.	AMS EXHIBIT AND BOOK SALE	MAA BOOK SALE
1:00 p.m. – 5:00 p.m.	EXHIBITS	
2:15 p.m. – 3:05 p.m.		MAA INVITED ADDRESS *Singularly perturbed equations – theory vs. applications* Jane Cronin Scanlon
2:15 p.m. – 4:15 p.m.		MAA MINICOURSE #5 (Part A) *Logo and problem solving* Charles A. Jones
2:15 p.m. – 6:05 p.m.	SPECIAL SESSIONS *Banach space theory I* *Modern trends in matrix analysis and applications I* *Measure theory and descriptive set theory I* *Nonlinear differential delay equations I* *Total positivity and applications I* *Abelian groups I* *Structural complexity theory I* *Optimization I* *Combinatorics and group representations I*	
2:15 p.m. – 6:05 p.m.	SESSIONS FOR CONTRIBUTED PAPERS	
3:20 p.m. – 4:10 p.m.		MAA INVITED ADDRESS *Perpendicular arrays and graph decompositions* Charles C. Lindner

WEDNESDAY, JANUARY 6 (cont'd)	American Mathematical Society	Mathematical Association of America and Other Organizations
3:20 p.m.– 4:20 p.m.		ASSOCIATION FOR WOMEN IN MATHEMATICS PANEL DISCUSSION *Is the climate for women in mathematics changing?* Louise Hay Judith Roitman (moderator) Mary Ellen Rudin Nancy K. Stanton Karen Uhlenbeck
4:20 p.m.– 4:50 p.m.		AWM BUSINESS MEETING
4:30 p.m.– 6:00 p.m.		MAA TWO-YEAR COLLEGE RECEPTION
4:30 p.m.– 6:30 p.m.		MAA MINICOURSE #1 (Part B) *Using computer graphing to enhance the teaching and learning of calculus and precalculus mathematics* Franklin D. Demana Bert K. Waits
4:30 p.m.– 6:30 p.m.		MAA MINICOURSE #6 (Part A) *Coloring and path following algorithms for approximating roots and fixed points* William F. Lucas
5:45 p.m.– 6:45 p.m.	NATIONAL SCIENCE FOUNDATION	
7:15 a.m.– 8:15 p.m.	INTERAGENCY COMMISSION FOR EXTRAMURAL MATHEMATICS PROGRAMS (ICEMAP) Jagdish Chandra (moderator)	
8:30 p.m.– 9:30 p.m.	JOSIAH WILLARD GIBBS LECTURE *How natural is our mathematics?* *The example of equilibrium statistical mechanics.* David P. Ruelle	
9:30 p.m.–11:00 p.m.		AWM OPEN RECEPTION

THURSDAY, JANUARY 7	AMS	MAA and Other Organizations
7:30 a.m.– 4:00 p.m.	REGISTRATION	
8:00 a.m.–10:55 a.m.	SPECIAL SESSIONS *Banach space theory II* *Modern trends in matrix analysis and applications II* *Measure theory and descriptive set theory II* *Nonlinear differential delay equations II* *Total positivity and applications II* *Abelian groups II* *Structural complexity theory II* *Optimization II* *Combinatorics and group representations II*	
8:00 a.m.–10:55 a.m.	SESSIONS FOR CONTRIBUTED PAPERS	
9:00 a.m.– 9:50 a.m.		MAA INVITED ADDRESS *What does it mean to understand the function concept?* Lawrence Couvillon
9:00 a.m.–10:00 a.m.		AWM EMMY NOETHER LECTURE *Title to be announced* Karen Uhlenbeck
9:00 a.m.–10:55 a.m.		MAA MINICOURSE #5 (Part B) *Logo and problem solving* Charles A. Jones
9:00 a.m.– 5:00 p.m.	AMS EXHIBIT AND BOOK SALE	MAA BOOK SALE
9:00 a.m.– 5:00 p.m.	EXHIBITS	

THURSDAY, JANUARY 7 (cont'd)	American Mathematical Society	Mathematical Association of America and Other Organizations
9:00 a.m.	EMPLOYMENT REGISTER DISTRIBUTION OF SCHEDULES	
9:30 a.m. – 5:30 p.m.	EMPLOYMENT REGISTER INTERVIEWS	
10:05 a.m. – 10:55 a.m.		MAA INVITED ADDRESS *Title to be announced* Jeffrey C. Lagarias
11:10 a.m. – noon	AMS-MAA INVITED ADDRESS *Oscar Zariski and his work* David Mumford	
1:00 p.m. – 2:00 p.m.	COLLOQUIUM LECTURE II *Spectral properties of Riemannian manifolds* Victor W. Guillemin	
2:15 p.m. – 3:05 p.m.	INVITED ADDRESS *Title to be announced* Constantine M. Dafermos	
2:15 p.m. – 4:15 p.m.		MAA TASK FORCE ON MINORITIES IN MATHEMATICS PANEL DISCUSSION *Mathematics, minorities and the MAA – How do they fit together?* Lida K. Barrett Manuel P. Berriozabal Wade Ellis, Jr. Reuben Hersh (moderator) Rogers J. Newman Kenneth A. Ross Paul J. Sally, Jr.
2:15 p.m. – 4:15 p.m.		MAA CONTRIBUTED PAPER SESSION *Writing as part of the mathematics curriculum* Andrew Sterrett
2:15 p.m. – 4:15 p.m.		MAA ICME-6 PANEL DISCUSSION *What can mathematicians contribute to mathematics education?* George Berzsenyi Thomas J. Cooney Donald M. Hill Jeremy Kilpatrick Warren Page Eileen L. Poiani (moderator) Lynn A. Steen
2:15 p.m. – 4:15 p.m.		MAA MINICOURSE #2 (Part B) *Computer software for differential equations* Howard Lewis Penn James Buchanan
2:15 p.m. – 4:15 p.m.		MAA MINICOURSE #3 (Part B) *Teaching mathematical modeling* Frank R. Giordano Maurice D. Weir
2:15 p.m. – 4:15 p.m.		MAA MINICOURSE #4 (Part B) *Teaching calculus with an HP-28C symbol manipulating calculator* John W. Kenelly
2:15 p.m. – 4:15 p.m.		ROCKY MOUNTAIN MATHEMATICS CONSORTIUM BOARD OF DIRECTORS' MEETING
3:20 p.m. – 4:10 p.m.	INVITED ADDRESS *Title to be announced* R. Mark Goresky	
4:25 p.m. – 6:00 p.m.	PRIZE SESSION AND BUSINESS MEETING	
7:00 p.m. – 9:00 p.m.	**100 YEARS OF AMERICAN MATHEMATICS BANQUET**	

THURSDAY, JANUARY 7 (cont'd)		**Mathematical Association of America**
7:00 p.m. – 9:00 p.m.		MAA MINICOURSE #3 (Part C) *Teaching mathematical modeling* Frank R. Giordano Maurice D. Weir
7:00 p.m. – 9:00 p.m.		MAA MINICOURSE #6 (Part B) *Coloring and path following algorithms for approximating roots and fixed points* William F. Lucas
FRIDAY, JANUARY 8	**American Mathematical Society**	**Mathematical Association of America and Other Organizations**
7:30 a.m. – 4:00 p.m.	REGISTRATION	
8:30 a.m. – 10:55 a.m.		MAA COMMITTEE ON COMPUTERS IN MATHEMATICS EDUCATION SYMPOSIUM *Applications and implications of computer algebra systems in mathematics instruction* Bruce W. Char John W. Kenelly Warren Page (organizer) Donald Small David A. Smith
9:00 a.m. – 9:50 a.m.	INVITED ADDRESS *Nonlinear Fourier analysis* Stephen William Semmes	
9:00 a.m. – 10:55 a.m.		MAA MINICOURSE #7 (Part A) *Computer based discrete mathematics* Nancy Baxter Ed Dubinsky
9:00 a.m. – 10:55 a.m.		MAA MINICOURSE #8 (Part A) *Laboratory projects for first year calculus* L. Carl Leinbach
9:00 a.m. – 10:55 a.m.		MAA MINICOURSE #9 (Part A) *Constructing placement examiniations* John G. Harvey
9:00 a.m. – 5:00 p.m.	AMS EXHIBIT AND BOOK SALE	MAA BOOK SALE
9:00 a.m. – 5:00 p.m.	EXHIBITS	
9:00 a.m.	EMPLOYMENT REGISTER DISTRIBUTION OF SCHEDULES	
9:30 a.m. – 10:55 a.m.		NAM-MAA PANEL DISCUSSION *Impact of computer science on the mathematics program* David W. Ballew (moderator)
9:30 a.m. – 5:30 p.m.	EMPLOYMENT REGISTER INTERVIEWS	
10:00 a.m. – 10:55 a.m.		MAA CTUM SUBCOMMITTEE ON TEACHING ASSISTANTS AND PART-TIME INSTRUCTORS PANEL DISCUSSION Thomas F. Banchoff Annette Blackwelder Bettye Anne Case (organizer) John Philip Huneke

FRIDAY, JANUARY 8 (cont'd)	American Mathematical Society	Mathematical Association of America
10:05 a.m. – 10:55 a.m.	INVITED ADDRESS *Title to be announced* Dusa McDuff	
11:10 a.m. – noon	AMS-MAA INVITED ADDRESS *The European mathematicians' migration to America* Lipman Bers	
1:00 p.m. – 2:00 p.m.	COLLOQUIUM LECTURE III *Spectral properties of Riemannian manifolds* Victor W. Guillemin	
1:00 p.m. – 4:50 p.m.	SPECIAL SESSIONS *Ordered algebraic systems I* *Toeplitz operators and geometry I* *Algebraic number theory and algorithms I* *Stability of differential and integro-differential equations I* *Applications of differential equations to population ecology I* *Geometry of nonlinear control systems I* *Graph theory I* *Discrete-time optimal stopping theory I* *Multidimensional inverse problems, related problems in analysis and applications I*	
1:00 p.m. – 4:50 p.m.	SESSIONS FOR CONTRIBUTED PAPERS	
1:30 p.m. – 2:20 p.m.		MAA COMMITTEE ON PARTICIPATION OF WOMEN PRESENTATION *Academic structure and women faculty* Donna Shavlik
1:30 p.m. – 3:30 p.m.		MAA MINICOURSE #10 (Part A) *Computer graphics in elementary statistics* Florence S. Gordon Sheldon P. Gordon
2:45 p.m. – 3:35 p.m.		MAA INVITED ADDRESS *Calculus: Past, present, and future* Ronald G. Douglas
3:50 p.m. – 4:40 p.m.		MAA RETIRING PRESIDENTIAL ADDRESS *Celebrating mathematics* Lynn A. Steen
5:00 p.m. – 6:00 p.m.		MAA BUSINESS MEETING
6:15 p.m.	**AMS-MAA SPECIAL PROGRAM ON FORCES FOR CHANGE IN MATHEMATICS EDUCATION**	
6:15 p.m. – 7:15 p.m.	EXHIBITOR-HOSTED OPEN RECEPTION AND LIGHT SUPPER	
7:30 p.m. – 9:00 p.m.	SESSION 1 *Calculus for a new century* Ronald G. Douglas Timothy O'Meara Lynn A. Steen	
7:30 p.m. – 9:00 p.m.	SESSION 2 *The beauty of fractals: A force for teaching the public* Hyman Bass Heinz-Otto Peitgen	
7:30 p.m. – 9:00 p.m.	SESSION 3 *Who will teach mathematics?* F. Joe Crosswhite John A. Dossey Marc Tucker	

TIMETABLE

FRIDAY, JANUARY 8 (cont'd)	American Mathematical Society	Mathematical Association of America
7:00 p.m. – 9:00 p.m.		MAA MINICOURSE #11 (Part A) *The use of computing in teaching linear algebra* Eugene Herman Charles Jepsen
7:00 p.m. – 9:00 p.m.		MAA MINICOURSE #12 (Part A) *Using computer algebra systems in undergraduate mathematics* Paul Zorn
7:00 p.m. – 9:00 p.m.		MAA MINICOURSE #13 (Part A) *Learning mathematics through discrete dynamical systems* James T. Sandefur
8:45 p.m. – 9:45 p.m.	NATIONAL MEETING OF DEPARTMENT HEADS	

SATURDAY, JANUARY 9	American Mathematical Society	Mathematical Association of America and Other Organizations
7:30 a.m. – 3:00 p.m.	REGISTRATION	
8:00 a.m. – 10:50 a.m.	SPECIAL SESSIONS *Ordered algebraic systems II* *Toeplitz operators and geometry II* *Algebraic number theory and algorithms II* *Stability of differential and integro-differential equations II* *Applications of differential equations to population ecology II* *Geometry of nonlinear control systems II* *Graph theory II* *Discrete-time optimal stopping theory II* *Multidimensional inverse problems, related problems in analysis and applications II*	
8:00 a.m. – 10:50 a.m.	SESSIONS FOR CONTRIBUTED PAPERS	
9:00 a.m. – 9:50 a.m.		MAA INVITED ADDRESS *Codes and designs – existence and uniqueness* Vera S. Pless
9:00 a.m. – 10:00 a.m.		NATIONAL ASSOCIATION FOR MATHEMATICIANS PANEL DISCUSSION
9:00 a.m. – 10:55 a.m.		MAA MINICOURSE #10 (Part B) *Computer graphics in elementary statistics* Florence S. Gordon Sheldon P. Gordon
9:00 a.m. – noon	AMS EXHIBIT AND BOOK SALE	MAA 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.		MAA INVITED ADDRESS *Title to be announced* Donald L. Kreider
11:10 a.m. – noon	AMS-MAA INVITED ADDRESS *Georg Cantor – The battle for transfinite set theory* Joseph W. Dauben	

SATURDAY, JANUARY 9 (cont'd)	American Mathematical Society	Mathematical Association of America and Other Organizations
1:00 p.m. – 2:00 p.m.	COLLOQUIUM LECTURE IV *Spectral properties of Riemannian manifolds* Victor W. Guillemin	
1:00 p.m. – 2:00 p.m.		NAM WILLIAM W.S. CLAYTOR SESSION OF INVITED PRESENTATIONS
1:00 p.m. – 3:00 p.m.	AAAS-AMS-MAA COMMITTEE ON OPPORTUNITES IN MATHEMATICS FOR DISADVANTAGED GROUPS PANEL DISCUSSION *How does ethno-mathematics make sense at the college level?* Marcia Ascher Ubiratan D'Ambrosio Solomon A. Garfunkel Gloria Gilmer (organizer) Arthur B. Powell, Jr.	
1:00 p.m. – 3:00 p.m.		MAA MINICOURSE #11 (Part B) *The use of computing in teaching linear algebra* Eugene Herman Charles Jepsen
1:00 p.m. – 3:00 p.m.		MAA MINICOURSE #12 (Part B) *Using computer algebra systems in undergraduate mathematics* Paul Zorn
1:00 p.m. – 3:00 p.m.		MAA MINICOURSE #13 (Part B) *Learning mathematics through discrete dynamical systems* James T. Sandefur
1:00 p.m. – 6:00 p.m.		MAA CONTRIBUTED PAPER SESSION *Teaching mathematical modeling* Jeanne Agnew
1:00 p.m. – 6:00 p.m.		MAA CONTRIBUTED PAPER SESSION *Strategies for teaching geometry* Doris Schattschneider
2:15 p.m. – 3:05 p.m.	INVITED ADDRESS *Determinants of Laplacians, heights and finiteness* Peter Clive Sarnak	
3:15 p.m. – 3:45 p.m.		MAA SPECIAL PRESENTATION *Teaching experiences in Soweto* Terry Lloyd Jenkins
3:20 p.m. – 4:10 p.m.	INVITED ADDRESS *Title to be announced* H. W. Lenstra, Jr.	
3:30 p.m. – 5:30 p.m.		MAA MINICOURSE #7 (Part B) *Computer based discrete mathematics* Nancy Baxter Ed Dubinsky
3:30 p.m. – 5:30 p.m.		MAA MINICOURSE #8 (Part B) *Laboratory projects for first year calculus* L. Carl Leinbach
3:30 p.m. – 5:30 p.m.		MAA MINICOURSE #9 (Part B) *Constructing placement examiniations* John G. Harvey
4:25 p.m. – 6:00 p.m.	COMMITTEE ON EMPLOYMENT AND EDUCATIONAL POLICY PANEL DISCUSSION *Recruiting U.S. mathematical talent for graduate programs (title tentative)*	

Mathematical Sciences Employment Register

January 1988 Meeting in Atlanta

The Mathematical Sciences Employment Register (MSER), held annually at the Joint Mathematics Meetings in January, provides opportunities for mathematical scientists seeking professional employment to meet employers who have positions to be filled. Job listings (or descriptions) and résumés prepared by employers and applicants are displayed at the meeting for the participants so that members of each group may determine which members of the other group they would like to have an opportunity to interview. A computer program assigns the appointments, matching requests to the extent possible, using an algorithm which maximizes the number of interviews which can be scheduled subject to constraints determined by the number of time periods available, the numbers of applicants and employers, and the pattern of requests. The report below outlines the operation of the register, indicating some of the procedures involved for the benefit of those not familiar with its operation.

The Mathematical Sciences Employment Register is apparently unique among employment services offered by professional organizations in the sciences, engineering and the humanities. The computer programs used are constructed around a matching program, devised by Donald R. Morrison, and based on an algorithm described in his paper "Matching Algorithms" in *Journal of Combinatorial Theory*, volume **6** (1969), pages 20 to 32; see also "Matching Algorithms" (abstract) *Notices*, August 1967, page 630. The number of interviews arranged by the program is significantly greater than the number possible at the employment registers of other organizations, in many cases greater by an order of magnitude.

1988 Employment Register in Atlanta

The Employment Register will take place in the International Hall South of the Atlanta Marriott Marquis, on Wednesday, Thursday, and Friday, January 6, 7, and 8, 1988. 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 6. The purpose of the orientation session is to familiarize participants with the operation of the Register and with the various forms involved. Following orientation, participants should pick up their material for participating in the Employment Register. Computer-scheduled interviews will be held on Thursday and Friday, January 7 and 8. **No interviews will be held on Wednesday.**

Fifteen-minute intervals are allowed for interviews, including two or three minutes between successive interviews. The interviews are scheduled in half-day sessions: Thursday morning and afternoon, and Friday morning and afternoon, amounting to four half-day sessions for interviews. There are ten time periods (9:30 – 11:45 a.m.) in which interviews can be scheduled in the morning and fourteen time periods (1:15 – 5:00 p.m.) in the afternoon. It is possible that an applicant or employer may be scheduled for the maximum number of interviews in a session. Requests for interviews will be accommodated depending on the availability of participants. The scheduling program does not have a provision allowing participants to specify particular times for interviews beyond the choice of session (day, and morning or afternoon). Such requests cannot be accommodated.

Requests for interviews taking place during the two sessions on Thursday MUST BE SUBMITTED on Wednesday between 9:30 a.m. and 4:00 p.m. Requests for interviews to take place during the Friday sessions must be submitted on Thursday before 4:00 p.m. Those who fail to do so cannot be included in the pool of available participants when the matching program which schedules the interviews is run on the computer that night. This applies to all employers and applicants both preregistered and on-site registrants. Forms submitted with preregistration achieve registration for the Employment Register only. These forms do not automatically include the participant in the interviewing process. The interview request forms handed out at the Employment Register must be turned in before the 4:00 p.m. deadline in order to receive a computer printed schedule the next day.

On Thursday and Friday mornings at 9 a.m. all schedules for applicants and employers for the day (both morning and afternoon sessions) will be available for distribution in the International Hall South.

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**

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.

vitae or résumés so that they may leave them with prospective employers.

The Mathematical Sciences Employment Register is sponsored by the American Mathematical Society, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics; it is operated by members of the AMS staff under the general supervision of the joint AMS-MAA-SIAM Committee on Employment Opportunities.

Anyone with questions about the Employment Register should contact Carole Kohanski at the American Mathematical Society at 401-272-9500, extension 286. The telephone number to be used after the Register begins will be announced later. Participants should note that this number will be for those who will be participating in the Employment Register and is not for contacting participants or taking messages. Those who wish to leave messages should call the message center telephone number found in the Atlanta meeting announcement.

Preregistered Employers/Applicants

Preregistration for the Mathematical Sciences Employment Register **must be completed by November 6, 1987**. Applicants and employers (including all interviewers) who wish to preregister for the Employment Register must also register for the Joint Mathematics Meetings. Forms for preregistration, housing, the applicant résumé form, and the employer form are located in the back of this issue. Preregistration for the Employment Register, in addition to permitting inclusion in the printed winter lists of Applicants and Employers, has the advantage of reduced fees and the services of the Mathematics Meetings Housing Bureau, and has the further advantage of helping to reduce waiting times at the meeting in Atlanta.

Employer or Applicant forms received after the November 6 deadline **cannot** be included in the printed lists. For details on registration and preregistration for the Atlanta Joint Mathematics Meetings, please refer to the information on these subjects which may be found elsewhere in this issue.

Employers and applicants who have preregistered for the Employment Register may pick up their MSER material after 9:30 a.m. on Wednesday, January 6, in the International Hall South. **(This material includes the interview request forms which are handed out at the meeting only.)** These are not the forms that are submitted with preregistration.

Employers' job listings and applicants' résumés will be posted at the meeting, so that applicants and employers may review them.

Material for the Employment Register will not be mailed in advance.

Preregistered Applicants

In addition to the Joint Meetings preregistration fee, there is an applicant fee of $15 payable prior to the November 6 deadline. These fees must be accompanied by the Preregistration/Housing Form.

Applicants' résumés will be made available to employers at the Employment Register in printed form, so that they may be studied carefully at leisure. The December issue of *Employment Information in the Mathematical Sciences* (EIMS) will contain photographic reproductions of the résumés of applicants who have preregistered **by November 6**. Forms not received in time cannot be included in this issue. **See the section on preparation of résumés elsewhere in this announcement.**

Employers' job listings and applicants' résumés will be posted at the meeting, so that applicants and employers may review them.

There is no additional charge for posting more than one position, provided they are in the same department.

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. **Please note that for the first time there will also be a separate charge for each interviewer.**

Please refer to the Preregistration/Housing Form for the Joint Mathematics Meetings and the Employment Register fees. These fees must be accompanied by the Preregistration/Housing Form. The registration fee for employers covers the cost of a copy of the December Issue of *Employment Information in the Mathematical Sciences* (EIMS). This publication contains printed copies of the résumés of applicants who preregistered prior to the deadline; it also contains a copy of the Winter List of Applicants. **It is requested that employers submit both employer and Preregistration/Housing Forms with appropriate fees in the same envelope. It would also be helpful if the names of cointerviewers are listed on the employer form. If possible, these individuals should also preregister at the same time.**

It is the policy of some institutions to pay for employer fees. These payments do not always accompany the preregistration forms but are sent in after the deadline has passed, or when the meeting is over. It is important that the institution's fiscal department indicate the name of the participating employer with their remittance advice or payment order so that proper credit can be made in Providence.

Employers are encouraged to provide more than one interviewer, when they are able to do so, in order to increase the number of interviews which may be scheduled. **Please take care to indicate on the form the number and names of interviewers for whom simultaneous interviews may be scheduled.** (If all interviewers will be interviewing for the same position, or for the same set of positions, only one form should be submitted and only one employer code number will be assigned; therefore, each interviewer would then receive a separate computer schedule and separate table number.) More than one employer code will be required if some interviewers will not interview for all positions. Thus, if there are two disjoint sets of positions, two forms are required and two employer codes will be assigned.

A coded strip at the bottom of the form summarizes the information on each form. All employers are required to complete the Summary Strip. This is used to prepare a computer-printed list of preregistered employers for distribution to the applicants.

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 Ivy Hall, Hyatt Regency Atlanta, 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 *Employment Information in the Mathematical Sciences* (EIMS). This publication contains printed copies of the résumés of applicants who preregistered prior to the deadline and a copy of the Winter List of Applicants.

After registration has been completed, applicants and employers should come to International Hall South in the Marriott to fill out the forms necessary to participate in the Employment Register.

Nonparticipating Employers

Employers who do not plan to participate in the Employment Register, but wish to display job descriptions, may obtain special forms from Carole Kohanski, MSER, P. O. Box 6248, Providence, RI 02940. These job descriptions, subject to approval, must be received in the Providence office by **November 6** in order to qualify for the reduced fee of $10. There is a $15 fee for listings received after the November 6 deadline.

Employers who attend the Joint Mathematics Meetings, but do not want to interview, can post job descriptions, subject to approval, at the Employment Register. Postings will not be allowed in the Joint Meetings registration area. A fee of $15 will be charged payable to the cashier at the Joint Mathematics Meetings registration desk. Participants should be sure to inform the cashier that they would like to post a job description but are not planning to interview and obtain the proper receipt in order to receive the form necessary for posting at the Employment Register desk.

Applicants Not Planning to Attend

Applicants for professional positions in the mathematical sciences, who do not plan to attend the meeting in Atlanta and participate in the Employment Register, may also submit résumés for publication in the December issue if they use the MSER Form for Applicants at the back of this issue and observe the deadline of November 6. **(It is, of course, not necessary to preregister for the meeting or pay the Employment Register registration fee if one is not attending the meeting. Résumés will not be posted at the Employment Register if the participant is not attending the meeting.)**

Winter Lists of Applicants and Employers

The Winter List of Applicants, which is a summary of the résumés of preregistered applicants, will be available for sale at the AMS Exhibits and Book Sale at the meeting. The price at the meeting is $5 each. Any copies remaining after the meeting will be available from the Providence office of the Society for $7 each.

The Winter List of Employers consists of summaries of the position listings submitted by the employers who preregistered for the meeting; it will be distributed to the applicants participating in the Register. Others may purchase the Winter List of Employers at the AMS Exhibits and Book Sale at the meeting or from the Providence office after the meeting. The prices are the same as stated in the previous paragraph.

Please note that these lists will not be updated with onsite employers or applicants after the Employment Register has concluded.

December Issue of Employment Information in the Mathematical Sciences

For several years the periodical *Employment Information in the Mathematical Sciences* (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 1987 issue provided they are received before the November 6 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 in Atlanta to the employers who participate in the Employment Register.

Job applicants planning to participate in the Employment Register in Atlanta are therefore strongly urged to preregister so that their résumés can appear in the December issue.

Please note that the December issue of EIMS contains the Winter List of Applicants, but does not contain the Winter List of Employers.

Additional copies of the December Issue of EIMS will be available for sale at the AMS Exhibits 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 $13.

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 Atlanta, along with those of the other participants. **Forms received past the deadline of November 6 will be returned.**

List of Retired Mathematicians Available for Employment

The annual *List of Retired Mathematicians* will be included in the December and January issues of the publication *Employment Information in the Mathematical Sciences*. Retired mathematicians who are interested in being included in the list may send the following information to the Mathematical Sciences Employment Register, American Mathematical Society, P. O. Box 6248, Providence, Rhode Island 02940.

1. Full Name
2. Mailing Address
3. Highest degree, year, university
4. Most recent employment: institution
5. Type of position desired
6. Academic or industrial employment preferred
7. Date available for employment (month/year)
8. Geographic location preferred

The deadline for receipt of this information is **November 6**. Offprints of the list will be available from the Mathematical Sciences Employment Register, American Mathematical Society, P.O. Box 6887, Providence, Rhode Island 02940.

American Mathematical Society Short Course Series

Computational Complexity Theory (January 5–6, 1988)

Synopses and Reading Lists

The following synopses are arranged in the order of presentation as currently scheduled. The final schedule will be available at the Short Course registration desk.

Overview of Computational Complexity Theory (Juris Hartmanis). Computational complexity theory is the study of the quantitative laws that govern computing. During the last twenty-five years, complexity theory has grown into a rich mathematical theory and today, it is one of the most active research areas in computer science. Among the most challenging open problems in complexity theory is the problem of understanding *what is and is not feasibly computable* and, more generally, a thorough understanding of the *structure of the feasible computations.* The best known of these open problems is the classic $P =? NP$ problem. It is interesting to note that these problems, which were formulated in computer science, are actually basic problems about the fundamental quantitative nature of mathematics. In essence, the $P =? NP$ problem is a question of how much harder is it to derive (computationally) a proof of a theorem than to check the validity of a proof.

This lecture will review the basic concepts and definitions of complexity theory and summarize the key techniques and results.

Topics include: models of computation, deterministic and nondeterministic Turing machines; computation time and space as complexity measures; diagonalization and the hierarchy results about time and space bounded computations; the classic complexity classes P and NP, representing deterministic and nondeterministic polynomial time computations, respectively; polynomial time reductions and complete problems of NP; the class $PSPACE$ and the polynomial time hierarchy, PH; relativization in complexity theory.

1. J. E. Hopcroft and J. D. Ullman, Introduction to automata theory, languages, and computation, Addison-Wesley, 1979, Chapters 7, 12, and 13.

2. J. Hartmanis, *Feasible computations and provable complexity properties*, SIAM, 1978.

The Isomorphism Conjecture and Sparse Sets (S. R. Mahaney). Following the initial discoveries of NP-complete sets by Cook and Karp (extensively discussed in [1]) came hundreds of complete sets from areas such as graph theory, network design, optimization, etc. Structural complexity studies the underlying properties of these diverse sets. Berman and Hartmanis [2] showed that all the known (in 1977) NP-complete sets are p-isomorphic. Thus, these sets can be viewed as different encodings of a representative set such as SAT. Berman and Hartmanis conjectured: all NP-Complete sets are p-isomorphic, unless $P = NP$ (isomorphism conjecture for NP). The isomorphism conjecture has been studied by relativization, translated to other complexity classes, and, in more general form, provided for certain sets not in NP.

Berman and Hartmanis also observed that known NP-complete sets have an exponential number of elements of size $\leq n$ and cannot be p-isomorphic to any sparse set, where a set S is sparse if there is a polynomial bound $p(n)$ on the number of elements of size $\leq n$. Their second conjecture states: there are no sparse NP-complete sets, unless $P = NP$ (sparseness conjecture for NP).

Sparse NP-complete sets are of special interest because they would permit solving NP problems by small circuits. Random polynomial time (RP) problems are solvable by small circuits and may be in NP-P. The sparseness conjecture for NP has been solved for $<_m^P$ reductions: P. Berman gave methods for sparse $coNP$-complete sets and Mahaney built on these methods to solve the conjecture for sparse NP-complete sets [3]. For weaker reductions to sparse sets, Karp and Lipton gave related results which also imply limits on the power of nondeterminism.

1. M. Garey and D. Johnson, Computers and intractability: a guide to the theory of NP-completeness, Freeman, San Francisco, 1979.

2. L. Berman and J. Hartmanis, *On isomorphism and density of NP and other complete sets*, SIAM Journal on Computing, **6** (1977), 305–322.

3. S. Mahaney, *Sparse sets and reducibilities*, *Studies in Complexity Theory*, R. V. Book (ed.), Research Notes in Theoretical Computer Science, Pitman, London, 63–118.

Restricted Relativizations of Complexity Classes (Ronald V. Book). The $P =? NP$ problems deals with the basic nature of computation and with the inherent computational complexity of problems, not simply with minor variations in the definitions of mathematical models of computers. Using a standard model of computation, the multi-tape Turing machine, it is easy to relativize the $P =? NP$ problem by means of machines that compute with the aid of an oracle. One might think that the relationship between the classes P and NP relativizes, that is, if $P = NP$, then for every set A, $P(A) = NP(A)$, while if $P \neq NP$, then for every set B, $P(B) \neq NP(B)$ (here, $P(A)$ denotes the class of languages accepted in polynomial time by deterministic machines that compute relative to the oracle set A, while $NP(A)$ denotes the analogous class specified by nondeterministic machines). However, this is not the case since there exist recursive sets A and B such that $P(A) = NP(A)$ and $P(B) \neq NP(B)$; this fact was established by Baker, Gill, and Solovay. Hence, it appears that one cannot solve the $P =? NP$ problem either by a straightforward simulation (in the case that $P = NP$) or by a standard diagonalization argument (in the case that $P \neq NP$).

The results of Baker, Gill, and Solovay led to flurry of activity involving the construction of oracle sets to show that the appropriate relativized complexity classes do or do not possess specific properties, e.g., sets A and B with the properties that there exists a set $L \in NP(A)$ such that L has an infinite subset in $P(A)$ and there exists a set $L' \in NP(B)$ such that L' has no infinite subset in $P(B)$. In addition, the notion of restricting the relativizations was considered. The idea here is to develop a restriction on the way the oracle is accessed or on the nature of the oracle set such that the resulting relativizations reflect the unrelativized relationship between the corrresponding complexity classes. For example, there is a restriction R such that $P = NP$ if and only if for all sets A, $P_R(A) = NP_R(A)$; here, $P_R(A)$ denotes the class of languages accepted in polynomial time by deterministic machines that compute relative to the oracle set A and have the restriction R, while $NP_R(A)$ denotes the analogous class specified by nondeterministic machines).

There are two themes in this lecture. The first is concerned with the proofs of the Baker-Gill-Solovay results. The second is concerned with the types of restricted relativizations that have been studied, in particular, the restricted relativizations that have arisen from considering the proofs of the Baker-Gill-Solovay results.

The items in the reading list are not intended to be interpreted as specific prerequisites for understanding the lecture but rather as sources where one can encounter some of the ideas to be presented.

1. M. Garey and D. Johnson, Computers and intractability: A guide to the theory of NP-completeness, Freeman, 1979: Chapters 1, 2, and 7, and specifically Section 7.6.

2. J. Hopcroft and J. Ullman, Introduction to automata theory, languages, and computation, Addison-Wesley, 1979: Chmapter 13 and specifically Section 13.7.

3. U. Schöning, *Complexity and structure*, Lecture Notes in Computer Science, Vol. 211, 1985, Springer-Verlag Publ. Co.: Chapter 6.

Descriptive and Computational Complexity (N. Immerman). Given a property, S, a natural issue is the computational complexity of checking whether or not an input satisfies S. One can also ask, "What is the complexity of *expressing* the property S?" It is not surprising that these two questions are related. However, it is startling how closely tied they are when the second question refers to expressing the property in first-order logic.

Let a property be any subset of the *finite* logical structures of a fixed vocabulary, e.g. graphs or binary strings. In 1974 Fagin gave a characterization of nondeterministic polynomial time (NP) as the set of properties expressible in second-order existential logic. We will begin with this result and then survey some more recent work relating first-order expressibility to computational complexity. Some of the results arising from this approach include characterizing polynomial time (P) as the set of properties expressible in first-order logic plus a least fixed point operator, and showing that the set of first-order inductive definitions for finite structures is closed under complement. We will end with an unexpected new result that was derived using this approach: **Theorem**. For any space constructible $s(n) \geq \log n$, nondeterministic space $s(n)$ is closed under complement.

The following papers include some of the material to be presented, but it is not necessary to read them in order to understand the lecture.

1. R. Fagin, *Generalized first-order spectra and polynomial-time recognizable sets*, Complexity of Computation, R. Karp (ed.), Proc. Amer. Math. Soc. **7** (1974), 27–41.

2. N. Immerman, *Relational queries computable in polynomial time*, Information and Control **68** (1986), 86–104.

3. N. Immerman, *Languages that capture complexity classes*, [6 SIAM J. Comput. **16**, No. 4 (1987), 760–778.

Complexity Issues in Cryptography (Alan L. Selman). The concept of public-key cryptosystems was introduced in 1976 by Diffie and Hellman. They envisioned a system that would make possible secure communication over insecure channels between totally unacquainted parties. One key insight that lead to their definition was the realization that a person who enciphers a message

does not need to be able to decipher it. Another key insight is the understanding that a cryptosystem can be useful even if it is completely insecure according to Shannon's information theory, and that it is only in the light of computational complexity that one can talk about its security. Indeed, if $P = NP$, then public-key cryptography does not exist. Several implementations have been proposed and each of them is secure only if some concrete combinatorial problem that belongs to NP cannot be solved in polynomial time. For example, Rivest, Shamir, and Adleman invented the first practical implementation of a public-key cryptosystem, and the security of their system rests on the assumption that there is no efficient algorithm to factor large integers.

We shall try to address some of the relationships between complexity theory and public-key cryptography. The problem of cracking a public-key cryptosystem can be formulated as a partial decision problem called by Even and Yacobi a "promise problem." With a promise problem one is presented with a promise predicate Q and a problem predicate R, and the issue is to determine whether there is an efficient algorithm that solves $R(x)$, for all inputs x that satisfy the promise predicate $Q(x)$. The theory of NP promise problems is somewhat analogous to the theory of NP decision problems, and assertions about promise problems imply assertions about public-key cryptosystems.

Another approach we will take to the study of public-key cryptography involves the notion of one-way functions. A function f is said to be one-way if $f(x)$ is easy to compute for every x in the domain of f, but for most y in the range of f it is computationally difficult to compute $f^{-1}(y)$. Since encoding should be easy but decoding (without additional information) should be hard, one way functions are at the core of public-key cryptosystems. A number of theorems about such functions can be easily proved. For example, there exist one-one length-increasing functions that are computable in polynomial time but not invertible in polynomial time if and only if $P \neq UP$, where UP is the complexity class of all languages in NP accepted by a nondeterministic polynomial-time Turing machine that never has more than one accepting path per input.

The items in the reading list below will serve as an introduction to public-key cryptography, but they should not be considered as prerequisite for understanding the lecture.

1. W. Diffie and M. Hellman, *New directions in cryptography*, IEEE Trans. Inform. Theory **22** (1976), 644–654.

2. R. Rivest, A. Shamir and L. Adleman, *A method for obtaining digital signatures and public-key cryptosystems*, Comm. ACM **21** (1978), 120–126.

3. A. Lempel, *Cryptology in transition*, Computing Surveys **11** (1979), 205–303.

Interactive Proof Systems (Shafi Goldwasser). Synopsis and reading list will appear in the November 1987 *Notices*.

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.

Atlanta, January 1988

Constantine M. Dafermos
R. Mark Goresky
Victor F. Guillemin (Colloquium Lecturer)
Philip J. Hanlon
H. W. Lenstra
Dusa McDuff
Roger D. Nussbaum
David P. Ruelle (Gibbs Lecturer)
Peter Clive Sarnak
Stephen W. Semmes

East Lansing, March 1988

Barbara Keyfitz
Karl Rubin

AMS Centennial Celebration Providence, August 1988

Michael Aschbacher
Luis A. Caffarelli
Persi Diaconis
Charles L. Fefferman
Michael H. Freedman
Harvey M. Friedman
Benedict H. Gross
Joseph Harris
Roger E. Howe
Vaughan F. R. Jones
Victor Kac
Andrew Majda
Charles S. Peskin
Dennis P. Sullivan
Robert E. Tarjan
William P. Thurston
Karen Uhlenbeck
Edward Witten

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.

Fall 1987 Meeting

Eastern Section
No meeting will be held

Fall 1987 Meeting

Southeastern Section
No meeting will be held

January 1988 Meeting in Atlanta

Associate Secretary: W. Wistar Comfort
Deadline for organizers: Expired
Deadline for consideration: Expired

Marlow Anderson and Todd Feil, *Ordered algebraic systems*
Alfred D. Andrew and John H. Elton, *Banach space theory*
Jean Bevis, George Davis, Frank Hall, Fred A. Massey, and Valerie Miller, *Modern trends in matrix analysis and applications*
Jack B. Brown and R. Daniel Mauldin, *Measure theory and descriptive set theory*
Shui-nee Chow and Roger D. Nussbaum, *Nonlinear differential delay equations*
Lewis A. Coburn, *Toeplitz operators and geometry*
Gary Cornell and H. W. Lenstra, Jr., *Algebraic number theory and algorithms*
Saber Elaydi, *Stability of differential and integrodifferential equations*
Herbert Freedman and Paul Waltman, *Applications of differential equations to population ecology*
Robert B. Gardner and Clyde Martin, *Geometry of nonlinear control systems*
Ronald Gould and Michael S. Jacobson, *Graph theory*
Johnny Henderson and R. A. Zalik, *Total positivity and applications*
Paul Hill, *Abelian groups*
Theodore P. Hill and Robert Kertz, *Discrete-time optimal stopping theory*
Stephen R. Mahaney, *Structural complexity theory*
Lynn McLinden and Jay S. Treiman, *Optimization*
A. G. Ramm, *Multidimensional inverse problems, related problems in analysis and applications*
Dennis Stanton, *Combinatorics and group representations*

March 1988 Meeting in East Lansing

Central Section
Deadline for organizers: September 15, 1987
Deadline for consideration: November 23, 1987

Barbara Keyfitz, *Non-linear conservation laws*
Karl Rubin, *Number theory*

March 1988 Meeting in Knoxville

Southeastern Section
Deadline for organizers: Expired
Deadline for consideration: December 28, 1987

April 1988 Meeting in College Park

Eastern Section
Deadline for organizers: October 15, 1987
Deadline for consideration: December 28, 1987

August 1988 AMS Centennial Celebration in Providence

There will be no Special Sessions.

Information for Organizers

Special Sessions at Annual and Summer Meetings are held under the general supervision of the Program Committee. They are administered by the Associate Secretary in charge of the meeting with staff assistance from the Society office in Providence.

Some Special Sessions arise from an invitation to a proposed organizer issued through the Associate Secretary. Others are spontaneously proposed by interested organizers or participants. Such proposals are welcomed by the Associate Secretaries.

The number of Special Sessions at a Summer or Annual Meeting is limited to twelve. Proposals, invited or offered, that are received at least nine months prior to the meeting are screened for suitability of the topic and of the proposed list of speakers, and for possible overlap or conflict with other proposals. (Specific deadlines for requesting approval for Special Sessions at national meetings are given above.) If necessary, the numerical limitation is enforced.

Proposals for Special Sessions should be submitted directly to the Associate Secretary in charge of the meeting (at the address given in the accompanying box). If such proposals are sent to the Providence office, addressed to *Notices*, or directed to anyone other than the Associate Secretary, they will have to be forwarded and may not be received before the quota is filled.

In accordance with an action of the Executive Committee of the Council, no Special Session may be arranged so late that it may not be announced in *Notices* early enough to allow any member of the Society who wishes to do so to submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration.

Special Sessions are effective at Sectional Meetings and can usually be accommodated. They are arranged by the Associate Secretary under the supervision of the Committee to Select Hour Speakers for the section. The limitation on the number of sessions depends on the space and time available. The same restriction as for national meetings applies to the deadline for announcing Special Sessions at sectional meetings: no Special Session may be approved too late for its announcement to appear in time to allow a reasonable interval for members to prepare and submit their abstracts prior to the special early deadline set for consideration of papers for Special Sessions.

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*.

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.

Send Proposals for Special Sessions to the Associate Secretaries

The programs of sectional meetings are arranged by the Associate Secretary for the section in question:

Far Western Section (Pacific and Mountain)

Hugo Rossi, Associate Secretary
Department of Mathematics
University of Utah
Salt Lake City, UT 84112
(Telephone 801-581-8159)

Central Section

Robert M. Fossum, Associate Secretary
Department of Mathematics
University of Illinois
1409 West Green Street
Urbana, IL 61801
(Telephone 217-333-3975)

Eastern Section

W. Wistar Comfort, Associate Secretary
Department of Mathematics
Wesleyan University
Middletown, CT 06457
(Telephone 203-347-9411)

Southeastern Section

Frank T. Birtel, Associate Secretary
Department of Mathematics
Tulane University
New Orleans, LA 70118
(Telephone 504-865-5646)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

Symposium on Some Mathematical Questions in Biology
The Dynamics of Excitable Media

Las Vegas, Nevada, May 1988

The twenty-second annual Symposium on Some Mathematical Questions in Biology will be held on a day to be determined during the annual meeting of the Federation of American Societies for Experimental Biology, May 1-6, 1988. The symposium is sponsored by the American Mathematical Society, the Society for Industrial and Applied Mathematics, and the Society for Mathematical Biology.

The AMS-SIAM Committee on Mathematics in the Life Sciences serves as the Organizing Committee for the symposium. The committee consists of Gail A. Carpenter (Northeastern University); Kenneth L. Lange (Massachusetts Institute of Technology); Hans G. Othmer (University of Utah); Alan S. Perelson (Los Alamos National Laboratory); Richard E. Plant, chairman (University of California, Davis); and John Rinzel (National Institutes of Health). Professor Othmer is the organizer of the symposium.

The theme of the symposium is *The Dynamics of Excitable Media.* There will be two half-day sessions, each including three one-hour lectures.

PROGRAM

Chairman: Hans G. Othmer

9:00 a.m. **Some Mathematical Questions in Biology—The Dynamics of Excitable Media**
Presiding: HANS G. OTHMER, University of Utah

An analysis of bursting in excitable cells. JAMES C. ALEXANDER, University of Maryland

Cardiac pacemaking: A consensus of sinus node cells. JOSE JALIFE, SUNY Upstate Medical Center

Aspects of propagation failure in excitable media. JAMES KEENER, University of Utah

2:00 p.m. **Some Mathematical Questions in Biology—The Dynamics of Excitable Media**
Presiding: HANS G. OTHMER, University of Utah

Wave propagation in aggregation fields of "Dictyostelium discoideum". PETER MONK, University of Delaware

The use of a bidomain model for propagation studies in cardiac tissue. ROBERT PLONSEY, Duke University

Collective behavior in the hippocampus. ROGER TRAUB, Thomas J. Watson Research Center and New York University

Symposium on American Mathematics Entering its Second Century

Boston, Massachusetts, February 13-14, 1988

A special Symposium on *American Mathematics Entering its Second Century* will be held on Saturday and Sunday, February 13–14, 1988, in the Sheraton Boston Hotel as part of the annual meeting of the American Association for the Advancement of Science. The symposium is sponsored by the American Mathematical Society in celebration of its centennial year.

The members of the Organizing Committee are HYMAN BASS, Columbia University (chairman); RAOUL H. BOTT, Harvard University; RONALD L. GRAHAM, AT&T Bell Laboratories; ROBION C. KIRBY, University of California, Berkeley; GEORGE DANIEL MOSTOW, Yale University; LYNN ARTHUR STEEN, St. Olaf College; and DENNIS P. SULLIVAN, City University of New York.

After 100 years of fundamental internal theoretical developments, two major trends are apparent in American mathematical research. First is the rejuvenation of the bonds with the natural sciences. Second is the emergence of the modern computer, which was first conceived and designed by mathematicians, and whose exploitation draws heavily on mathematical tools.

The symposium presents four areas of important mathematical research and activity illustrating the above trends.

Computer aided mathematical modeling has become a fundamental research tool in almost every field of science and technology. Three distinguished practicioners will present cases of this methodology: GEORGE F. CARRIER, Harvard University; DAVID MUMFORD, Harvard University; and CHARLES S. PESKIN, Courant Institute of Mathematical Sciences.

Fundamental structures in mathematics and the physical sciences are governed by principles of symmetry. GEORGE DANIEL MOSTOW, Yale University, will discuss how symmetry is mathematically expressed by the concept of a group. Symmetry appears geometrically in the sphere packing problem as discussed by JOHN CONWAY, Princeton University. Statistician PERCI DIACONIS, Stanford University, will conclude the session on symmetry with discussions on random walks on groups.

Revolutionary developments in low dimensional geometry have occured in the last decade. These have revealed striking and unanticipated connections between diverse branches of mathematics and theoretical physics. Presenters for this session include JOHN MORGAN, Columbia University; DAVID A. HOFFMAN, University of Massachusetts, Amherst; WILLIAM P. THURSTON, Princeton University; and ROBION C. KIRBY, University of California, Berkeley.

The plenary address will be delivered by RAOUL H. BOTT, Harvard University, on Sunday, February 14.

The theme of the final session of the symposium centers on the close alliance of physics and mathematics including topics on fluid dynamics, dynamical systems and string theory. The list of speakers will include DANIEL G. QUILLEN, Oxford University; JAMES A. YORKE, University of Maryland; and JAMES G. GLIMM, Courant Institute of Mathematical Sciences.

Details regarding registration, local arrangements and program information will appear in future issues of *Science* and the *Notices*.

Joint Summer Research Conferences in the Mathematical Sciences

Bowdoin College, Brunswick, Maine, June 11 to August 5, 1988

The 1988 Joint Summer Research Conferences in the Mathematical Sciences will be held at Bowdoin College, Brunswick, Maine, from June 11 to August 5. It is anticipated that the series of conferences will be supported by grants from the National Science Foundation and other agencies.

There will be ten conferences in ten different areas of mathematics. The topics and organizers for the conferences were selected by the AMS-IMS-SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences. The selections were based on suggestions made by the members of the committee and individuals submitting proposals. The committee considered it important that the conferences represent diverse areas of mathematical activity, with emphasis on areas currently especially active, and paid careful attention to subjects in which there is important interdisciplinary activity at present.

The conferences are similiar in scientific structure to those held throughout the year at Oberwolfach. These conferences are intended to complement the Society's program of annual Summer Institutes and Summer Seminars, which have a larger attendance and are substantially broader in scope. The conferences are research conferences, and are not intended to provide an entree to a field in which a participant has not already worked.

It is expected that funding will be available for a limited number of participants in each conference. Others, in addition to those funded, will be welcome, within the limitations of the facilities of the campus. In the spring a brochure will be mailed to all who are invited to attend the conferences. The brochure will include information on room and board rates, the residence and dining hall facilities, travel and local information and a Residence Housing Form to use for on-campus housing accommodations. Information on off-campus housing will also be included in the brochure. Participants are required to make their own housing and travel arrangements. Each participant will be required to pay a fee of $25 to cover the cost of social events and refreshments served at breaks, in addition to a $10 registration fee.

The Joint Summer Research Conferences in the Mathematical Sciences are under the direction of the AMS-IMS-SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences. The following Committee members chose the topics for the 1988 conferences: William B. Arveson, James Daniel, Martin Golubitsky, Ronald L. Graham, James I. Lepowsky, John R. Martin, Tilla Klotz Milnor, Evelyn Nelson, and Ingram Olkin.

Descriptions of the topics listed below and the dates of each of the 1988 Conferences will appear in the November issue of *Notices*.

The mathematics and physics of order and disorder

Geometric problems in Fourier analysis

Computational number theory

Spatial statistics and imaging

Current progress in hyperbolic systems: Riemann problems and computations

Mathematical developments arising from linear programming algorithms

Mathematical problems posed by anisotropic materials

Elliptic genera and elliptic cohomology

Control theory and multibody systems

Geometric and topological invariants of elliptic operators

Special Meetings

THIS SECTION contains announcements of meetings 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 both in this section and on the inside front cover. All meetings listed here, to the best of our knowledge, are open meetings and the public is invited to attend.

AN ANNOUNCEMENT will be published in *Notices* if it contains the place, date, and the subject (when applicable); 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.

IN GENERAL, announcements of meetings 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 special meetings 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.

1987 Ramanujan Centennial Year, Wichita State University, Wichita, Kansas.

Program: Ongoing talks, both from local and invited speakers, are scheduled throughout 1987 to celebrate Ramanujan's 100th Birthday.

Information: P. Bajaj or B. Fridman, Department of Mathematics and Statistics, Wichita State University, Wichita, Kansas 67208.

1987–1988. **Academic Year Devoted to Several Complex Variables**, Mittag-Leffler Institute, Djursholm, Sweden. (January 1987, p. 131)

September 13, 1987–December 13, 1987. **Mathematisches Forschungsinstitut Oberwolfach** (Weekly Conferences), Federal Republic of Germany. (October 1986, p. 840)

September 14, 1987–June 25, 1988. **Program on Applied Combinatorics**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota. (April 1987, p. 548)

January–July 1988. **Symposium on Representation Theory and Group Theory**, Manchester, England. (April 1987, p. 548)

April 17, 1988–December 24, 1988. **Mathematisches Forschunginstitut Oberwolfach** (Weekly Conferences), Federal Republic of Germany.

Information: M. Barner, Alberstrasse 24, D-7800 Freiburg, Federal Republic of Germany.

April

17–23. Berechnung von Verzweigungen in mechanischen Systemen, *Chairmen*: T. Küpper, Hannover; R. Seydel, Würzburg; H. Troger, Wien.

24–30. Kombinatorik geordneter Mengen, *Chairmen*: M. Aigner, Berlin; R. Wille, Darmstadt.

May

1–7. Gruppen und Geometrien, *Chairmen*: M. Aschbacher, Pasadena; B. Fischer, Bielefeld; D. Higman, Michigan; F. Timmesfeld, Giessen.

8–14. Mathematical Problems in the Kinetic Theory of Gases, *Chairmen*: C. Cercignani, Mailand; H. Neunzert, Kaiserslautern; D. Pack, Glasgow.

8–14. Approximation und Interpolation mit Lösungen partieller Differentialgleichungen, *Chairmen*: M. von Golitschek, Würzburg; W. Haussmann, Duisburg.

15–21. Computational Group Theory, *Chairmen*: J. Neubüser, Aachen; C. Sims, New Brunswick.

22–28. Konstruktive algebraische Zahlentheorie, *Chairmen*: H. Lenstra, Jr., Berkeley; M. Pohst, Düsseldorf; H. Zimmer, Saarbrücken.

June

12–18. Graphentheorie, *Chairmen*: W. Mader, Hannover; G. Ringel, Santa Cruz.

July

3–9. Kombinatorik (symmetrische Gruppen, klassische Algebra und spezielle Funktionen), *Chairmen*: D. Foata, Strasbourg; A. Kerber, Bayreuth.

31–August 6. Theory of Large Deviations, *Chairmen*: E. Bolthausen, Berlin; S. Varadhan, New York.

August

21–27. Gruppentheorie, *Chairmen*: T. Hawkes, Coventry; O. Kegel, Freiburg.

September

11–17. 4-Dimensional Manifolds, *Chairmen*: S. Donaldson, Oxford; M. Kreck, Mainz.

18–24. The Navier-Stokes Equations: Theory and Numerical Methods, *Chairmen*: J. Heywood, Vancouver; K. Masuda, Tokyo; R. Rautmann, Paderborn; V. Solonnikov, Leningrad.

October

30–November 5. Linear Operators and Applications, *Chairmen*: I. Gohberg, Tel Aviv; B. Gramsch, Mainz; H. Schaefer, Tübingen.

November

6–12. Mathematische Logik, *Chairmen*: W. Felscher, Tübingen; H. Schwichtenberg, München; A. Troelstra, Amsterdam.

13–19. Komplexitätstheorie, *Chairmen*: C. Schnorr, Frankfurt; A. Schönhage, Tübingen; V. Strassen, Zürich.

December

4–10. Praktische Behandlung von Integralgleichungen, Randelementmethoden und singuläre Gleichungen, *Chairmen*: G. Hämmerlin, München; E. Meister, Darmstadt; W. Wendland, Stuggart.

11–17. Martingalmethoden in der Statistik, *Chairmen*: R. Gill, Amsterdam; H. Strasser, Bayreuth.

18–24. Grundlagen der Geometrie, *Chairman*: W. Benz, Hamburg.

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OCTOBER 1987

October. **Journées Méthodes Numériques en Méchanique des Fluides**, Sophia-Antipolis, France. (August 1986, p. 655)

5–9. **Tenth Conference on Probability and Statistics in Atmospheric Science**, Edmonton, Alberta, Canada. (June 1987, p. 684)

9–10. **Fifteenth Annual Mathematics and Statistics Conference**, Miami University, Oxford, Ohio. (April 1987, p. 553)

9–10. **Sixth Annual Midwest Statistics Conference**, University of Illinois, Urbana-Champaign, Illinois. (June 1987, p. 684)

9–10. **Thirteenth Annual Student Conference**, Miami University, Oxford, Ohio. (April 1987, p. 553)

10. **Tenth Conference on Probability and Statistics in Atmospheric Science**, Alberta, Canada. (April 1987, p. 553)

10–11. **Second Fall Foliage Topology Seminar**, Moosilauke Ravine Lodge, North Woodstock, New Hampshire. (August 1987, p. 812)

12–15. **Society for Industrial and Applied Mathematics (SIAM) 35th Anniversary Meeting**, Denver, Colorado. (August 1987, p. 812)

16–17. **Third Eastern Small College Computing Conference**, Marist College, Poughkeepsie, New York. (February 1987, p. 363)

19–23. **20th International Conference on the Application of Computers and Mathematics in the Mineral Industries**, Johannesburg, South Africa. (June 1987, p. 684)

19–23. **Workshop on Orderly Dispositions in Space**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota. (August 1987, p. 812)

20–22. **Fourth International Conference on Text Processing Systems (PROTEXT IV)**, Boston, Massachusetts. (June 1987, p. 684)

22–23. **31st Annual Fall Technical Conference**, Atlantic City, New Jersey. (August 1987, p. 812)

23–24. **Combined Midwest-Southeast Differential Equations Conference**, Vanderbilt University, Nashville, Tennessee. (June 1987, p. 684)

23–24. **Ninth Midwest Probability Colloquium**, Northwestern University, Evanston, Illinois. (August 1987, p. 812)

25–27. **Sixth Annual Pacific Northwest Computer Graphics Conference Applications on the Leading Edge**, Eugene Conference Center and Hult Center for the Performing Arts, Eugene, Oregon.
Information: Conference Manager, Sixth Annual Pacific Northwest Computer Graphics Conference, University of Oregon Continuation Center, 1553 Moss Street, Eugene, Oregon 97403, 503-686-3537 or 800-824-2714 (Oregon toll free).

25–28. **Joint National Meeting of the Operations Research Society of America and the Institute of Management Sciences**, Saint Louis, Missouri. (June 1987, p. 684)

25–29. **1987 Institute of Electrical and Electronics Engineers Computer Society's Fall Joint Computer Conference**, Dallas, Texas.
Information: D. Anthony, Institute of Electrical and Electronics Engineers Computer Society, 1730 Massachusetts Avenue, Northwest, Washington, District of Columbia 20036-1903, 214-575-2151.

25–31. **International Conference on Population Mathematics**, Schwerin, German Democratic Republic. (June 1987, p. 684)

26–28. **The Operations Research Society of America and The Institute of Management Sciences Joint National Meeting**, Saint Louis, Missouri. (August 1987, p. 813)

26–30. **Third Asian Conference in Mathematical Logic**, Beijing, China. (June 1987, p. 684)

26–31. **Mathematical Methods in Operations Research**, Sofia, Bulgaria. (January 1987, p. 135)

27–30. **Computer Communication for Developing Countries '87**, New Delhi, India. (June 1987, p. 684)

28–29. **Calculus for a New Century**, National Academy of Sciences, Washington, District of Columbia.
Information: Calculus Conference, MS 2000 National Research Council, 2101 Constitution Avenue, Washington, District of Columbia 20418.

28–30. **Mathematical Approaches to Environmental and Ecological Problems**, Cornell University, Ithaca, New York. (August 1987, p. 813)

29–31. **Weighted Norm Inequalities and Applications**, Centre de Recherches Mathématiques, Université de Montréal, Canada.
Organizers: C. Herz (McGill University) and E. Sawyer (McMaster University).
Information: F. Clarke, Director, Centre de Recherches Mathématiques, Université de Montréal, Carte Postale 6128-A, Montréal, Quebec, Canada H3C 3J7.

30–November 1. **837th Meeting of the AMS**, Lincoln, Nebraska. (April 1987, p. 553)
Information: For further details, see the Meetings section of this issue of *Notices*.

NOVEMBER 1987

1–6. **Conference on Combinatorics, Algorithms, and Coding Theory**, Taipei, Taiwan, Republic of China. (August 1987, p. 813)

9–12. **Institute of Electrical and Electronics Engineers International Conference on Computer Aided Design (ICCAD)**, Santa Clara, California.
Information: ICCAD 1987, B. Chawla, AT&T Bell Laboratories, 1247 South Cedar Crest Boulevard, Allentown, Pennsylvania 18103, 215-770-3484.

9–December 18. **College on Riemann Surfaces**, Trieste, Italy. (February 1987, p. 363)

12–14. **350 Years After Descartes: Postmodern Vistas in Mathematics**, San Jose State University, San Jose, California.
Invited Speakers: R. Abraham, D. Chakerian, J. Crutchfield, R. DeVogelaere, V. Goldberg, J. Grabiner, N. Green, R. Guy, P. Hilton, N. Kagan, M. Newman, and J. Pedersen.
Organizers: T. Deretsky and R. Rucker.
Information: Reneco, Department of Mathematics and Computer Science, San Jose State University, San Jose, California 95192, 408-277-2411.

14–15. **838th Meeting of the AMS**, Los Angeles, California. (April 1987, p. 553)
Information: For further details, see the Meetings section of this issue of *Notices*.

15–22. **Kodierungstheorie und Algebraische Geometrie**, Düsseldorf, Federal Republic of Germany.
Invited Speakers: G. van der Geer, Amsterdam, and J. van Lint, Eindhoven.
Information: Mathematisches Forschungsinstitut Oberwolfach, Alberstrasse 24, D-7800 Freiburg, Federal Republic of Germany.

DECEMBER 1987

7–9. **42nd Annual Conference on Applied Statistics**, Newark, New Jersey. (August 1987, p. 813)

7–11. **Conference on Algebraic K-theory: Connections with Geometry and Topology**, Chateau Lake Louise, Lake Louise, Alberta, Canada.
Invited Speakers: S. Bloch, G. Carlsson, H. Gillet, T. Goodwillie, R. Joshua, B. Kahn, M. Levine, W. Raskind, L. Roberts, S. Saito, C. Soulé, V. Snaith, R. Thomason, W. van der Kallen, and C. Weibel.
Information: J. Jardine, Mathematics Department, University of Western Ontario, London, Ontario, N6A 5B7, Canada, 519-661-3638, extension 6518.

14–18. **Workshop on Applications of Combinatorics and Graph Theory to Computer Science**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota. (August 1987, p. 813)

15–18. **The Ramanujan Centennial Conference**, Annamalainagar, India.

Program: The program will include invited lectures on various aspects of number theory: analytic, algebraic, computational, combinatorial and arithmetic of modular forms, elliptic curves and abelian varieties. There will also be sessions for contributed papers in these and related areas.

Information: R. Balakrishnan, Head of the Department of Mathematics, Annamalai University, Annamalainagar-608 002, India.

16–21. **International Conference on Transformation Groups**, Osaka, Japan.

Information: K. Kawakubo, Department of Mathematics, Osaka University, Toyonaka, Osaka 560, Japan.

19–21. **International Conference on Mathematics**, Madras, India.

Program: The program will include half hour invited talks and fifteen minute communications, and special sessions on Number Theory (works related to those of Ramanujan) and computer applications will also form part of the program.

Information: G. Ramanaiah, Chairman, International Conference on Mathematics, Dean of Science and Humanities, Anna University, Madras-600 025, India.

22–24. **Eleventh National Systems Conference - 1987**, Kurukshetra, India. (April 1987, p. 553)

26–28. **Ramanujan Birth Centenary Year International Symposium on Analysis**, Pune, India. (June 1987, p. 685)

28–29. **1987-1988 Association for Symbolic Logic Annual Meeting**, New York City, New York. (August 1987, p. 813)

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JANUARY 1988

4–6. **Fourth Haifa Matrix Conference**, Haifa, Israel.

Organizing Committee: A. Berman, D. Hershkowitz, and L. Lerer.

Information: D. Hershkowitz, Department of Mathematics, Technion-Israel Institute of Technology, Haifa 32000, Israel.

4–8. **Fifth Caribbean Conference in Combinatorics and Computing**, University of the West Indies, Cave Hill, Barbados. (June 1987, p. 685)

5–6. **1988 AMS Short Course: Computational Complexity Theory**, Atlanta, Georgia.

Information: For further details, see the Meetings section of this issue of Notices

6–8. **American Statistical Association Winter Conference: Statistics in Biotechnology**, San Antonio, Texas. (August 1987, p. 813)

6–9. **Joint Mathematics Meetings**, Atlanta, Georgia. (April 1987, p. 553)

Information: For further details, see the Meetings section of this issue of Notices

11–15. **National Science Foundation-Conference Board of the Mathematical Sciences Regional Conference on Kaluza-Klein Theory**, University of New Mexico, Albuquerque, New Mexico. (April 1987, p. 553)

18–22. **Workshop on Application of Combinatorics and Graph Theory to the Biological and Social Sciences**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota. (August 1987, p. 813)

20–22. **Conference on Transport Theory, Invariant Imbedding, and Integral Equations**, Eldorado Hotel, Santa Fe, New Mexico.

Call for Papers: Abstracts describing advances in all aspects of transport theory, invariant imbedding, and integral equations should be submitted by October 15, 1987, to S. Girard, Computer Research and Applications, MS B265, Los Alamos National Laboratory, Los Alamos, New Mexico 87545.

Invited Speakers: J. Corones, Ames Laboratory; V. Faber, Los Alamos National Laboratory; H. Kaper, Argonne National Laboratory, H. Keller, California Institute of Technology; T. Mullikin, Purdue University; Z. Nashed, University of Delaware; P. Nelson, Air Force Weapons Laboratory; and P. Prenter, Colorado State University.

Information: D. Seth, C-3, MS B265, Los Alamos National Laboratory, Los Alamos, New Mexico 87545, 505-667-7046 or 505-667-7028.

20–February 5. **Twenty-eighth Summer Research Institute of the Australian Mathematical Society**, Shortland, Australia. (June 1987, p. 685)

FEBRUARY 1988

7–11. **1988 Australian Applied Mathematics Conference**, Leura, Australia. (February 1987, p. 363)

8–12. **Workshop on Representations of p-adic Groups and Applications to Automorphic Forms**, Mathematical Sciences Research Institute, Berkeley, California. (August 1987, p. 813)

13–14. **Symposium on American Mathematics Entering its Second Century**, Boston, Massachusetts.

Information: For further details, see the Meetings section of this issue of Notices

15–19. **The Nineteenth Southeastern International Conference on Combinatorics, Graph Theory and Computing**, Louisiana State University, Baton Rouge, Louisiana.

Information: After October 15, 1987, K. Reid, Chairman, Department of Mathematics, Louisiana State University, Baton Rouge, Louisiana 70803.

MARCH 1988

7–10. **Second International Conference on Computer Workstations**, Santa Clara, California.

Information: P. Mantey, 335A Applied Science Building, Department of Computer Engineering, University of California, Santa Cruz, California 95064, 408-429-2158.

7–11. **Period of Concentration on q-Series and Partitions**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota. (August 1987, p. 814)

8–11. **1988 International Zurich Seminar on Digital Communications**, Zurich, Switzerland.

Information: Secretariat IZS 88, P. Gunzburger, Hasler AG, TDS, Belpstrasse 23, CH-3000 Bern 14, Switzerland. Telephone: 41-31-632808.

14–18. **Fourth International Conference on Artificial Intelligence Conference Applications**, Sheraton Harbour Island, San Diego, California.

Information: Artificial Intelligence Conference, Computer Society, 1730 Massachusetts Avenue, Northwest, Washington, District of Columbia 20036-1903, 202-371-1013.

14–18. **Second International Conference on Hyperbolic Problems**, Aachen, Federal Republic of Germany. (February 1987, p. 363)

16–18. **Twenty-first Annual Simulation Symposium**, Tampa, Florida. (August 1987, p. 814)

18–19. **840th Meeting of the AMS**, East Lansing, Michigan.

Information: John Balletto, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02940.

21–25. **International Conference on Theory and Applications of Differential Equations**, Ohio University, Athens, Ohio. (August 1987, p. 814)

21–25. **Workshop on Invariant Theory and Tableaux**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota. (August 1987, p. 814)

25–26. **841st Meeting of the AMS**, Knoxville, Tennessee.
Information: John Balletto, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02940.

28–31. **Nineteenth Iranian Mathematical Conference**, Rasht, Iran. (August 1987, p. 814)

28–April 3. **Complex Analysis Days in Guadeloupe**, Pointe a Pitre, Guadeloupe.
Call for Communication: Those who wish to give a lecture must send an abstract by December 15, 1987, to L. Gruman, Pouyebon, 32320 Montesquiou, France.
Information: A. Meril, Section de Mathématiques/Informatique, U.F.R. Sciences Exactes et Naturelles, Boîte Postale 592, 97167 Pointe a Pitre Cedex, Guadeloupe.

APRIL 1988

11–13. **1988 Computer Networking Symposium**, Sheraton National Hotel, Arlington, Virginia.
Information: G. Chang, 6 Corporation Place, Piscataway, New Jersey 08854, 201-699-3879.

11–15. **Institute of Electrical and Electronics Engineers Computer Society's 10th International Conference on Software Engineering**, Raffles City, Singapore.
Information: T. Nam or L. Say, 71 Science Park, Singapore 0511. Telephone: (65) 772-0200.

17–30. **The First Canadian Number Theory Society Conference**, Banff, Alberta, Canada. (February 1987, p. 364)

23–24. **842nd Meeting of the AMS**, College Park, Maryland.
Information: John Balletto, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02940.

24–28. **International Council on Mathematics in Developing Countries' Symposium on Mathematics of Computation**, Ho Chi Minh City, Vietnam.
Objectives: To give mathematicians in developing countries, as well as from developed countries, an opportunity to exchange experiences and research results in areas of the mathematics of computation, and to enhance cooperation in the Southeast Asian region.
Topics: Topics of the symposium include: numerical methods in algebra, numerical methods for solving differential equations, computational probability and statistics, numerical simulation, mathematical programming, algorithms for discrete problems, computational complexity, parallel computation.
Information: J. M. Steyaert, Centre de Mathématiques Appliquées, École Polytechnique de Paris, 91128 Palaiseau Cedex, France; or Neal Koblitz, Department of Mathematics, GN-50, University of Washington, Seattle, WA 98195 USA, 206-543-4386.

MAY 1988

Symposium on Some Mathematical Questions in Biology: The Dynamics of Excitable Media, Las Vegas, Nevada.
Information: For further details, see the Meetings section of this issue of the *Notices*. (Exact dates for this symposium are undetermined).

5–6. **Nineteenth Annual Pittsburgh Conference on Modeling and Simulation**, University of Pittsburgh, Pittsburgh, Pennsylvania.
Call for Papers: Only papers not published previously will be considered. Submit two copies of titles, authors, all author's addresses, abstracts, and summaries by January 31, 1988, to the address below. The abstract should be approximately 50 words in length and the summary should be of sufficient length and detail to permit careful evaluation. Identify one author as the correspondent for the paper.
Information: W. Vogt or M. Mickle, Modeling and Simulation Conference, 348 Benedum Engineering Hall, University of Pittsburgh, Pittsburgh, Pennsylvania 15261.

16–20. **Ninth Australian Statistical Conference**, Canberra, Australia. (August 1987, p. 814)

16–20. **1988 Mathematical Sciences Congress and 32nd Annual General Meeting of the Australian Mathematical Society**, Canberra, Australia. (June 1987, p. 685)

23–27. **Conference on Mathematical Methods and Applications**, Chiangmai, Thailand. (June 1987, p. 685)

29–31. **Eighteenth International Symposium on Multiple-Valued Logic**, Madrid, Spain.
Information: E. Trillas, Consejo Superior, Investigaciones Cientificas, Serrano 117, 28006-Madrid, Spain. Telephone: (91) 6216264.

29–June 4. **Symposium on the Legacy of John von Neumann**, Hofstra University, Hempstead, New York.
Information: John Balletto, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02940.

30–June 3. **International Conference on Numerical Mathematics**, Kent Ridge, Republic of Singapore. (April 1987, p. 553)

30–June 3. **Sixth International Conference on the Theory and Applications of Graphs**, Western Michigan University, Kalamazoo, Michigan. (June 1987, p. 685)

30–June 7. **Canadian Applied Mathematics Society Conference and Workshop on Continuum Mechanics and its Applications**, Simon Fraser University, British Columbia, Canada.
Information: C. Graham, Department of Mathematics and Statistics, Simon Fraser University, Burnaby, British Columbia, Canada V5A 1S6.

JUNE 1988

4–August 11. **Joint Summer Research Conferences in the Mathematical Sciences**, Bowdoin College, Brunswick, Maine.
Information: For further details, see the Meetings section in this issue of *Notices*.

5–9. **Institute of Electrical and Electronics Engineers Computer Society's Conference on Computer Vision and Pattern Recognition**, University of Michigan, Ann Arbor, Michigan.
Information: R. Jain, Department of Electrical Engineering and Computer Science, 3215 Electrical Engineering and Computer Science Building, University of Michigan, Ann Arbor, Michigan 48109-2122, 313-763-0387.

5–12. **Third International Symposium on Differential Geometry**, Peñiscola, Spain.
Invited Speakers: T. Aubin, M. Barros, J. Bourguignon, R. Deheuvels, M. do Carmo, S. Donaldson, H. Donnelly, J. Eells, P. Gilkey, J. Girbau, J. Kazdan, R. Kulkarni, A. Lichnerowicz, and R. Osserman.
Organizing Committee: A. Naveira, O. Gil-Medrano, F. Carreras.
Information: Departamento de Geometria y Topologia, Facultad de Matemáticas, Universidad de Valencia, BURJASOT (Valencia), Spain.

11–14. **International Conference on Almost Everywhere Convergence in Probability and Ergodic Theory**, Columbus, Ohio.
Organizing Committee: M. Akcoglu, A. Bellow, D. Burkholder, G. Edgar, and L. Sucheston.
Information: G. Edgar, Department of Mathematics, Ohio State University, Columbus, Ohio 43210.

12–18. **Workshop on Coding Theory and Applications**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota. (August 1987, p. 814)

13–17. **Nonlinear Hyperbolic Problems Conference**, Talence, France.
Organizing Committee: C. Carasso, P. Charrier, B. Hanouzet, and J. Joly.
Information: A. Polzin, D Département de Mathématiques Appliquées, Université de Bordeaux I, 351, cours de la Libération, 33405 Talence Cedex, France.

15–17. **Ninth National Educational Computing Conference (NECC '88)**, Anatole Hotel, Dallas, Texas.
Call for Papers: Papers due by November 1, 1987. Specifications for submission of original papers are available by writing to the address below.
Information: NECC '88, International Council for Computers in Education, University of Oregon, 1787 Agate Street, Eugene, Oregon 97403-9905, 503-686-4414.

19–24. **1988 IEEE International Symposium on Information Theory**, Kobe, Japan.
Call for Papers: Long papers (40 minutes) and short (20 minutes) will be accepted. The deadline for submission for a long paper is November 1, 1987, and December 1, 1987, for a short paper. All submitted papers accompanied by an abstract of no more than 180 words should be sent in triplicate to either S. Lin, Department of Electrical Engineering, University of Hawaii at Manoa, Holmes Hall 483, 2540 Dole Street, Honolulu, Hawaii 96822 or S. Arimoto, Faculty of Engineering Science, Osaka University, Toyonaka, Osaka 560, Japan.
Information: D. Costello, Department of Electrical Engineering, University of Notre Dame, Notre Dame, Indiana 46556 or T. Kasami, Faculty of Engineering Science, Osaka University, Toyonaka, Osaka 560, Japan.

19–25. **Workshop on Design Theory and Applications**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota. (August 1987, p. 814)

20–24. **Fifth International Conference on Boundary and Interior Layers: Computational and Asymptotic Methods**, Shanghai, China. (June 1987, p. 685)

20–24. **International Algebra Conference**, Lisbon, Portugal. (February 1987, p. 364)

25–30. **International Conference on Biomathematics**, Xian, China.
Information: L. Chen, Mathematical Institute, Chinese Academy of Sciences, Beijing, People's Republic of China.

27–July 15. **Microprogram on the Structure of Banach Spaces**, Mathematical Sciences Research Institute, Berkeley, California. (June 1987, p. 685)

JULY 1988

5–8. **Tenth Dundee Conference on the Theory of Ordinary and Partial Differential Equations**, Dundee, Scotland.
Invited Speakers: P. Browne, D. Jones, R. Leis, H. Levine, J. McLeod, B. Matkowsky, J. Mawhin, R. Smith, J. Toland, J. Tyson, and W. Winfree.
Information: R. Jarvis, Department of Mathematics and Computer Science, The University, Dundee, DD1 4HN, Scotland, United Kingdom.

10–16. **Representation Theory and Group Theory**, Manchester, England. (February 1987, p. 364)

13–20. **Edinburgh Mathematical Society's 1988 Saint Andrews Colloquium**, St. Andrews, Fife, Scotland. (February 1987, p. 364)

17–27. **Ninth Congress of the International Association of Mathematical Physics**, Swansea, Wales. (February 1987, p. 364)

18–22. **Twelfth IMACS World Congress on Scientific Computation**, Paris, France. (February 1987, p. 364)

23–August 3. **Sixth International Congress on Mathematical Education**, Budapest, Hungary. (February 1987, p. 364)

24–30. **International Conference on Radicals – Theory and Applications**, Sapporo, Japan.
Information: S. Kyuno, Department of Mathematics, Tohoku Gakuin University, Tagajo, Miyagi 985, Japan.

25–30. **Third International Congress on Computational and Applied Mathematics**, University of Leuven, Belgium. (August 1987, p. 814)

AUGUST 1988

1–5. **Fifteenth Annual Conference and Exhibition on Computer Graphics and Interactive Techniques (SIGGRAPH '88)**, Georgia World Congress Center, Atlanta, Georgia.
Information: A. Newton, University of Waterloo, Department of Computer Science, Waterloo, Ontario, Canada N2L 3G1, 519-888-4534.

4–11. **Algebraic Logic Conference**, Budapest, Hungary.
Topics: Cylindric-, relation-, polyadic-, dynamic-, monadic-algebras, Boolean algebras with operators, interactions of algebraic logic with model theory, universal algebra, non-classical logic, abstract model theory, categories; categorical logic.
Information: I. Németi, Department of Mathematics, Iowa State University, Ames, Iowa 50011 and/or Secretary, Bolyai Mathematical Society, Budapest, Anker-köz 1-3, H-1061 Hungary.

8–12. **AMS Centennial Celebration**, Providence, Rhode Island. (April 1987, p. 553)
Information: H. Daly, American Mathematical Society, Meetings Department, Post OfficeBox 6248, Providence, Rhode Island 02940.

9–12. **International Symposium in Real Analysis**, University of Ulster, Coleraine, Northern Ireland. (February 1987, p. 364)

11–14. **International Conference on Mathematical Modelling in Science and Technology**, Madras, India.
Call for Papers: Papers on modelling on all aspects of the sciences, engineering, technology, and industries with sufficient mathematics input through analytical methods/techniques such as discrete/numerical/probabilistic/optimization ... are to be sent to the address below by May 1, 1988.
Information: S. Majhi, International Conference on Mathematical Modelling in Science and Technology-88, Department of Mathematics, Indian Institute of Technology, Madras-600 036, India.

14–18. **Institute of Mathematical Statistics Annual Meeting**, Fort Collins, Colorado.
Information: L. Billard, Program Secretary, Department of Statistics and Computer Science, University of Georgia, Athens, Georgia 30602.

14–27. **Harmonic Analysis on Reductive Groups**, Bowdoin College, Brunswick, Maine. (June 1987, p. 686)

15–19. **New Directions in Dynamical Systems**, Brown University, Providence, Rhode Island.
Program: In addition to invited speakers, there will be a limited number of contributed papers.
Organizers: J. Ball, S.-N Chow, C. Dafermos, J. Mallet-Paret, and G. Sell.
Information: Dynamics Conference, J. Mallet-Paret, Division of Applied Mathematics, Brown University, Providence, Rhode Island 02912.

16–19. **Institute of Mathematical Statistics Symposium on Probability and its Applications**, Colorado State University, Fort Collins, Colorado.
Topics: Applications in Brownian Motion and Martingales, Inference in Stochastic Processes, Probability and its Applications to Physics, Extreme Value Theory and

Applications, Large Deviations, Applications of Probability in Banach Spaces, Spatial Processes and Inference, Markov Processes, and Random Fields.
Information: R. Taylor, Program Chairman, Department of Statistics, University of Georgia, Athens, Georgia 30602.

20–26. **Groups**, Pusan, Republic of Korea. (June 1987, p. 686)

21–27. **Seventeenth International Congress of Theoretical and Applied Mechanics**, Grenoble, France. (January 1987, p. 135)

22–25. **1988 Joint Statistical Meetings**, New Orleans, Louisiana. (June 1987, p. 686)

22–26. **Conference on Categorical Topology and its Relations to Algebra, Analysis and Combinatorics**, Prague, Czechoslovakia.
Topics: Categorical topology, topological groups, convergence structures.
Information: M. Hušek, Math. Inst. of Charles University, Sokolovská 83, 186 00 Prague, Czechoslovakia.

29–September 2. **ICO Topical Meeting on Optical Computing**, Orsay, France.
Information: S. Lowenthal, Insitut D'Uptique Boîte Postale 43, 91406 Orsay, Cedex, France.

29–September 2. **Orbit Method in Representation Theory**, Copenhagen, Denmark.
Invited Speakers: M. Duflo, A. Kirillov, B. Kostant, L. Pukanszky, and M. Vergne.
Information: N. Pedersen, Mathematics Department, University of Copenhagen, Universitetsparken 5, 2100 Copenhagen, Denmark.

SEPTEMBER 1988

26–October 1. **Fifth International Conference on Complex Analysis**, Halle, German Democratic Republic.
Topics: The conference will cover the whole area of complex analysis, such as geometric function theory, functions of several complex variables, applications to partial differential equations, integral transformations, and applications in the theory of elasticity.
Information: Fifth Conference on Complex Analysis, Martin-Luther-University, Department of Mathematics, Universitätsplatz 6, DDR-4010 Halle (Saale).

DECEMBER 1988

6–8. **First International Conference on Matter Elements Analysis**, Guangzhou, Guangdong, People's Republic of China.
Program: The session will cover the birth of Matter Elements Analysis, difference between classical set, fuzzy set and extension set, theoretical frame of Matter Elements Analysis, some applications of Matter Elements Analysis on Value Engineering, large-scale system decision making, and more.
Information: C. Wen, Guangdong Institute of Technology, Guangzhou, People's Republic of China.

JANUARY 1989

8–11. **First Caribbean Conference on Fluid Dynamics**, Saint Augustine, Trinidad, West Indies. (June 1987, p. 686)

11–14. **Joint Mathematics Meetings**, Phoenix, Arizona. (April 1987, p. 553)
Information: H. Daly, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02940.

JULY 1989

5–19. **Microprogram on Noncommutative Rings**, Mathematical Sciences Research Institute, Berkeley, California. (June 1987, p. 686)

AUGUST 1989

28–September 1. **Third International Conference on the Theory of Groups and Related Topics**, Canberra, Australia. (June 1987, p. 686)

JANUARY 1990

17–20. **Joint Mathematics Meetings**, Louisville, Kentucky. (April 1987, p. 553)
Information: H. Daly, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02940.

NEW AMS PUBLICATIONS

MOMENTS IN MATHEMATICS

Henry J. Landau, Editor

(Proceedings of Symposia in Applied Mathematics, Volume 37)

Function theory, spectral decomposition of operators, probability, approximation, electrical and mechanical inverse problems, prediction of stochastic processes, the design of algorithms for signal-processing VLSI chips—these are among a host of important theoretical and applied topics illuminated by the classical moment problem. To survey some of these ramifications and the research which derives from them, the AMS sponsored the Short Course *Moments in Mathematics* at the Joint Mathematics Meetings, held in San Antonio, Texas, in January 1987. This volume contains the six lectures presented during that course.

In his paper, Henry J. Landau sketches the main ideas of past work related to the moment problem by such mathematicians as Caratheodory, Herglotz, Schur, Riesz, and Krein and describes the way the moment problem has interconnected so many diverse areas of research. J. H. B. Kemperman examines the moment problem from a geometric viewpoint which involves a certain natural duality method and leads to interesting applications in linear programming, measure theory, and dilations. Donald Sarason first provides a brief review of the theory of unbounded self-adjoint operators then goes on to sketch the operator-theoretic treatment of the Hamburger problem and to discuss Hankel operators, the Adamjan-Arov-Krein approach, and the theory of unitary dilations. Exploring the interplay of trigonometric moment problems and signal processing, Thomas Kailath describes the role of Szego polynomials in linear predictive coding methods, parallel implementation, one-dimensional inverse scattering problems, and the Toeplitz moment matrices. Christian Berg contrasts the multi-dimensional moment problem with the one-dimensional theory and shows how the theory of the moment problem may be viewed as part of harmonic analysis on semigroups. Persi Diaconis reviews the historical use of moment estimators as a basic component of applied statistics and discusses some recent novel examples that have kept the subject alive.

Contents

1980 *Mathematics Subject Classifications*: 44A60, 60E15, 47A20, 47A40, 60F05
ISBN 0-8218-0114-7, LC 87-19384
ISSN 0160-7634
168 pages, October 1987
Hardcover: **Individual member $18**, List price $30, Institutional member $24
Softcover: **Individual member $15**, List price $25, Institutional member $20
To order, please specify PSAPM/37N (hardcover), PSAPMS/37N (softcover)

INVARIANT THEORY AND SUPERALGEBRAS

Frank Grosshans, Gian-Carlo Rota, and Joel A. Stein

(CBMS Regional Conference Series, Number 69 Supported by the National Science Foundation)

This book brings the reader to the frontiers of research in some topics in superalgebras and symbolic method in invariant theory. Superalgebras are algebras containing positively-signed and negatively-signed variables. One of the book's major results is an extension of the standard basis theorem to superalgebras. This extension requires a rethinking of some basic concepts of linear algebra, such as matrices and coordinate systems, and may lead to an extension of the entire apparatus of linear algebra to "signed" modules. The authors also present the symbolic method for the invariant theory of symmetric and of skew-symmetric tensors. In both cases, the invariants are obtained from the symbolic representation by applying what the authors call the umbral operator. This operator can be used to systematically develop anticommutative analogs of

concepts of algebraic geometry, and such results may ultimately turn out to be the main byproduct of this investigation.

While it will be of special interest to mathematicians and physicists doing research in superalgebras, invariant theory, straightening algorithms, Young bitableaux, and Grassmann's calculus of extension, the book starts from basic principles and should therefore be accessible to those who have completed the standard graduate level courses in algebra and/or combinatorics.

Contents

1980 *Mathematics Subject Classifications*: 15A72, 15A15, 15A75, 16A24, 20G45
ISBN 0-8218-0719-6, LC 87-21146
ISSN 0160-7642
104 pages (softcover), October 1987
All individuals $10, List price $16
To order, please specify CBMS/69N

NOETHERIAN RINGS AND THEIR APPLICATIONS

Lance W. Small, Editor
(Mathematical Surveys and Monographs, Volume 24)

Researchers in ring theory or allied topics, such as the representation theory of finite dimensional Lie algebras, will appreciate this collection of expository lectures on recent advances in ring theory and their applications to other areas. Five of the lectures were delivered at a conference on Noetherian rings at the Mathematisches Forschungsinstitut, Oberwolfach, in January 1983, and the sixth was delivered at a London Mathematical Society Durham conference in July 1983. The study of the prime and primitive ideal spectra of various classes of rings forms a common theme in the lectures, and they touch on such topics as the structure of group rings of polycyclic-by-finite groups, localization in noncommutative rings, and rings of differential operators. The lectures require the background of an advanced graduate student in ring theory and may be used in seminars in ring theory at this level.

Contents

1980 *Mathematics Subject Classifications*: 16, 17, 20
ISBN 0-8218-1525-3, LC 87-14997
ISSN 0076-5376
128 pages (hardcover), October 1987
Individual member $23*, List price $38*, Institutional member $30*
To order, please specify SURV/24N

***Please note**: Price on SURV/24 has been revised *downward*.

CALCULUS OF PRINCIPALLY TWISTED VERTEX OPERATORS

Leila Figueiredo, Editor
(Memoirs of the AMS, Number 371)

In this memoir, the author uses a new method to recover an earlier construction of Kac-Kazhdan-Lepowsky-Wilson of the basic modules for the affine Lie algebras of type $A^{(K)}$, $D^{(K)}$, or $E^{(K)}$. The author begins with an even lattice and an automorphism which has certain properties similar to those of the Coxeter element of the Weyl group and builds the entire theory from these properties. She defines the vertex operators on a certain vector space and, using the "calculus" of formal Laurent series, proves the paper's central result: an identity that permits direct computation of the brackets of the vertex operators. This computation gives rise to cocycles which satisfy the appropriate conditions to construct a finite-dimensional semisimple Lie algebra. In particular, the author shows that the vertex operators (together with certain other operators) provide an irreducible representation of the twisted affinization of that finite-dimensional Lie algebra.

When the lattice and automorphism satisfy certain conditions, the author shows that one obtains the "principal realization" of the affine Lie algebras of type $A^{(K)}$, $D^{(K)}$, or $E^{(K)}$ and that the representation constructed is the basic representation in the theory of Kac-Moody Lie algebras.

Contents

1980 *Mathematics Subject Classifications*: 17B65, 17B10, 17B20
ISBN 0-8218-2434-1, LC 87-19695
ISSN 0065-9266
64 pages (softcover), September 1987
Individual member $7, List price $11, Institutional member $9
To order, please specify MEMO/371N

CLASSIFICATION OF RING AND C*-ALGEBRA DIRECT LIMITS OF FINITE-DIMENSIONAL SEMISIMPLE REAL ALGEBRAS

K. R. Goodearl and D. E. Handelman
(Memoirs of the AMS, Number 372)

Aimed at researchers and graduate students interested in operator algebras, ordered K-theory, ordered abelian groups, or ring theory, this memoir requires only a first-year graduate algebra course as background, yet gives the reader a familiarity with a frontier of research in operator algebras. The authors focus on two kinds of direct limit algebras: (1) direct limits of countable sequences of finite-dimensional semisimple real algebras, and (2) approximately finite-dimensional real C^*-algebras. Using an invariant triple, the authors classified the unital algebras in (1) up to Morita equivalence, and all algebras in (2) up to stable isomorphism, show how the classification easily distinguishes various types of algebras within the given classes. A complete description of the triples arising in this classification is obtained for certain cases, including the case of algebras constructed using only real and quaternion matrix algebras, or using only complex matrix algebras (connected by real algebra homomorphisms).

Contents

1980 *Mathematics Subject Classifications*: 46L80, 19K14, 16A30; 06F20, 16A48, 16A54, 46L35, 46L40
ISBN 0-8218-2435-X, LC 87-17448
ISSN 0065-9266
160 pages (softcover), September 1987
Individual member $11, List price $19, Institutional member $15
To order, please specify MEMO/372N

GEOMETRIC AND ARITHMETIC METHODS IN THE SPECTRAL THEORY OF MULTIDIMENSIONAL PERIODIC OPERATORS

M. M. Skriganov
(Proceedings of the Steklov Institute, Volume 171)

The main goal of this work is to explore the unexpected connections between spectral theory and the geometry and arithmetic of spatial lattices. While the author examines the band structure of the spectrum for multidimensional periodic operators in general, the multidimensional Schrödinger operator with periodic potential is examined in particular, since an investigation of its band structure constitutes a mathematical foundation for solid state quantum theory. The book is intended for experts in spectral theory and the mathematical aspects of quantum mechanics, as well as those interested in applications of geometry and number theory.

Contents

1980 *Mathematics Subject Classifications*: 11H06, 35J10, 35P05, 35P20; 31B30, 47A55, 58G25, 81C99
ISBN 0-8218-3104-6, LC 87-19332
ISSN 0081-5438
125 pages (softcover), October 1987
Individual member $32, List price $53, Institutional member $42
To order, please specify STEKLO/171N

SOCIÉTÉ MATHÉMATIQUE DE FRANCE, ASTÉRISQUE

The AMS distributes Astérisque only in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF, B.P. 126-05, 75226 Paris Cedex 05, France, or to OFFILIB, 48 rue Gay-Lussac, 75240 Paris Cedex 05, France. Individual members of either AMS or SMF are entitled to the member price. (ISSN 0303-1179)

HOMOLOGIE CYCLIQUE ET K-THÉORIE

M. Karoubi

(Astérisque, Number 149)

La K-théorie peut être décrite comme la topologie algébrique des anneaux éventuellement non commutatifs et est due à de nombreux auteurs: Grothendieck, Atiyah, Hirzebruch, Quillen,...

L'homologie cyclique est l'analogue en "géométrie différentielle non commutative" (suivant la terminologie d'Alain Connes) de la cohomologie de De Rham des variétés X en considérant l'anneau A des fonctions C^∞ sur X.

Cette homologie cyclique a été introduite essentiellement par A. Connes, par Feigin et Tsygan sous le nom de "K-théorie additive" (en relation avec l'homologie des algèbres de Lie), par l'auteur sous le nom d'homologie de De Rham non commutative (en considérant un complexe de De Rham non commutatif).

L'objet de ce livre est d'établir quelques relations fondamentales entre la K-théorie et les diverses versions de l'homologie cyclique. En particulier, nous généralisons la théorie de Chern-Weil classique à ce cadre.

148 pages (softcover), 1987
Individual member $12, List price $17
To order, please specify AST/149N

SINGULARITÉS D'ÉQUATIONS DIFFÉRENTIELLES, DIJON, 20–25 MAI 1985

(Astérisque, Number 150–151)

On trouvera dans ce volume les textes de certains exposés présentés aux journées "Equations différentielles singulières" des 20–25 mai à Dijon. La plupart portent sur les singularités des difféomorphismes et des champs de vecteurs dans les domaines réels ou complexes.

188 pages (softcover), 1987
Individual member $15, List price $21
To order, please specify AST/150/151N

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Fairfield, Iowa

Personal Items

David E. Betounes of the University of Southern Mississippi has been promoted to Professor of Mathematics at that institution.

Per Enflo, Professor at the Royal Institute of Technology in Stockholm, has been appointed Professor at Kent State University, beginning in January 1988.

Igor B. Frenkel of Yale University, has been promoted to Professor of Mathematics at that institution.

Frederick W. Gehring of the University of Michigan was named a T. H. Hildebrandt Distinguished University Professor by the Board of Regents of that University, on May 22, 1987.

Michael Lacey of the University of Illinois has been appointed Assistant Professor at Louisiana State University.

William I. Layton of Newberry College, Newberry, South Carolina, was honored for his first 50 years of dedication to the teaching profession during commencement exercises on May 10, 1987.

Clyde F. Martin of Texas Tech University has been appointed Chairman of the Department of Mathematics at that institution.

Brian B. Murphy of Gabriel, Roeder, Smith and Company, formerly of Wayne State University, has been named a Fellow of the Society of Actuaries.

Kenji Nagasaka of Shinshu University, Nagano University, Nagano, Japan has been appointed Associate Professor at the University of the Air, Chiba, Japan.

Peter Ohring of the University of Colorado, has been appointed Assistant Professor at Louisiana State University.

K. Brooks Reid of Louisiana State University has been appointed Chairman of the Department of Mathematics at that institution effective January 1987.

Walter Schnyder of Purdue University, has been appointed Assistant Professor at Louisiana State University.

Jayaram Sethuraman has been appointed Chairman of the Department of Statistics at Florida State University starting in the fall of 1987.

Jonathan Shapiro of Cypress, California, received the California Institute of Technology's E.T. Bell Undergraduate Mathematics Research Prize for a paper entitled, "Some Analytic and Algebraic Aspects of the Quaternions."

Marshall Slemrod of Rensselaer Polytechnic Institute has been appointed professor of mathematics at the University of Wisconsin.

Lawrence Smolinsky, Gibbs Instructor at Yale University, has been appointed Assistant Professor at Louisiana State University.

Deaths

Richard V. Andree Professor Emeritus of the University of Oklahoma, died on May 8, 1987, at the age of 67. He was a member of the Society for 43 years.

Maurice A. Biot of Brussels, Belgium, died on September 12, 1985, at the age of 80. He was a member of the Society for 44 years.

John D. Elder, Professor Emeritus of Saint Louis University, St. Louis, Missouri, died March 11, 1987, at the age of 88. He was a member of the Society for 58 years.

Frances Harshbarger, Professor Emerita of Kent State University, died February 11, 1987, at the age of 84. She was a member of the Society for 56 years.

Reciprocity Agreement

(Supplementary Listing)

The following is an update of the information on the Secció de Matemàtiques of the Societat Catalana de Ciències Fìsiques, Quìmiques i Matemàtiques that appeared on page 840 of the August 1987 issue of *Notices*. See **News and Announcements** in this issue for additional information.

Societat Catalana de Matemàtiques

Apply to: Secretari de la Societat Catalana de Matemàtiques. Carrer del Carme 47, 08001 Barcelona, Spain.

Dues: 1000 pessetes for members of the AMS, payable to the Societat Catalana de matemàtiques.

Privileges: *Butlettí de la Societat Catalana de Matemàtiques*, (2 numbers a year).

Officers: J. Girbau (President), Carles Perelló (Secretary), Rubi Corberó (Associated Secretary).

Visiting Mathematicians (*Supplementary List*)

The list of visiting mathematicians includes both foreign mathematicians visiting in the United States and Canada, and Americans visiting abroad. Note that there are two separate lists.

American Mathematicians Visiting Abroad

Name and Home Country	Host Institution	Field of Special Interest	Period of Visit
Kushner, Harold (U.S.A.)	Kyoto Insitute of Technology, Japan	Dynamical Systems	9/87 - 10/87
Luke, Trevor M. (Canada)	University College, United Kingdom	Low Energy Atomic Physics	9/87 - 4/88
MacDougall, James (Canada)	University of Newcastle, Australia	Combinatories, Linear Algebra	7/87 - 6/88
McKeon, D.C.G. (Canada)	Cambridge University, England	Quantum Field Theory	1/88 - 6/88
Su, Chau-Hsing (U.S.A.)	University of Grenoble I, France	Mechanics	9/87 - 8/88

Visiting Foreign Mathematicians

Barles, Guy (France)	Brown University	Dynamical Systems	1/88 - 6/88
Benedicks, Michael (Sweden)	Yale University	Analysis	9/87 - 5/88
Beran, Jan (Switzerland)	University of North Carolina at Chapel Hill	Statistics	7/87 - 6/88
Chaber, Joseph (Poland)	Texas Tech University	Topology	9/87 - 5/88
Chen, Yunlong (People's Republic of China)	Brown University	Dynamical Systems	9/87 - 8/88
Comets, Francis (France)	Brown University	Distributed Parameter Systems	2/88 - 7/88
Daley, Daryl (Australia)	University of North Carolina at Chapel Hill	Statistics	7/87 - 12/87
Damek, Ewa (Poland)	University of Georgia	Harmonic Analysis	9/87 - 6/88
Deng, Bo (China)	Brown University	Dynamical Systems	8/87 - 6/88
Fang, Kai-Tai (People's Republic of China)	University of North Carolina at Chapel Hill	Statistics	1/88 - 6/88
Gangopadhyay, Ashis (India)	University of North Carolina at Chapel Hill	Statistics	7/87 - 6/88
Ghosh, Sucharita (India)	University of North Carolina at Chapel Hill	Statistics	7/87 - 6/88
Haines, Linda (Republic of South Africa)	University of North Carolina Chapel Hill	Statistics	7/87 - 12/87
Hernandez-Lurma, Onesimo (Mexico)	Texas Tech University	Stochastic Control	9/87 - 5/88
Ishii, Hitoshi (Japan)	Brown University	Dynamical Systems	8/87 - 6/88
Kraft, Hanspeter (Switzerland)	University of Hawaii	Transformation Groups, Algebraic Geometry	2/88 - 3/88
Kulkarni, Pandurang N. (India)	University of Georgia	Time Series and Generalized Linear Models	9/87 - 6/88
Li, Dening (China)	University of Colorado	Hyperbolic PDE, Pseudo-differential Operators	8/87 - 5/88
Light, William A. (United Kingdom)	University of Texas, Austin	Numerical Analysis	9/87 - 1/88
Miekisz, Jacek (Poland)	University of Texas, Austin	Mathematical Physics	9/87 - 5/88
Naito, Toshiki (Japan)	Brown University	Dynamical Systems	9/87 - 7/88
Park, Byeong (Korea)	University of North Carolina at Chapel Hill	Statistics	7/87 - 6/88
Park, Hung (Korea)	Brown University	Fluid Mechanics	6/87 - 5/88
Peng, Shi Ge (China)	Brown University	Perturbation Methods in Stochastic Control	9/87 - 11/87
Presutti, Errico (Italy)	University of Colorado	Interacting Particle Systems, Infinite-dimensional Dynamical Systems	1/88 - 5/88
Ruymgaart, Frits (The Netherlands)	University of North Carolina at Chapel Hill	Statistics	7/87 - 12/87
Sanchez-Palencia, Evariste (France)	Brown University	Mechanics and Applied Mathematics	9/87 - 10/87

Name and Home Country	Host Institution	Field of Special Interest	Period of Visit
Sankaran, N. (India)	University of Hawaii	Commutative Algebra	8/87 - 7/88
Schofield, Aidan H. (England)	Yale University	Algebra	9/87 - 5/88
Schoombie, Schalk (South Africa)	Brown University	Numerical Analysis/Scientific Computation	10/87 - 01/88
Sersouri, Abderrazzak (Morocco)	University of Texas, Austin	Banach Spaces	1/88 - 5/88
Shen, Y. H. (China)	SUNY at Buffalo	Analysis	9/87 - 8/88
Singh, Umed (India)	Central Michigan University	Applied Statistics	9/87 - 6/88
Sonn, Jack (Israel)	Yale University	Algebra	9/87 - 5/87
Sternfeld, Jacob (Israel)	University of Texas, Austin	Banach Spaces	9/87 - 1/88
Sun, JinShan (China)	Brown University	Mechanics	7/87 - 8/88
Swarup, Gadde Ananada (India)	University of Texas, Austin	Low dimensional Topology, Cohomological Group Theory	9/87 - 1/88
Tal-Ezar, Hillel (Israel)	Brown University	Numerical Analysis/Scientific Computation	8/87 - 2/88
Todorcevic, Stevo (Yugoslavia)	University of Colorado	Set Theory	8/87 - 12/87
Trotman, David (France)	University of Hawaii	Topology	8/87 - 1/88
Wen, Lan (China)	University of Texas, Austin	Hyperbolic Attractors	9/87 - 1/88

Application Deadlines for Grants and Assistantships

Many fellowship programs have deadlines for receipt of applications. These deadlines are noted in news items and in the Stipends Section of the December *Notices*. They are listed below for your convenience, and as a reminder since many of these deadlines occur before the publication date of the special December issue on *Assistantships and Fellowships*. Dates taken from the 1986 special issue have been updated with information received in preparation for the December 1987 issue. For information about the various programs the reader is referred to the appropriate part of the Stipends Section of the December 1986 *Notices* as follows: [GS] = Graduate Support Section; [PS] = Postdoctoral Support Section; [TSA] = Travel and Study Abroad Section; [SFN] = Study in the U.S. for Foreign Nationals.

* Information from the December 1986 issue not yet confirmed this year.

• Refers to a news item in this issue of *Notices*.

October 1

American Philosophical Society [PS]
John Simon Guggenheim Memorial Foundation Fellowships [PS]

October 15

Bunting Institute of Radcliffe College (Science Scholar Fellowships) [PS]

October 21

Kennedy Scholarships [SFN]

November 1

American-Scandinavian Foundation [TSA]
Fannie and John Hertz Foundation Fellowships [GS]

November 7

North Atlantic Treaty Organization (Postdoctoral Fellowships) [TSA]

November 13

NSF Graduate Fellowships [GS]
NSF Minority Graduate Fellowships [GS]
National Research Foundation (Ford Foundation Predoctoral and Dissertation Fellowships for Minorities) [GS]

November 14

Royal Norwegian Council for Scientific and Industrial Research (Postdoctorate Fellowships) [TSA]

November 15

Kosciuszko Foundation [SFN]
Los Alamos National Laboratory (J. Robert Oppenheimer Research Fellowship) [PS]
* NSF Mathematical Sciences Postdoctoral Research Fellowships [PS]

November 30

North Atlantic Treaty Organization [TSA]

December 1

AMS Research Fellowships [PS]
American Philosophical Society [PS]
Lady Davis Fellowship Trust [TSA]
Lady Davis Visiting Professorships [TSA]
Sigma Delta Epsilon, Graduate Women in Science (Eloise Gerry Fellowship) [GS]

December 15

IBM Thomas J. Watson Research Center (Postdoctoral and Junior Faculty Fellowships for Research in Mathematical Sciences) [PS]
Mathematical Sciences Research Institute [PS]

December 31

Institute for Advanced Study Memberships [PS]
Massachusetts Institute of Technology (C.L.E. Moore Instructorships in Mathematics) [PS]
University of Wisconsin, Madison (Van Vleck Assistant Professorship in Mathematics) [PS]

January 1

R. H. Bing Faculty Fellowship [PS]
* Brown University (Jacob David Tamarkin Assistant Professorships) [PS]
California Institute of Technology (Harry Bateman Research Instructorships) [PS]
Courant Institute (Instructorships in Mathematics) [PS]
Courant Institute (Postdoctoral Visiting Memberships) [PS]
Harvard University (Benjamin Peirce Lectureships) [PS]
Indiana University, Bloomington (Václav Hlavatý Research Assistant Professorships) [PS]
* University of California, Los Angeles (Earle Raymond Hedrick Assistant Professorships in Mathematics) [PS]
University of Chicago (Leonard Eugene Dickson Instructorships in Mathematics) [PS]
University of Chicago (Leonard Eugene Dickson Instructorships in Mathematics) [PS]
Weizmann Institute of Sciences (Feinberg Graduate School Postdoctoral Fellowships [TSA]
Weizmann Institute of Sciences (Openings for Scientists) [TSA]

January 6

University of Michigan, Ann Arbor (T. H. Hildebrandt Research Assistant Professorships) [PS]

January 15

* AAAS Science, Engineering and Diplomacy Fellowships [PS]
* Dartmouth College (John Wesley Young Research Instructorships) [PS]

Institute for Mathematics and its Applications [PS]

Kosciuszko Foundation [GS]

Kosciuszko Foundation (Graduate and Postgraduate Exchange with Poland) [TSA]

National Center for Atmospheric Research (Advanced Study Program) [PS]

National Research Council (Research Associateship Programs) [PS]

Rice University (Griffith Conrad Evans Instructorships) [PS]

Rutgers University (Hill Assistant Professorships) [PS]

University of Pittsburgh (Andrew Mellon Postdoctoral Fellowships) [PS]

January 16

Fulbright Program (Collaborative Research Grants) [TSA]

January 17

National Research Council (Postdoctoral Fellowships for Minorities) [PS]

January 19

* Committee on Institutional Cooperation (Minorities Fellowships in the Sciences, Mathematics and Engineering) [GS]

January 30

Centro de Investigacion del IPN (Solomon Lefschetz Research Instructorships) [TSA]

January 31

* Yale University (Josiah Willard Gibbs Instructorships) [PS]

February 1

AAAS Summer Fellowship [GS]

American Philosophical Society [PS]

American Society for Engineering Education (NASA-ASEE Summer Faculty Fellowships) [PS]

American Society for Engineering Education (Navy- and DOE-ASEE Summer Faculty Research Programs) [PS]

American Society for Engineering Education (ONR Graduate Fellowship Program [GS]

Sigma Delta Epsilon, Graduate Women in Science (Grants-in-Aid) [GS]

* University of Cincinnati (Charles Phelps Taft Postdoctoral Fellowships) [PS]

February 11

* California State Graduate Fellowships [GS]

March 1

American Philosophical Society [PS]

March 31

* Hubert H. Humphrey Doctoral Fellowships [GS]

North Atlantic Treaty Organization [TSA]

April 1

American Philosophical Society [PS]

May 15

Weizmann Institute of Sciences (Feinberg Graduate School Postdoctoral Fellowships [TSA]

Weizmann Institute of Sciences (Openings for Scientists) [TSA]

June 15

Indo-American Fellowship Program [TSA]

August 1

American Philosophical Society [PS]

August 15

North Atlantic Treaty Organization [TSA]

Recent Appointments

Committee members' terms of office on standing committees expire on December 31 of the year given in parentheses following their names, unless otherwise specified.

Richard A. Askey, Bruno Harris, Uta Merzbach, and Peter L. Duren have been appointed to a standing committee of the Council, the *Committee on the History of Mathematics* by President G. D. Mostow. Professor Duren will serve as chairman.

A *Poster Committee*, a subcommittee of the *Centennial Committee*, has been appointed by President G. D. Mostow. Members of the committee are Thomas F. Banchoff, chairman, F. Alberto Grunbaum, and Nelson Lee Max.

President G. D. Mostow has appointed John W. Addison, Jr., Yousef Alavi, William G. Chinn, Ronald R. Coifman, Ronald L. Graham, Peter J. Hilton, Don R. Lick, Jean Pedersen, and C. Taubes to the *Centennial Public Information Committee*, a subcommittee of the *Centennial Committee*. Professor Alavi will serve as chairman.

Frederick J. Almgren, Jr. (1989), John W. Morgan (1989), and Peter Clive Sarnak (1989) have been appointed to the *Committee on Research Fellowships* by President G. D. Mostow. Philip C. Kutzko (1988) has been appointed chairman. Continuing members of the committee are George Lisztig (1988), M. Beth Ruskai (1988), and Nancy K. Stanton (1988). Terms expire on June 30.

Seymour V. Parter (1989) has been appointed to the *Committee on Science Policy* by President G. D. Mostow. Continuing members of the committee are Hyman Bass (1987), Felix E. Browder (1987), Carl-Wilhelm R. de Boor (1988), Ronald G. Douglas (1989), chairman, Frederick W. Gehring (1987), James G. Glimm (1989), Ronald L. Lipsman (1989), James W. Maxwell (ex officio), G. D. Mostow (ex officio), Robert Osserman (1988), Judith D. Sally (1988), David A. Sanchez (1989), William P. Thurston (1989), and Guido L. Weiss (1988).

Henry P. McKean, Jr. (1990), and Michael E. Taylor (1990) have been appointed by President G. D. Mostow to the *Committee to Select the Winner of the Steele Prize*. William S. Massey (1989) has been appointed chairman. Continuing members of the committee are Frederick J. Almgren, Jr. (1989), Hermann Flaschka (1988), John P. Hempel (1988), Frank A. Raymond (1989), Louis Solomon (1989), and Richard P. Stanley (1989). Terms expire on June 30.

President G. D. Mostow has appointed Thomas C. Spencer (1990), and Scott A. Wolpert (1990) to the *Committee on Summer Institutes and Special Symposia*. Linda Preiss Rothschild (1989) has been appointed chairman. Continuing members of the committee are Eric M. Friedlander (1988), Robert B. Warfield, Jr. (1989), and John Wermer (1988). Terms expire on February 28.

Joseph N. Bernstein (1990) and Anatole Katok (1990) have been appointed to the AMS-ASL-IMS-SIAM *Committee on Translations from Russian and Other Slavic Languages* by President G. D. Mostow. The chairman of the committee is Boris M. Schein (1987). The AMS subcommittee members are Michael I. Brin (1987), Charles V. Coffman (1988), Courtney S. Coleman (1989), Allen Devinatz (1988), Igor Dolgachev (1987), Richard Ericson (1987), Vladislav V. Goldberg (1988), John R. Isbell (1988), Dmitry Khavinson (1987), L. G. Makar-Lianov (1989), Paul G. Nevai (1989) and Boris M. Schein (1987), chairman. The ASL subcommittee members are Vladimir Lifschitz (1987), Elliott Mendelson, chairman, Gregory Minc (1987), and B. F. Wells. The IMS subcommittee members are Eugene Dynkin, chairman, B. Pittel, A. Rukhin, and W. J. Studden.

President G. D. Mostow has appointed John W. Morgan (AMS) to the AMS-IMS-SIAM *Ad Hoc Executive Committee of the Evaluation Panel for NSF Postdoctoral Fellowships in the Mathematical Sciences*. The other members of the committee are Dianne O'Leary (SIAM), chairman, and George C. Tiao (IMS).

Reports of Past Meetings

The April Meeting in Newark

The eight hundred thirty-fourth meeting of the American Mathematical Society was held at the New Jersey Institute of Technology in Newark, New Jersey, on Saturday and Sunday, April 25 and 26, 1987. There were 195 registrants, including 170 members of the Society.

Welcoming Remarks. Participants were welcomed to the meeting by Dr. Saul Fenster, President of the New Jersey Institute of Technology.

Invited Addresses. By invitation of the Committee to Select Hour Speakers for Eastern Sectional Meetings, there were four invited addresses. The speakers, their affiliations, and the titles of their talks are as follows:

ROBERT V. KOHN, New York University, Courant Institute of Mathematical Sciences, *Determining conductivity by boundary measurements*;

RODOLFO R. ROSALES, Massachusetts Institute of Technology, *Weakly nonlinear geometrical optics for hyperbolic systems of conservation laws and reacting gas flows*;

BIRGIT SPEH, Cornell University, *Representation theory and the cohomology of locally symmetric spaces*; and

LARS B. WAHLBIN, Cornell University, *Local behavior in finite element methods: An overview.*

The speakers were introduced by Daljit Ahluwalia, Robert V. Kohn, David Vogan, and Richard Falk, respectively.

Special Sessions. By invitation of the same committee, there were nine special sessions of selected twenty-minute papers. The topics of these sessions, and the names and affiliations of the mathematicians arranging them, are as follows:

Inverse problems, DALJIT SINGH AHLUWALIA, New Jersey Institute of Technology, and ROBERT V. KOHN.

Nonlinear dynamics and chaos, DENIS BLACKMORE, New Jersey Institute of Technology;

Cellular automata and symbolic dynamics, ROBERT J. GILMAN, Stevens Institute of Technology;

Computational mathematics and applications, ROMAN ANDRUSHKIW and ROY PLASTOCK, New Jersey Institute of Technology;

Nonlinear functional analysis, PETRONIJE MILOJEVIĆ, New Jersey Institute of Technology;

Differential geometry, VLADISLAV V. GOLDBERG, New Jersey Institute of Technology;

Harmonic analysis on reductive p-adic Lie groups, C. DAVID KEYS, Rutgers University of Newark;

Unitary representations, cohomology and G/Γ, ANTHONY W. KNAPP, SUNY at Stony Brook and Cornell University;

Group actions on manifolds, JOHN D. RANDALL and MARK STEINBERGER, Rutgers University at Newark.

Contributed Papers. There were also four sessions for contributed ten-minute papers. The topics of these, and the names of the mathematicians who chaired, are as follows:

Algebra, LESLIE COHN and IAN D. MACDONALD;

Analysis, THOMAS BENGSTON and T. K. PUTTASWAMY;

Applied Mathematics and Physics, EDWARD DOUGHERTY and J. S. RNO; and

Topology, CHRIS BERNHARDT and FRANCIS D. LONERGAN.

AWM Lecture. By invitation of the New Jersey Chapter of the Association for Women in Mathematics, Ann Hibner Koblitz of Wellesley College delivered a lecture titled *Sofia Kovalevskaia and gender perceptions: Was she a monstrosity or the princess of mathematics?*

Committee. The undersigned Associate Secretary is pleased to thank the Local Arrangements Committee for extensive, effective service. The members of the Committee were Roman Andrushkiw, Denis Blackmore (chairman), and John Tavanzis.

W. Wistar Comfort
Middletown, Connecticut — Associate Secretary

The Council Meeting in Salt Lake City

The Council met at 5:00 PM on 4 August 1987 in the Mill Creek and Cottonwood Rooms of the Marriott Hotel in Salt Lake City. President G. D. Mostow was in the chair.

The Council nominated candidates for various offices in the election of 1987 as follows.

Vice President	Herbert S. Wilf
Member-at-large	Gunnar Erik Carlsson
	Richard K. Guy
	Rhonda J. Hughes
	Robion C. Kirby
	Peter B. Shalen
Committee to Monitor Problems in Communication	Richard G. Larson

These names should be added to those already reported in the June issue of the *Notices*, pp. 663 and 700.

The Council and the Board of Trustees have agreed on several new publishing ventures. First is what is provisionally called the University Lecture Series. There are colleges and universities that have funded series of distinguished lectures. These are the named series in which a mathematician distinguished in research and exposition gives a set of several lectures. It is proposed to provide a vehicle for the publication of such lectures under Society imprint. The source institution along with the lecturer would be publicized. An institution that sponsors such a set of lectures should know that the offering of a manuscript would be welcome. Financial arrangements are open to discussion.

The Society has agreed to start a soft cover series of reprints of selected good books that commercial publishers, compelled by changes in tax laws, are allowing to go out of print.

The Society proposes to encourage the publication of material on the history of mathematics.

The Society has approved in principle the establishment of a journal for the publication of translations of the Japanese journal *SUGAKU*.

Each of these publication projects will be handled through an editorial committee to referee or monitor the work.

The Council has endorsed the principle that applications of mathematics should regularly be the subject of invited addresses and AMS-sponsored conferences. The Council has further endorsed the principle that the AMS should regularly cosponsor sessions on topics involving applications of mathematics within regular meetings of other societies. Thus the program on Some Mathematical Questions in Biology, which has been held regularly at AAAS meetings, will now be rotated among some societies in quantitative biology that have expressed interest. There are several proposals for cosponsorship of conferences that are under consideration through the Committee on Summer Institutes and Special Symposia.

The Council recommends two unrelated amendments to the bylaws. The first repairs an omission in the recent reinstitution of life membership by taking appropriate account of members by reciprocity. The second provides for indemnification of officials of the Society to protect them from financial loss from suits related to the performance of their duties. Each of these amendments is to be presented to the membership for approval along with the ballot for the 1987 election.

The Council considered an amendment to allow members to request not to receive the *Bulletin* and to receive a reduction in dues to correspond. The Trustees observed that the marginal cost of the *Bulletin* (principally paper, printing, wrapping, postage) comes to $2.13 and suggested $5.00 as the appropriate reduction. The Council considered the small size of this reduction and the obligation of a mathematical research society to provide some mathematics to every member and did not recommend the proposed amendment.

The Council took specific steps to carry out the referendum in January 1988 mandated by the Council of 25 April 1987. See the June *Notices*, pp. 699–700 and particularly p. 615, items 2 and 3.

The referendum is to cover five resolutions as follows.

Motion 1′. Many scientists consider SDI (commonly referred to as Star Wars) incapable of achieving its stated goals and dangerously destabilizing. Participation by universities and professional organizations lends a spurious scientific legitimacy to it. Therefore the AMS will lend no support to the Star Wars program. In particular, persons representing the AMS shall make no efforts to obtain funding for Star Wars research or to mediate between agencies granting Star Wars funds and people seeking these funds.

Motion 2′. The AMS is concerned about the large proportion of military funding of mathematics research. There is a tendency to distribute this support through narrowly focused (mission oriented) programs and to circumvent peer review procedures. This situation may skew and ultimately injure mathematics in the United States. Therefore those representing the AMS are requested to direct their efforts towards increasing the fraction of non-military funding for mathematics research, as well as towards increasing total research support.

Motion 3′. Most seminal research in mathematics comes from individuals and small informal collaborations, not from large teams. The seriously low level of Federal funding for individual investigators documented in the 1984 David Report has recovered only slightly, and many of our best mathematicians are currently unable to find funding for research. Therefore, we urge that the Federal funding agencies not allow the recent trend toward large teams and big projects to compromise the strength through diversity of mathematics. We urge that in their continued attempts to bring mathematics funding into balance with that for related fields these agencies make every effort to increase the numbers of individual investigators to the levels recommended in the David Report.

Motion 4′. Many advances in science and technology come from fundamental mathematics which has been developed without applications in mind. In recognition, we urge agencies which fund research in mathematics to also fund a balanced proportion of basic research.

Motion 5′. We urge funding agencies in the mathematical sciences to solicit proposals openly and broadly and to assure that reviews of scientific merit are conducted by a diversified group of expert scientists.

There are to be three choices on each motion, to approve, not to approve, or to abstain. The outcome is governed by plurality of votes cast. The presentation of the referendum is to contain explanatory material and references but no enclosures. The *Notices* through January 1988 are open to comment on the motions.

The Council recommended to the Business Meeting of 7 August 1987 that Motions 1 and 2 (see the August *Notices*, p. 784), on the agenda of that meeting, be tabled in deference to the referendum.

The Council had recessed for dinner from 6:30 PM to 8:30 PM and adjourned at 11:20 PM.

The Business Meeting in Salt Lake City

The Business Meeting took place on 7 August 1987 in the Fine Arts Auditorium of the Utah Museum of Fine Arts Building on the campus of the University of Utah. It immediately followed the award of the Steele Prizes and began at 4:15 PM. President G. D. Mostow was in the chair.

The Secretary reported on actions of the Council of 25 April 1987 and 4 August 1987 of

interest to the membership as detailed in the June issue of these *Notices*, pp. 699–700, and in the report above.

The meeting considered Motions 1 and 2, stated on p. 784 of the August issue of these *Notices*, and followed the recommendation of the Council to table them in deference to the referendum.

The report of the Secretary had included the statement of the motions in the referendum and the meeting held an extended discussion of the meaning and import of the motions.

The Business Meeting passed by acclamation a resolution of thanks by Professor Robert Fossum to the Committee on Arrangements.

The meeting adjourned at 5:45 PM.

Everett Pitcher
Bethlehem, Pennsylvania Secretary

Classified Advertisements

SUGGESTED USES for classified advertising are books or lecture notes for sale, books being sought, positions available, exchange or rental of houses, and typing services.

THE RATE IS $.75 per word with a minimum of $37.50. The same ad in 7 consecutive issues is $4.00 per word. Type will be set solid unless centering and spacing are requested. A centered line of any length or the equivalent in white space is $7.00. A word is defined as a group of characters with space at each end. Prepayment is required of individuals but not of institutions. For an additional $10.00 charge, announcements can be placed anonymously. Correspondence will be forwarded.

DEADLINES are listed on the inside front cover.

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 following the Classified Advertisements in the January and August issues of the *Notices*.

SITUATIONS WANTED ADVERTISEMENTS from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-556-7774 and speak to Wahlene Siconio for further information.

SEND AD AND CHECK TO: Advertising Department, AMS, P. O. Box 6248, Providence, Rhode Island 02940. Individuals are requested to pay in advance, institutions are not required to do so.

POSITIONS AVAILABLE

OREGON STATE UNIVERSITY
Numerical Analysis with Applications

Assistant Professor position in numerical analysis with applications may become available September 1988. Salary depends on qualifications. Closing date January 4, 1988. Write to:

Professor Robert Higdon
Staff Selection Committee
Department of Mathematics
Oregon State University
Corvallis, OR 97331

Oregon State University is an Affirmative Action/Equal Opportunity Employer and complies with Section 504 of the Rehabilitation Act of 1973.

OREGON STATE UNIVERSITY

Assistant Professor position in Algebra, Analysis, Geometry, Probability, or Topology may become available September 1988. Salary depends on qualifications. Closing date January 4, 1988. Write to:

Professor Bent Petersen
Staff Selection Committee
Department of Mathematics
Oregon State University
Corvallis, OR 97331

Oregon State University is an Affirmative Action/Equal Opportunity Employer and complies with Section 504 of the Rehabilitation Act of 1973.

CENTRE COLLEGE
MATHEMATICS POSITION

Applications are invited for a tenure-track position at the rank of assistant or associate professor beginning September 1988. Ph.D. in mathematics required. The position requires the teaching of a wide range of undergraduate courses and a strong commitment to liberal arts education. Ability to teach mathematical statistics or computer programming is desirable. Salary commensurate with experience. Excellent fringe benefit program including home mortgage plan and tuition scholarship program for dependent children. Applications, résumés, transcripts, and three letters of reference to Leonard DiLillo, Dean, Centre College, Danville, Kentucky 40422. E.O.E.

University of Missouri-Rolla
Chair – Department of Mathematics and Statistics

The Department invites applications for the position of Department Chair, to begin September 1, 1988. The Rolla campus is one of four within the University of Missouri system, has an enrollment of about 5500, and emphasizes engineering and science. The Department has 22 faculty and offers bachelor, master, and doctoral programs in mathematics and statistics. Candidates should have a strong research record and a commitment to excellent teaching. The review of applications will begin October 1, 1987, and will continue until the position is filled. A vita and at least three references should be sent to Professor Glen Haddock, Department of Mathematics and Statistics, University of Missouri-Rolla, Rolla, MO 65401. Applications by minorities are encouraged. AA/EOE.

TENNESSEE STATE UNIVERSITY
Department of Physics, Mathematics, and Computer Science

Full-time tenure track positions in Mathematics beginning August 17, 1987 in the areas of Topology and/or Analysis. Applicants must have a Ph.D. (or near) in Mathematics, teaching experience, a strong interest in research and a desire to help build a strong graduate program. Applicants should send vita, three letters of recommendation and transcripts to Dr. Raymond Richardson, Head. Applications accepted until positions are filled. Inquiries should be directed to: Dr. Raymond Richardson, Head-Department of Physics, Mathematics and Computer Science, Tennessee State University, 3500 John A. Merritt Boulevard, Nashville, Tennessee 37203. An equal opportunity/affirmative action employer.

Boston University
Department of Mathematics

Position for Professor of Applied Mathematics for Fall 1988. Record of distinguished achievements in research and commitment to excellence in teaching required. Preference to candidates in partial differential equations and/or mathematical physics with distinguished contribution to pure mathematics. Women and minorities are encouraged to apply. Send nominations and applications by November 1, 1987 to Search Committee, Department of Mathematics, 111 Cummington St., Boston, MA 02215. The University is an EO/AA employer.

POSITIONS AVAILABLE

CLAREMONT McKENNA COLLEGE
Endowed Position in Computer Science and Applied Mathematics

Applications are invited for an endowed tenure-track position in Computer Science and Applied Mathematics with rank and salary dependent on qualifications. Starting date fall 1988.

Claremont McKenna College is a liberal arts college with 800 students. It is a member of the Claremont Colleges (along with Pomona, Scripps, Harvey Mudd, and Pitzer Colleges and Claremont Graduate School). The Claremont Colleges have a total of forty-three mathematicians and computer scientists, and are located in Claremont, Southern California.

Qualifications for the positions include a Ph.D. in a computer-related field such as Computer Science, Mathematics, Operations Research, or Information Science. If the degree is in a field other than Computer Science, substantial formal education in Computer Science is required.

Applicants should have a strong commitment to undergraduate teaching, an established scholarly record, and practical experience with computer applications. The appointee will be expected to teach some applied mathematics courses in addition to computer science courses and to participate in course and program development.

The College is an equal opportunity/affirmative action employer. Applications will be reviewed as soon as received and a decision reached preferably by January 1988. Please send resume and the names of four references to Professor John Ferling, Chairman, Computer Science Search Committee, c/o Dean of Faculty's Office, Claremont McKenna College, Claremont, CA 91711.

Institute for Computer Applications in Science and Engineering (ICASE). A limited number of visiting appointments are available for both junior- and senior-level researchers at the Institute for Computer Applications in Science and Engineering (ICASE) which is operated by the Universities Space Research Association. ICASE serves as a center for interaction between Langley Research Center staff and the academic community in the areas of applied and numerical mathematics, applied computer science, and development of mathematical models in a variety of application areas. Applications for partial support while on sabbatical leave are encouraged as are applications from Ph.D.'s for two-year renewable appointments. Inquiries should be addressed to the Director, ICASE, Mailstop 132C, NASA Langley Research Center, Hampton, Virginia 23665. An Equal Opportunity Employer.

MILLS COLLEGE
Department of Mathematics and Computer Science
Oakland, California 94613

Mills College is seeking outstanding candidates for a tenure-track position as Assistant, Associate or Full Professor of Mathematics commencing Fall 1988. Candidates must submit evidence of superior teaching and research abilities, and demonstrate a commitment to become involved in a highly innovative and energetic department. Rank and salary will depend on experience and qualifications. The initial contract will be for three years, subject to final administrative approval. Mills College is an Affirmative Action/Equal Opportunity Employer.

Send vita and direct three letters of reference to:

Professor Richard Bassein
Chair of the Mathematics Search Committee
Mills College
Oakland, CA 94613

Deadline for application: January 15, 1988

Department of Mathematics and Statistics
McGill University

The Department of Mathematics and Statistics at McGill University is seeking to fill two tenure-track Assistant Professorships in September 1988. A further two appointments may be available for September 1988 or September 1989, but the latter two are still subject to budgetary approval. Candidates should have a Ph.D. and a solid record of achievement in research.

There are three priority areas: algebraic or differential geometry; numerical analysis (preferably associated with partial differential equations); and mathematical statistics (where a more senior appointment can be considered). However, we will entertain applications from outstanding candidates in other areas.

The applications should be sent to:

Professor M. Herschorn, Chairman
Department of Mathematics and Statistics
McGill University
805 Sherbrooke Street West
Montreal, Quebec, Canada
H3A 2K6

Please include a statement of research accomplishments and plans along with your letter of application, and arrange for 3 letters of recommendation to be forwarded. McGill University is an equal opportunity employer, but in accordance with the Canadian Immigration requirements priority will be given to Canadian citizens and permanent residents.

The deadline for the receipt of completed applications is November 15, 1987.

Pohang Inst of Science & Tech
Department of Mathematics
Pohang, 680 Korea

Positions at all levels are available for mathematicians holding a Ph.D. in Mathematics. Preference is given to candidates who can speak the Korean language, and have shown strong evidence of ability for doing original research in mathematics. Salaries are higher and teaching loads are lower than comparable institutions in Korea. Interested persons should write to Professor C. N. Lee at the above address.

Department of Mathematics
University of Toronto

The Department of Mathematics, University of Toronto is looking for strong applicants in pure or applied mathematics to nominate as candidates for NSERC Research Fellowships beginning July 1, 1988. These are five year research positions (subject to a review in the third year) with teaching load of at most one course per year. One of the five years may usually be taken as a sabbatical. Successful candidates may in special circumstances be considered directly for a tenure-stream position.

Applicants should be mathematicians with a relatively recent doctorate and who have demonstrated their ability with some substantive post-thesis research accomplishment. They must be Canadian citizens or landed immigrants by November 1, 1987. University of Toronto encourages both men and women to apply for these fellowships.

Applicants should send an up-to-date curriculum vitae and a short description of their research program to Professor J. Friedlander, Acting Chairman, Department of Mathematics, University of Toronto, Toronto, Ontario, Canada, M5S 1A1, (416)978-3320, and arrange to have sent three letters of reference. This material should arrive before Thursday, October 8, 1987 at which time the Department's choice of candidates will be made. The final decision by NSERC is announced (by NSERC) in the spring.

POSITIONS AVAILABLE

Department of Mathematics
VANDERBILT UNIVERSITY
STEVENSON PROFESSORSHIP
in computer-related mathematics
beginning Fall, 1988

This named, endowed, chair is intended for a person of distinction whose primary research involves actual computing.

Have curriculum vitae and letters of recommendation sent to

Professor Glenn F. Webb, Chairman
Mathematics Department
Vanderbilt University
Nashville, TN 37235
Inquiries are welcome.

VANDERBILT UNIVERSITY IS AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER.

University of California, Santa Barbara
Department of Mathematics

Applications are invited for a tenure track appointment at the assistant professor level, effective July 1, 1988. Junior candidates in all areas of the mathematical sciences will be given serious consideration. Candidates in the area of applied discrete mathematics are especially sought. Outstanding research and teaching accomplishments and potential will be the primary criteria for selection. Ph.D. required by the time of appointment. Applicants should send vita and publication list, and arrange to have three letters of recommendation sent to: Alex Rosenberg, Chair, Department of Mathematics, South Hall 6607, University of California, Santa Barbara, CA 93106 by January 11, 1988. Proof of U.S. citizenship or eligibility for U.S. employment will be required prior to employment (Immigration Reform and Control Act of 1986). An equal opportunity/affirmative action employer.

University of California, Santa Barbara
Department of Mathematics

Applications are invited for the KY FAN ASSISTANT PROFESSORSHIP. The Ky Fan assistant professorship is a special two-year nonrenewable position which carries a research stipend. Appointment is effective July 1, 1988. Candidates must possess a Ph.D. by September 1988. Selection will be based primarily on demonstrated research achievement. Teaching experience is desirable. Teaching load will consist of four one-quarter courses per year. To apply send vita and publication list, and arrange to have three letters of recommendation sent to: Alex Rosenberg, Chair, Department of Mathematics, University of California, Santa Barbara, CA 93106. All applications received by January 11, 1988 will be given thorough consideration. Proof of U.S. citizenship or eligibility for U.S. employment will be required prior to employment (Immigration Reform and Control Act of 1986.) UCSB is an equal opportunity/affirmative action employer.

WHITTIER COLLEGE

The Department of Mathematics invites applications for a tenure track position, at the level of Asst. Prof. beginning Fall 1988. The five members of the department teach a wide range of undergraduate courses in mathematics and computer science. Ph.D. in Mathematics preferred, but no particular field is required. A background in Computer Science would be most welcome. Candidates should submit a vita, graduate transcripts, three letters of recommendation, and a statement of teaching philosophy to Dr. Fritz Smith, Department of Mathematics, Whittier College, Whittier, California 90608. EO/AAE

UNIVERSITY OF CALIFORNIA, IRVINE
DEPARTMENT OF MATHEMATICS
IRVINE, CALIFORNIA 92717

A position at the level of Assistant Professor in Applied Mathematics, available beginning academic year 1988-89. A Ph.D. degree, several publications and evidence of active interest in quality teaching are required. Examples of preferred research areas: partial differential equations, nonlinear phenomena and applied functional analysis. Send applications, a curriculum vitae and arrange for three or more letters of recommendations to be sent to Professor Martin Schechter, Department of Mathematics, University of California, Irvine, CA 92717. An Affirmative Action/Equal Opportunity Employer.

BROWN UNIVERSITY, Providence, RI 02912. Two professorships at the Associate Professor level or above, with tenure, to begin July 1, 1988. Salary to be negotiated. Preference to be given to applicants with research interests consonant with those of Department members; for one position preference will be given to number theory. 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 November 15, 1987, to: Professor Brian Cole, Executive Officer, Department of Mathematics, Brown University, Providence, Rhode Island 02912. Brown University is an Equal Opportunity/Affirmative Action employer.

Department of Mathematics
University of Alberta
Edmonton, Alberta, Canada

Applications are invited for one tenure-track position in Approximation Theory and closely related areas at the Assistant Professor level starting July 1, 1988. Requirements are a Ph.D. and proven ability or demonstrated potential for research and teaching. Current salary range is from $31,612 (Canadian) per annum depending upon qualifications. Send vitae and arrange for three letters of reference to be sent to: Professor L. Erbe, Chairman, Department of Mathematics, University of Alberta, Edmonton, Canada, T6G 2G1. The University of Alberta is an equal opportunity employer, but in accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents. Closing date for applications is December 31, 1987. Please refer to File AP-1 when responding to this advertisement.

Department of Mathematics
University of Alberta
Edmonton, Alberta, Canada

Applications are invited for one tenure-track position at the Assistant Professor level starting July 1, 1988. Requirements are a Ph.D. and proven ability or demonstrated potential for research and teaching. Current salary range is from $31,612 (Canadian) depending upon qualifications. Send vitae and arrange for three letters of reference to be sent to: Professor L. Erbe, Chairman, Department of Mathematics, University of Alberta, Edmonton, Canada, T6G 2G1. The University of Alberta is an equal opportunity employer, but in accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents. Closing date for applications is December 31, 1987. Please refer to File OP-1 when responding to this advertisement.

POSITIONS AVAILABLE

The Ohio State University
Department of Mathematics

The Department of Mathematics of The Ohio State University hopes to fill several positions, both visiting and permanent, effective Autumn Quarter 1988. Candidates in all areas of applied and pure mathematics are invited to apply. Significant research accomplishments or exceptional research promise, and evidence of good teaching ability, will be expected of successful applicants.

Please send credentials and have letters of recommendation sent to Professor Joseph Ferrar, Department of Mathematics, The Ohio State University, 231 W. 18th Avenue, Columbus, Ohio 43210. Review of resumes will begin immediately.

The Ohio State University is an Equal Opportunity/Affirmative Action Employer.

The Ohio State University
Department of Mathematics
Research Instructorships in Mathematics

Applications are invited for the position of research instructor in mathematics for the academic year 1988-89. Candidates should hold a Ph.D. (or equivalent) in mathematics and show strong research promise.

Please send credentials and have letters of recommendation sent to Professor Joseph Ferrar, Department of Mathematics, The Ohio State University, 231 W. 18th Avenue, Columbus, Ohio 43210. The Ohio State University is an Equal Opportunity/Affirmative Action Employer.

Pending final budgetary approval, we invite applications for two faculty positions, one tenure-track Assistant Professorship and one tenured Associate or Full Professorship, both to begin July 1, 1988. We will consider strong candidates in any area of theoretical and applied statistics, computer-intensive statistics, probability and applied probability theory.

Interdisciplinary interests are encouraged and joint appointments are a possibility. Send inquiries and applications including a resume and three references by January 15, 1988 to:

P. J. Bickel
Personnel Committee
Department of Statistics
University of California
Berkeley, California 94720

The University of California is an Equal Opportunity/Affirmative Action Employer.

DEPARTMENT OF MATHEMATICS & COMPUTER SCIENCE
UNIVERSITY OF MIAMI

One or two tenure-track positions in Mathematics are anticipated beginning January or August, 1988. Ranks and salaries are open, commensurate upon qualifications of the applicants. Candidate must have the Ph.D. degree and excellent research record, or a definite research potential, with a strong commitment to teaching and research. Applicants should send vitae and three letters of reference to: Shiar Ahmad, Chairman, Department of Mathematics & Computer Science, University of Miami, P. O. Box 249085, Coral Gables, Florida 33124. The University of Miami is an EO/AA Employer.

Southern Methodist University
Department of Mathematics

Applications are invited for two positions beginning fall semester 1988, one at the full professor level. For the professorship, all distinguished researchers in applied mathematics will be considered, but the department has particular interest in the study of areas such as fluid dynamics, shocks, solitons, chaotic dynamics, and inverse scattering. Supervision of doctoral dissertations and a successful grant record are desirable.

We anticipate making the second appointment a tenure-track assistant professor. However, applicants with qualifications for a higher rank will be considered. Candidates should have an outstanding research record or superior potential. Preference will be given to candidates who can contribute to our Ph.D. program in Applied Mathematics, Numerical Analysis, and Scientific Computation.

Our growing faculty now include ten active applied mathematicians doing research in areas such as mathematical modeling, nonlinear wave phenomena, perturbation methods, computational fluid dynamics, parameter estimation, numerical bifurcation, and mathematical software for differential equations. The teaching load for both positions is two courses (six hours) per semester. A commitment to excellence in teaching is expected.

Review of applications will begin October 1, 1987 (full professor) and January 15, 1988 (assistant professor), and will continue until the positions are filled. Applicants should send a vita (and, for the junior position, three letters of recommendation) to Richard Haberman, Chairman, Department of Mathematics, Southern Methodist University, Dallas, TX 75275, or call him at (214) 692-2506.

The University is an Equal Opportunity/Affirmative Action/Title IX employer.

DEPARTMENT OF MATHEMATICS AND STATISTICS
Simon Fraser University
FACULTY APPOINTMENT

The Department of Mathematics and Statistics at Simon Fraser University invites applications for a tenure track position in Numerical Analysis at the level of Assistant Professor. The position could commence as early as January 1, 1988. Requirements include a Ph.D. degree and duties include teaching and research.

Applications, including curriculum vitae, should be sent as soon as possible to:

Dr. A. R. Freedman, Chairman
Department of Mathematics and Statistics
Simon Fraser University
Burnaby, B.C., V5A 1S6
Canada

Please arrange for three letters of reference to be sent directly from the referees.

In accordance with Canadian Immigration requirements, priority will be given to Canadian citizens and permanent residents.

Simon Fraser University serves 11,500 undergraduate students and 1,500 graduate students. The Department of Mathematics and Statistics with a faculty of 34, has 49 graduate students (20 in the Ph.D. program).

Simon Fraser University is situated on the top of Burnaby Mountain lying just east of the cosmopolitan city of Vancouver. The site commands magnificent views of Burrard Inlet, the mountains, the Fraser River, and the Vancouver Harbour. This Lower Mainland area of British Columbia is unique in Canada for its mild climate and varied recreational facilities.

POSITIONS AVAILABLE

Department of Mathematics
University of Alberta
Edmonton, Alberta, Canada

Applications are invited for one tenure-track position in Optimization and/or Control at the Assistant Professor level starting July 1, 1988. Requirements are a Ph.D. and proven ability or demonstrated potential for research and teaching. Current salary range is from $31,612 (Canadian) per annum depending upon qualifications. Send vitae and arrange for three letters of reference to be sent to: Professor L. Erbe, Chairman, Department of Mathematics, University of Alberta, Edmonton, Canada, T6G 2G1. The University of Alberta is an equal opportunity employer, but in accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents. Closing date for applications is November 30, 1987. Please refer to File OC-1 when responding to this advertisement.

NORTHWESTERN UNIVERSITY
MATHEMATICS DEPARTMENT

The Mathematics Department invites application for tenure or tenure track positions at all levels from mathematicians with strong research interests. A very substantial research record and the ability to provide scientific leadership is required for a tenured appointment. Preference will be given to those areas which complement the present department strengths. Applications should include a Curriculum Vitae (including a list of publications) and the applicant should have three reference letters sent to the Chairman, Personnel Committee, Department of Mathematics, Northwestern University, Evanston, IL 60208.

Northwestern University is an Affirmative Action/Equal Opportunity Employer.

APPLIED MATHEMATICS
ILLINOIS INSTITUTE OF TECHNOLOGY

Two tenure-track faculty positions at the Assistant Professor level will be available in the Department of Mathematics beginning August 1988. Applicants should have a Ph.D. in an area of applied mathematics or statistics and should show evidence of strong research potential and teaching ability.

Candidates are especially sought who are interested in solving scientific and/or engineering problems using mathematical tools. U.S. citizenship or resident status is required. The closing date is January 31, 1988.

Send a letter of application, vita, and three letters of recommendation to: M. J. Frank, Chairman, Department of Mathematics, Illinois Institute of Technology, Chicago, IL 60616.

An Equal Opportunity Affirmative Action Employer.

Department of Mathematics
John Jay College of Criminal Justice
The City University of New York

Assistant Professor, tenure-track position, 2/1/88. 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 Samuel Graff, Chairperson, Department of Mathematics, John Jay College of Criminal Justice, 445 West 59th Street, N.Y., N.Y. 10019 by December 1, 1987. AA/EOE Employer.

CASE WESTERN RESERVE UNIVERSITY
Department of Mathematics and Statistics

Tenure-Track, possibly senior, positions anticipated to begin August 15, 1988. Outstanding research record and/or proven research potential and teaching excellence required. Preferred areas: statistics and numerical methods, but candidates in areas of global analysis, dynamical systems, control theory, probability and functional analysis will also be considered for junior positions. Women and minority groups candidates are especially encouraged to apply. Visiting positions most likely in the area of applications of probability and graph theory to chemistry. Send vita plus three letters of recommendations to Professor W. A. Woyczynski, Chairman, Department of Mathematics and Statistics, Case Western Reserve University, Cleveland, OH 44106.

An affirmative action equal opportunity employer

THE CITADEL

Applications are invited for a tenure track position at the assistant professor level. Qualifications include a Ph.D. in Mathematics or Statistics with a capacity for research and a dedication to undergraduate teaching. Preference will be given to an individual with a strong statistics background. Salary negotiable. The position is available January, 1988.

The Citadel is a state-supported, liberal arts, military college offering undergraduate degrees in the Arts, Sciences, Engineering, Education and Business Administration. The Department of Mathematics and Computer Science offers the B.S. and B.A. Degree in Mathematics and also the B.S. Degree in Computer Science.

Please send resume and three letters of reference to Charles E. Cleaver, Head, Department of Mathematics and Computer Science, The Citadel, Charleston, South Carolina 29409. Applications should be received by November 15, 1987, to insure consideration.

Minorities and women are encouraged to apply. The Citadel is an equal opportunity/affirmative action employer.

CARNEGIE MELLON UNIVERSITY
Department of Mathematics

The Department expects to make one tenure-track appointment in the area of numerical analysis beginning in Fall 1988. Although this appointment is expected to be at the Assistant Professor level, we also solicit exceptionally well-qualified applicants for more advanced positions. Candidates should send a resume to: Appointments Committee, Department of Mathematics, Carnegie Mellon University, Pittsburgh, PA 15213. Carnegie Mellon University is an Affirmative Action/Equal Opportunity Employer.

NEW MEXICO STATE UNIVERSITY, DEPT. MATH SCI., LAS CRUCES, NM 88003

Visiting positions and possible tenure-track assistant professor positions in pure and applied mathematics, numerical analysis, statistics, computer vision. Start August 22, 1988. Salary competitive. Ph.D. (or equivalent) and strong commitment to teaching and research essential. Applications are kept on file through hiring period and positions filled as openings occur. Send vita and arrange for three reference letters to be sent to Carol L. Walker, Head, Department of Mathematical Sciences, Box 30001, New Mexico State University, Las Cruces, NM 88003. An Equal Opportunity/Affirmative Action Employer.

POSITIONS AVAILABLE

OKLAHOMA STATE UNIVERSITY
Department of Mathematics
Department Head

The Department invites applications and nominations for the position of Department Head, starting July 1, 1988. Rank and salary are dependent on qualifications. Candidates must have a Ph.D. or equivalent degree, a strong research record, and a commitment to excellent teaching. Oklahoma State University is a comprehensive research university with an enrollment of about 21,000. The Department has 31 faculty members and offers bachelor, masters and doctoral degree programs. For full consideration send a vita and three letters of reference by December 15, 1987 to Search Committee, Department of Mathematics, Oklahoma State University, Stillwater, OK 74078. Applications by women and minorities are encouraged. Oklahoma State University is an Affirmative Action/Equal Opportunity employer.

Marquette University

Tenure-track position requiring the Ph.D. to begin Jan. or Aug. 1988. Preference given to candidates who can teach upper division computer science courses. Also possible visiting positions of 1 or 2 semesters for faculty who wish to spend sabbatical leave at Marquette. Preference given to applicants whose research areas match faculty interests. To apply send vita, transcripts and 3 letters of recommendation to Douglas Harris (Chairman), Dept. of Mathematics, Statistics & Computer Science, Marquette University, Milwaukee, WI 53233. **Closing date:** Oct. 31, 1987 or until filled. **Marquette University is an EEO/AA Employer.**

YORK UNIVERSITY
Department of Mathematics
Toronto, Canada

Applications are invited for a tenure-track position in Statistics, rank open, to commence July 1, 1988. Applications should have proven ability or demonstrated potential for research in Statistics and the ability to teach Applied Statistics at the undergraduate and graduate levels. One or more limited-term or tenure track positions, rank and field open, are also anticipated, subject to university approval. Resumes and three letters of recommendation should be sent by January 1, 1988 to: **Joan Wick Pelletier, Chair, Department of Mathematics, 4700 Keele Street, North York, Ontario, M3J 1P3 Canada**. York University is implementing a policy of employment equity. Qualified women and men are invited to apply. In accordance with Canadian Immigration requirements this advertisement is directed to Canadian citizens and permanent residents of Canada.

STATE UNIVERSITY OF NEW YORK AT BINGHAMTON
Department of Mathematical Sciences

invites applications at all levels for several openings. Senior applicants must have an outstanding research record. Junior applicants must show great promise. All areas, including mathematical computer science and statistics, will be considered. The department has a healthy doctoral program and an attractive future. Vita and letters of recommendation should be sent to: David L. Hanson, Chairman, Dept. of Math. Sciences, SUNY-Binghamton, Binghamton, NY 13901. An AA/EO employer.

MARY WASHINGTON COLLEGE
Department of Mathematics

A tenure-track assistant professor in mathematics position is anticipated starting Fall '88. Candidates should have (by Aug. '88) a Ph.D. in pure or applied mathematics, and must possess both a strong commitment to teaching and to continuing scholarly development. MWC is a small (3200), state-supported, coeducational, selective, undergraduate, liberal arts college located 50 miles from Richmond and Washington, D.C. Teaching load is 12 hr/sem. Send resume, graduate transcript, and 3 letters of reference – all to arrive by January 11, 1988 – to: John R. Tucker, Search Committee Chairman, Department of Mathematics, Monroe 209D, Mary Washington College, Fredericksburg, VA 22401-5358. AA/EEO.

A tenure track position (Assistant Professor) in mathematics is available beginning in September 1988. Applicants should have a Ph.D. in mathematics and a strong commitment to quality teaching. The teaching load is twelve hours per semester. Salary and fringe benefits are competitive, commensurate with credentials and experience.

Applicants should send resume, transcripts and three letters of reference to Dr. Richard Escobales, Chairman, Department of Mathematics, Canisius College, Buffalo, New York 14208. AA/EOE.

University of Toronto
Department of Mathematics

Applications are invited from recent Ph.D.'s for one or more positions, tenure-stream and limited term, at Erindale Campus beginning July 1, 1988. These positions, which are subject to final budgetary approval, are open to all branches of pure and applied mathematics.

Duties will consist of research and teaching and candidates must demonstrate clear strength in both.

Applicants should send their complete curriculum vitae, together with a list of publications and arrange to have at least three recent letters of reference sent directly to:

Professor D. R. Masson
Associate Chairman
Department of Mathematics
University of Toronto
Toronto, Canada M5S 1A1

To insure full consideration, applications and letters of reference should be received by January 31, 1988.

The University of Toronto encourages both men and women to apply. In accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents.

UNIVERSITY OF NORTH FLORIDA
Department of Mathematical Sciences

Applications are invited for Visiting Instructor/Assistant Professor for the SPRING SEMESTER, 1988, (January 4–May 7). The M.S./Ph.D. in Mathematical Science is required. Duties include teaching major, graduate and/or service courses depending upon qualifications. Excellence in teaching is required. The Department offers the B.S. and M. S. in Mathematics and in Statistics and has a faculty with research interests in a variety of areas of both Mathematics and Statistics. Send vita, transcripts and three letters of recommendation by November 15, 1987, to Leonard J. Lipkin, Chairman, Department of Mathematical Sciences, University of North Florida, 4567 St. Johns Bluff Road, Jacksonville, Florida 32216. EEO/AA.

POSITIONS AVAILABLE

THE UNIVERSITY OF FLORIDA
Department of Mathematics

The Department of Mathematics is in its second year of a five year program to fill over 20 new tenure track faculty positions with mathematicians of exceptional caliber. At least one third of these positions will be senior positions.

The Department invites applications for six tenure track positions beginning in Fall, 1988, two of which will be filled with senior appointments. Senior candidates chosen by the department will be given a role in the selection of this year's candidates for junior positions. The Department is especially interested this year in attracting candidates in the fields of Algebra (particularly Group Theory and Algebraic Geometry); Mathematical Physics (and related areas); Algorithms (incl. Numerical Analysis and Combinatorics). Candidates should have strong research potential and a documented interest in teaching. Preference will be given to applicants with at least two years of postdoctoral experience. Rank and salary will be commensurate with experience and achievements. Candidates should forward a resume (including a list of publications) and should arrange for at least three letters of reference to be sent to:

Gerard G. Emch, Chairman
Department of Mathematics
201 Walker Hall
University of Florida
Gainesville, FL 32611

All applications for the academic year 1988-1989 must be complete by December 31, 1987. The University of Florida is an equal opportunity employer.

The Mathematics Department will sponsor NSERC University Research Fellows for terms beginning July 1, 1988. Candidates should have demonstrated high potential for research. In the past, successful candidates for NSERC University Research Fellowships have had at least one year of Post-Doctoral experience. Under NSERC regulations, candidates must be Canadian citizens or permanent residents of Canada. Subject to availability of funds, the fellowships are for three years and renewable for an additional two years. A University Research Fellow receives the salary of an Assistant Professor with comparable qualifications but teaches, at most, one course. Applications including CV, list of publications and three letters of recommendation should be sent to Dr. D. Boyd, Head, Department of Mathematics, The University of British Columbia, Vancouver, B.C. V6T 1Y4 before October 15, 1987. In accordance with Canadian immigration requirements, this advertisement is directed to Canadian citizens and permanent residents.

THE UNIVERSITY OF TENNESSEE/KNOXVILLE

Several tenure-track and visiting positions are available for Fall 1988. Applications will be considered for all professorial ranks in areas in or related to algebra, analysis, integral equations, mathematical ecology, numerical analysis, ordinary and partial differential equations, probability, statistics, topology. Priority will be given to candidates in analysis, numerical analysis and topology. Send vita to John S. Bradley, Head, Department of Mathematics, The University of Tennessee, 124 Ayres Hall, Knoxville, TN 37996/1300. **AN EEO TITLE IX/SECTION 504 EMPLOYER.**

DEPARTMENT OF MATHEMATICS & COMPUTER SCIENCE RUTGERS UNIVERSITY AT NEWARK

The Department of Mathematics and Computer Science anticipates several openings beginning September 1988. These include:

(i) One Full Professorship. Candidates should exhibit strong research accomplishments and be able to play a leadership role in the department. Salary and teaching load are negotiable.

(ii) One or two tenure track assistant or associate professorships. Assistant Professorships may possibly carry a Henry Rutgers Research Fellowship. Candidates should exhibit strong research accomplishments or potential. Salary and teaching load are negotiable.

(iii) One one-year visiting research lecturer at the rank of associate or full professor.

Applicants from all fields are invited. Areas of research interest in the department include number theory, representation theory, automorphic forms and p-adic Lie groups, combinatorics, topology and low-dimensional topology and Teichmüller theory.

Candidates should send a resume and have references write to:

Jane Gilman, Chair
Department of Mathematics & Computer Science
Rutgers-The State University-FASN
Newark, New Jersey 07102

The closing date for applications is January 15, 1988. However, late applications will be accepted until the positions are filled. Rutgers University is an equal opportunity, affirmative action employer.

DEPARTMENT OF MATHEMATICS AND STATISTICS UNIVERSITY OF PITTSBURGH

Applications are invited for one tenure track position in pure mathematics and one in applied mathematics. In pure mathematics the field is open, but must be one with substantial current activity. In applied mathematics the search will emphasize formal asymptotics, to complement our current efforts in fluid mechanics and mathematical biology. Applicants should send a vita and list of publications, and have at least four letters of reference sent to Professor Stuart Hastings, Chairman, Department of Mathematics and Statistics, University of Pittsburgh, Pittsburgh, PA 15260. The University of Pittsburgh is an Equal Opportunity/Affirmative Action Employer.

AUBURN UNIVERSITY
Department of Algebra, Combinatorics and Analysis

The department expects to make several tenure track appointments beginning September 1988. At least one position in applied mathematics, numerical analysis, or approximation theory; at least one in linear algebra or numerical linear algebra; one in group theory or ring theory. Rank open, salary negotiable. Also temporary or visiting positions may be available in above areas or differential equations, probability, combinatorics.

Send resume and arrange for three letters of reference to be sent to James R. Wall, 120 Math Annex, Auburn University, AL 36849. Minorities and women are encouraged to apply.

AUBURN UNIVERSITY IS AN EQUAL OPPORTUNITY AFFIRMATIVE ACTION EMPLOYER.

POSITIONS AVAILABLE

UNIVERSITY OF WISCONSIN-MADISON
Department of Mathematics
Employment Opportunities

The Department of Mathematics at the University of Wisconsin-Madison solicits applications for the following positions to begin fall 1988.

Tenure and Tenure Track Positions. Appointments will be made at the Assistant Professor level unless qualifications and experience require appointment at higher rank.

Van Vleck Assistant Professorships. Appointments are for a specified term of three years at an academic year salary of at least $28,500. The usual teaching load is two courses per semester. Candidates must receive their doctorate prior to September 1988. Preference will be given to candidates who are likely to interact well with other members of the Department.

Candidates for these positions should have a strong commitment to good teaching and exhibit outstanding potential for mathematical research. Supporting materials should include a vita, a one to three page abstract of the candidate's dissertation, and three or four letters of recommendation at least one of which discusses the candidate's experience and capabilities as a teacher in detail.

Application forms are available from the Hiring Committee, Department of Mathematics, 223 Van Vleck Hall, 480 Lincoln Drive, Madison, WI, 53706. Applications will be accepted until all positions are filled; however, in order to ensure full consideration, the application and all supporting materials must be received by December 31, 1987. The University of Wisconsin is an AA/EOE employer.

UNIVERSITY OF WISCONSIN-MADISON
Position In Mathematics Extension and Outreach

Applications are solicited for a tenure-track position directing and teaching in the extension and outreach program in mathematics at the University of Wisconsin-Madison beginning July 1, 1988. The appointment will be as an assistant professor in the Department of Mathematics unless qualifications and experience require appointment at a higher rank. The responsibilities of the position include administration and development of and teaching in programs of the Division of University Outreach and a limited amount of teaching in the Department of Mathematics. The outreach programs include correspondence study and non-credit continuing-education courses which have a large audience throughout the state at both the high school and university levels. The new faculty member will have the challenge of developing continuing and professional education programs designed to introduce new developments in the mathematical sciences to the broad public at all career levels.

To assure full consideration all materials should be received by January 1, 1988. Application forms are available from Mathematics Extension Search Committee, Mathematics Department, 223 Van Vleck Hall, 480 Lincoln Drive, Madison, WI 53706.

The University of Wisconsin-Madison is an Equal Opportunity/Affirmative Action employer.

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM
DEPARTMENT OF MATHEMATICS

The department of mathematics has faculty positions at all ranks. The department is especially interested in establishing a group in Numerical PDE/Scientific computation over the next five years. Access to the Alabama Super Computer (using a Sun Station and a T-1 line to a Cray X-MP/24) will be available in February, 1988. Other areas which will enhance our proposed Ph.D. in Applied Mathematics will be seriously considered. Applicants for senior positions must demonstrate excellence in research, while applicants for junior positions must exhibit the promise of excellence. Send as soon as possible a curriculum vitae, list of publications, a few selected reprints, and the names of three references to Search Committee, Department of Mathematics, University of Alabama at Birmingham, Birmingham, AL 35294. UAB is an Affirmative Action/Equal Opportunity Employer.

UNIVERSITY OF SOUTHERN MISSISSIPPI
Department of Mathematics

Applications are invited for two tenure-track positions, both at the assistant professor level. Candidates must have the Ph.D. in mathematics, serious research interests, and a dedication to teaching. Preference will be given to those candidates whose research interests complement those of the current faculty. These interests include algebra, combinatorics, differential geometry, graph theory, matrix theory, linear algebra, and mathematical physics. We are also interested in developing a research base in numerical analysis and differential equations. Success in attracting external funding to support basic and/or applied research, though not required, will enhance the application.

The normal teaching load is 6-9 credit hours per semester (15-16 per academic year), including both undergraduate and graduate courses. The successful applicant will be expected to establish an active mathematical research program and to participate in the usual faculty service activities (e.g., advisement, curriculum development, committee assignments).

The salary is negotiable and competitive, dependent upon qualifications. The starting date will be Fall, 1988-89. While the application deadline is open, selection may begin as early as 2/1/88. Interviews will be conducted at the 94th Annual Meeting of the AMS, January 6-9, 1988, in Atlanta, GA. Candidates should contact the Department prior to January 1 to schedule interviews of duration longer than those available through the MSER.

The University of Southern Mississippi is one of the State's three designated comprehensive universities, with an on-campus enrollment of 10,000+. The department has 26 full-time faculty members and offers the B.S., B.A., and M.S. degrees in mathematics. We also offer the course work to support the Ph.D. in secondary education with mathematics as a specialization area. Hattiesburg is a city of about 45,000 people in the pine-forested, rolling hills just 70 miles north of the beautiful and bustling Mississippi Gulf Coast. Outdoor recreational opportunities are abundant. The white sands and emerald water of the Florida Gulf Coast are just a few hours away, while New Orleans is within an easy two-hour drive. The climate is subtropical, with mild winters. The average daily high in January is 65° F. Early spring produces an astounding display of color from the indigenous azalea, dogwood and magnolia.

Send resume and three letters of recommendation to: Chair, Search Committee, Department of Mathematics, University of Southern Mississippi, Hattiesburg, MS, 39406-5045. The University of Southern Mississippi is an affirmative action, equal opportunity employer. Applications from women and minority group members are encouraged.

POSITIONS AVAILABLE

Faculty Position

Mathematics. Visiting or tenure-track Assistant Professor (pending manpower clearance and funding) to begin January 1988 or August, 1988). Duties. Teach introductory and advanced undergraduate courses in mathematics; advise students; carry out appropriate research and service activities. Minimum Qualifications: Doctorate in mathematics or a closely related field; college teaching experience; demonstrated research potential. The University of Hawaii at Hilo is a four year undergraduate institution with approximately 3,500 students, located on the island of Hawaii. Current faculty interests include algebra, analysis, differential geometry, Lie groups, numerical analysis, operations research, probability, statistics, systems theory. Applicants should send curriculum vita, three letters of recommendation, and other relevant material to: Chair, Mathematics Department, University of Hawaii at Hilo, Hilo, Hawaii 96720-4091. Closing Date: October 30, 1987 or until position is filled. An Affirmative Action/Equal Opportunity Employer.

SITUATIONS WANTED

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MATHEMATICS ASSISTANT PROFESSOR, TEACHING AND RESEARCH. Ph.D. 1986. Age 31. Speciality: EXTREMAL PROBLEMS, OPERATIONS RESEARCH. Two published articles. Five years experience in teaching and academic research, including one in foreign university. Fluent in Russian. References and résumé available upon request. Available immediately. Sambasivam Ezhilarasan, S-15, Goldsworth Valley, Kalamazoo, MI 49008.

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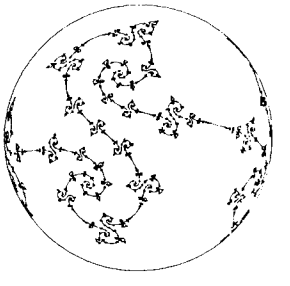

The limit set of a quasifuchsian group

We expect to receive funding very soon from NSF and University of Minnesota for the Geometry Supercomputer Project. This is a unique 3 year project to do research broadly relating to geometry in conjunction with the Cray2 supercomputer. The principal investigators (Geometry Computing Group) are F. Almgren, J. Cannon, D. Dobkin, A. Douady, D.B.A. Epstein, J. Hubbard, B. Mandelbrot, A. Marden, D. Mumford, R. Tarjan, W. Thurston and A. Wilks.

We would like to hear from individuals who have a strong background in math and/or computer science who are interested in the possibility of doing research under the direction of the Group and helping to achieve the goals of the Project. Such individuals should also have exceptional proficiency and substantial experience in programming, preferably in both Fortran and C. Strong proficiency in computer graphics is very desirable as well. Normally, at least two years of post-doctoral or comparable experience is expected.

Associates of the Project will be based in Minnesota but, if appropriate, may spend even substantial periods of time at one or more of the other sites where members of the Group are based. The remuneration can be in the range 40K/year with additional flexibility for more senior persons. The optimal period of association is in units of roughly one year but any period over 3 months will be considered. There may be up to 6 positions available. Applications for any period up to September, 1990 will be considered. The closing date for applications is July 30, 1988, but the appointments for the first and possibly second years will be made sooner. Please write to Al Marden explaining your interest and qualifications. One or two supporting letters of reference may be helpful to the Group in assessing your work.

Al Marden, Organizer

mg13301@umn-rei-uc.arpa

Until Dec. 1: Institute for Advanced Study
Princeton, N.J. 08540

Afterwards: Geometry Computing Group
c/o Minnesota Supercomputer Institute
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INSTITUTE FOR MATHEMATICS AND ITS APPLICATIONS

University of Minnesota
announces a program on

NONLINEAR WAVES

September 16, 1988 to June 30, 1989

Organizing Commitee: James Glimm, Daniel Joseph, Barbara Keyfitz, Andrew Majda, Alan Newell, Peter Olver, David Sattinger, David Schaeffer.

For the scientific program see the article in the News and Announcements section of this issue of the AMS Notices. A six-week summer program on SIGNAL PROCESSING is scheduled to precede the nonlinear waves program, and a program on STATISTICS will follow in the summer of 1989.

VISITING MEMBERSHIPS AVAILABLE

POSTDOCTORAL MEMBERSHIPS are available. All requirements for a doctorate should be completed by September 15, 1988. Applicants must show evidence of mathematical excellence, but they do not need to be specialists in nonlinear waves or even "applied mathematicians"

The following materials must be submitted:

(1) • Personal statement of scientific interests, research plans, and reasons for wishing to participate in this program. (This is an essential part of the application.) Applicants who wish to begin with the SIGNAL PROCESSING program and/or remain for the STATISTICS program should include these topics in their statement.

(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, 1988.

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
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IMA PARTICIPATING CORPORATIONS: 3M Corporation, Honeywell Inc. and Cray Research Inc.

The Rocky Mountain Mathematics Consortium announces publication of the *Journal of Integral Equations and Applications.* It will be devoted to the theory, applications and numerical analysis of integral equations of all types. The primary aim of this international journal is to publish high-quality research papers in the area of integral equations and their applications, and will be particularly devoted to: the deterministic and probabilistic theory of linear and nonlinear integral equations of various types, integrodifferential equations and related operator equations; numerical analysis and approximation methods for integral equations; and applications of integral equations in the sciences, engineering, and technology.

The journal will also publish occasional survey and expository articles presenting, in some depth, recent advances with respect to particular topics. It will serve as a forum for an exchange of ideas that will stimulate significant contributions in new fields and promote the most salient aspects of the theory of integral equations.

The scope and methodologies will embrace classical and complex analysis methods, functional analysis techniques and topological/geometric methods for development of the theory of integral equations.

The editors are P. M. Anselone, Oregon State University and M. Z. Nashed, University of Delaware. Associate editors are K. E. Atkinson, Univ. of Iowa; C. T. H. Baker, Univ. of Manchester; C. Corduneanu, Univ. Texas at Arlington; D. Elliot, Univ. of Tasmania; K. B. Hannsgen, Virginia Polytechnic Inst.; P. Kress, Univ. Gottingen; J. W. Lee, Oregon State; R. K. Miller, Iowa State; T. W. Mullikin, Purdue Univ.; J. A. Nohel, Univ. of Wisconsin; I. H. Sloan, Univ. of New South Wales; I. Stakgold, Univ. of Delaware; and G. G. Wahba, Univ. of Wisconsin.

Inquiries and orders should be directed to the Rocky Mountain Mathematics Consortium, Dept. of Mathematics, Arizona State University, Tempe, AZ 85287-1904 (phone 602-965-3788).

1988 SPRING TOPOLOGY CONFERENCE

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The TRADITIONAL AREAS of research include set theory, set theoretic and general topology, infinite dimensional topology, shape theory, continuum theory, and geometric topology. In addition, SPECIAL FOCUS AREAS will be dynamical systems, group actions, and applications of topology to chemistry.

Hour speakers will include Mladen Bestvina, James Cannon, and R. F. Williams.

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(2) Group Actions and Geometric Topology

(3) Set Theory and General Topology

Special airline fares have been arranged with HOUSE OF TRAVEL, 3415 West University Ave., Gainesville, Florida 32607. Please contact them directly to make your travel arrangements, and mention that you are with the "1988 SPRING TOPOLOGY CONFERENCE". Their phone numbers are:

Florida calls:	1-904-378-1601
	1-904-5351
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For further information, contact any of the committee members: Louis Block, Beverly Brechner, Albert Fathi, James Keesling, and Chris Stark. The UF Math Department phone number is: 1-904-392-0281.

PLAN EARLY TO ATTEND!

DEAN

COLLEGE OF ENGINEERING AND MATHEMATICS

Applications and nominations are invited for the position of Dean of the College of Engineering and Mathematics. The Dean serves as the chief administrative officer of the College, with responsibility for the administration and planning of the instructional, research and service functions of the College. The three Departments and two Programs in the College offer undergraduate programs in Civil Engineering, Computer Science, Electrical Engineering, Engineering Management, Mathematics, Mechanical Engineering, and Statistics. Masters level programs are offered in Biomedical Engineering, Biostatistics, Civil Engineering, Computer Science, Electrical Engineering, Materials Science, Mathematics, Mechanical Engineering, and Statistics. The Ph.D. degree is offered in Electrical Engineering, Materials Science, and Mechanical Engineering. Over sixty FTE faculty serve approximately 1,200 undergraduate and 175 graduate students.

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Send nominations and applications, including resume and references, by December 1, 1987 to:
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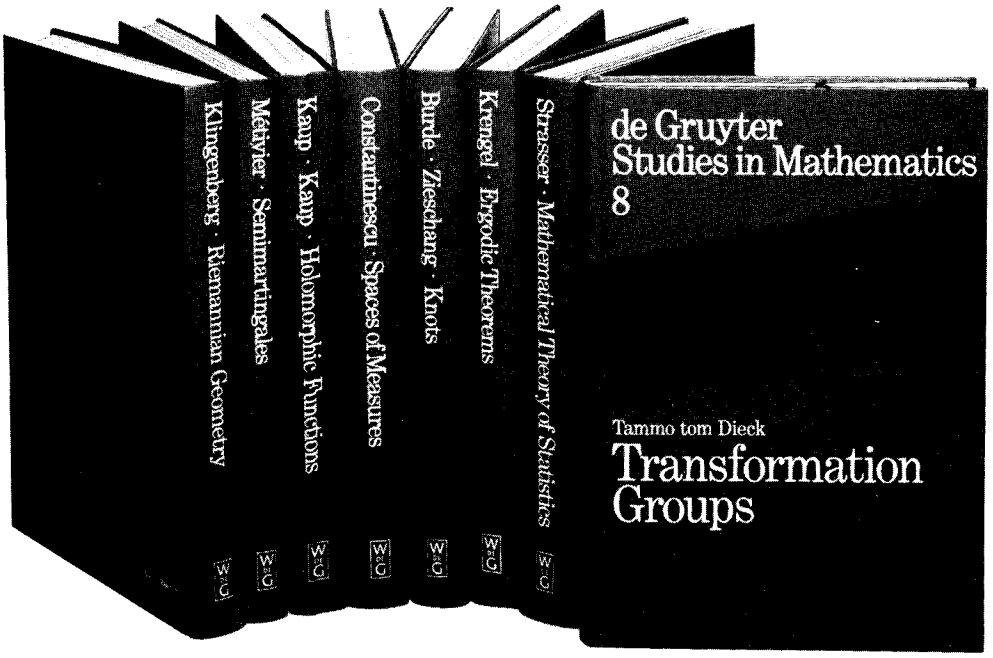

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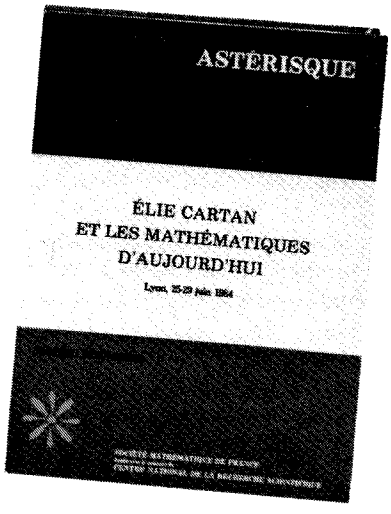

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The Joy of TEX

A Gourmet Guide to Typesetting with the AMS-TEX macro package

M. D. SPIVAK

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This book is designed as a user's guide to the AMS-TEX macro package and details many features of this extremely useful text processing package. Parts 1 and 2, entitled "Starters" and "Main Courses," teach the reader how to typeset most normally encountered text and mathematics. "Sauces and Pickles," the third section, treats more exotic problems and includes a 60-page dictionary of special TEXniques.

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Shipping/Handling: 1st book $2, each add'l $1, max. $25; by air, 1st book $5, each add'l $3, max. $100

PREPAYMENT REQUIRED. Order from
American Mathematical Society
PO Box 1571
Annex Station
Providence, RI 02901-9930
or call 800-556-7774 to use VISA or MasterCard.
Prices subject to change.

Preregistration/Housing Form, Atlanta, Georgia

January 6-9, 1988

Must Be Received in Providence No Later Than November 6, 1987

Please complete this form and return it with your payment to
Mathematics Meetings Housing Bureau
P.O. Box 6887, Providence, Rhode Island 02940 – Telephone: (401) 272-9500, Ext. 290-Telex: 797192

DEADLINES:

Room Lottery Qualification	October 26, 1987
Preregistration	November 6, 1987
Hotel Reservations through Housing Bureau	December 9, 1987
Changes/Cancellations	December 23, 1987
50% Refund on Preregistration	December 23, 1987 (no refunds after this date)

		REGISTRATION FEES Preregistration by mail by November 6, 1987	At Meeting
		$	$
JOINT MATHEMATICS MEETINGS			
	Member of AMS, CMS, MAA	61	79
	Nonmember	94	122
*	Student, Unemployed, or Emeritus	17	22
AMS SHORT COURSE			
	Member/Nonmember	35	45
*	Student or Unemployed	10	15
EMPLOYMENT REGISTER	– Employer fee (1st Interviewer)	75	100
	– Employer fee (2nd / 3rd Interviewer)	35	50
	– Applicant fee	15	20
	– Posting fee for job descriptions for noninterviewing employers	10	15
AMS/MAA TUG WORKSHOP		60	80

(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 from his or her latest position.

PREREGISTRATION SECTION: Please check the function(s) for which you are preregistering:

Joint Meetings ☐; AMS Short Course (January 5-6, 1988) ☐; Employer ☐; Applicant ☐; Posting ☐; TUG Workshop (January 5, 1988) ☐

1) _____ Telephone: _____
(Please print) Surname First Middle

2) _____
(Mailing address)

3) Badge information: a) Nickname (optional): _____ b) Affiliation: _____

4) I am a student at _____ 5) Emeritus member ☐; Unemployed ☐

6) Accompanied by spouse _____; Number of children _____ (List only if accompanying to meeting)

7) Member of AMS ☐; CMS ☐; MAA ☐; Nonmember ☐; (Member discount applies only to members of AMS, CMS, and MAA.)
Member of other organizations: AWM ☐; NAM ☐

8) Joint Meetings fee $ _____ 9) **AMS** Short course fee $ _____ 10) TUG Workshop $ _____ 11) Employer fee(s) $ _____

12) Applicant fee $ _____ 13) Posting fee $ _____ 14) Hotel deposit $ _____

15) _____ Banquet ticket(s) @ $30 each = $ _____ _____ Banquet ticket(s)+one calculator @ $90 each = $ _____
_____ Dollar-A-Year Centennial Package(s) @ $100 each = $ _____

16) TOTAL AMOUNT ENCLOSED FOR 7 through 15 $_____ 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 CHECK HERE IF YOU WILL NOT REQUIRE A ROOM

☐ PLEASE CHECK HERE IF YOU WILL BE STAYING AT A HOTEL/MOTEL NOT LISTED ON THE REVERSE

Please complete the section on the reverse if you will require hotel accommodations.

For office use only:

Codes:	Options:	Hotel:	Room type:
Dates:	Hotel Deposit	Total Amt. Paid:	
Special Remarks:			

HOUSING SECTION: PREREGISTRATION/HOUSING FORM, Atlanta, Georgia January 6-9, 1988

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.

GUARANTEE REQUIREMENTS: $50 by check, VISA, or MasterCard credit cards. No other credit cards will be accepted. PLEASE SUPPLY THIS INFORMATION ON THE REVERSE, together with mailing address for confirmation of room reservation.

Order of choice		Single	Double	Twin double	Triple 2 beds	Triple 2 beds w/cot	Quad 2 beds	Quad 2 beds w/cot	Suite
		$	$	$	$	$	$	$	$
	Hyatt Regency (Headquarters Hotel)	69	80	80	89	89	98	98	Upon Request
	Marriott Marquis	71	81	81	101	101	121	121	Upon Request
	Radisson	60	65	65	70	86	75	91	Upon Request
	American	55	60	60	65	70	65	70	Upon Request
	Days Inn Downtown	55	65	65	65	N/A	65	N/A	Upon Request

I will arrive on (date) _____ at _____ a.m./p.m., and depart on (date) _____ at _____ a.m./p.m.

Please list other room occupants.

FULL NAME ARRIVAL DATE DEPARTURE DATE

_____

_____

_____

MAA Minicourse Preregistration Form, Atlanta, Georgia

January 6–9, 1988

NOTE: This is not an AMS Short Course Form. Please use the Joint Meetings Pregistration/Housing Form to preregister for the Short Course.

To register for MAA Minicourse(s), please complete THIS form and return it with your payment to:

Jane Heckler
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 6, 1987
- Deadline for cancellation in order to receive a 50% refund: December 23, 1987
- Registration for the Joint Meetings is a requirement in order to participate in the MAA Minicourses. Complete the Preregistration/Housing Form included in the meeting announcement and return it to Providence with the applicable Joint Meetings preregistration fee. **DO NOT SEND MAA MINICOURSE FORM OR FEES TO PROVIDENCE.**
- Each participant must fill out a separate Minicourse form.
- Enrollment is limited to two Minicourses, subject to availability.
- Please complete the following and send both form and payment to Jane Heckler 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. Using computer graphing to enhance the teaching and learning of calculus and precalculus mathematics	Franklin D. Demana & Bert K. Waits	$40
2. Computer software for differential equations	Howard Lewis Penn & James Buchanan	$40
3. Teaching mathematical modeling	Frank R. Giordano & Maurice D. Weir	$30
4. Teaching calculus with an *HP-28C* symbol	John W. Kenelly	$30
5. Logo and problem solving	Charles A. Jones	$40
6. Coloring and path following algorithms for approximating roots and fixed points	William F. Lucas	$30
7. Computer based discrete mathematics	Nancy Baxter & Ed Dubinsky	$40
8. Laboratory projects for first year calculus	L. Carl Leinbach	$30
9. Constructing placement examinations	John G. Harvey	$30
10. Computer graphics in elementary statistics	Florence S. & Sheldon P. Gordon	$40
11. The use of computing in teaching linear algebra	Eugene Herman & Charles Jepsen	$40
12. Using computer algebra systems in undergraduate mathematics	Paul Zorn	$30
13. Learning mathematics through discrete dynamical systems	James T. Sandefur	$30

☐ I plan on preregistering for the Joint 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 Joint Meetings preregistration fee will be made.

MATHEMATICAL SCIENCES EMPLOYMENT REGISTER

Instructions for Applicant's Form on facing page

The form. Applicants' forms submitted for the Employment Register will be photographically reproduced in the December 1987 issue of *Employment Information in the Mathematical Sciences*. Résumés of those attending will be posted at the meeting.

The forms **must be** carefully typed using a fresh black ribbon. The best results are obtained with a carbon-coated polyethylene film ribbon, but satisfactory results may be obtained using a ribbon made of nylon or other woven fabric if suitable care is exercised. It is important that the keys be clean and make a sharp, clear impression. Do not erase—it causes smudges which reproduce when photographed. Use a correcting typewriter or correction tape or fluid if necessary. Submit the original typed version only. Copies will not reproduce properly and are not acceptable. **Hand lettered forms will be returned.**

Applicants' forms must be received by the Society by **November 6, 1987** 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. Forms received past the deadline or not completed will be returned.

The summary strip. Information provided here will be used to prepare a printed list of applicants for distribution to employers. Please supply all information requested, and confine your characters to the boxes provided. Use the codes below. Circled letters identify corresponding items on the form and the strip.

(A) Specialties

AL = Algebra	AN = Analysis
BI = Biomathematics	BS = Biostatistics
CB = Combinatorics	CM = Communication
CN = Control	CS = Computer Science
CT = Circuits	DE = Differential Equations
EC = Economics	ED = Mathematical Education
FA = Functional Analysis	FI = Financial Mathematics
FL = Fluid Mechanics	GE = Geometry
HM = History of Math	LO = Logic
MB = Mathematical Biology	ME = Mechanics
MO = Modelling	MP = Mathematical Physics
MS = Management Science	NA = Numerical Analysis
NT = Number Theory	OR = Operations Research
PR = Probability	SA = Systems Analysis
ST = Statistics	TO = Topology

(B) Career Objectives

AR = Academic Research	AT = Academic Teaching
NR = Nonacademic R&D	NC = Nonacad. Consulting
NS = Nonacademic Supervision	

(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

(L) U.S. Citizenship Status

C = U.S. Citizen	P = Permanent Resident
T = Temporarily in U.S.	N = Non-U.S. Citizen

MATHEMATICAL SCIENCES EMPLOYMENT REGISTER

APPLICANT FORM JANUARY 6-8, 1988 ATLANTA, GEORGIA

APPLICANT: Name_____

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_____ Salary_____

Ⓚ References (Name and Institution)

_____

_____

_____

Ⓛ Citizenship_____

Ⓜ AVAILABLE FOR INTERVIEWS:

(Interviews for Session 4 scheduled on the basis of employer's request only.)

Session 1 ☐	Session 2 ☐	Session 3 ☐	Session 4 ☐
Thurs. AM 9:30-11:45	**Thurs. PM 1:15-5:00**	**Fri. AM 9:30-11:45**	**Fri. PM 1:15-5:00**

I do not plan to attend the Winter Meeting ☐

SUMMARY STRIP

Family Name, First Name, Mailing Address, Address (cont'd.), Address (cont'd.), State & Zip Code, Ⓐ Specialties, Ⓑ Career objectives, Ⓒ Highest Degree, Ⓒ Yr., Ⓒ Institution, Ⓓ, Ⓔ, Ⓕ, Ⓖ Most recent employer, Ⓗ Present duties, Ⓘ Desired duties, Ⓙ Available mo./yr., Ⓛ, Ⓜ Sessions

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 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 Atlanta meeting announcement.)**

EMPLOYER FORM Institution _____ Dept. _____

Name of Interviewer(s) 1. _____ 2. _____

3. _____ 4. _____

City, State, Zip _____

Ⓐ Title(s) of Position(s) _____ Ⓑ Number of Positions _____ Number of People Supervised _____

Ⓒ Starting Date ____/____ mo. yr. Salary _____ Ⓓ Term of Appointment _____ yrs. Ⓔ Renewal ( ) Possible ( ) Impossible Tenure Track Position Yes ( ) No ( ) Unknown ( )

Teaching hrs./week _____ Ⓕ Specialties Sought _____

Ⓖ Degree Preferred _____ Ⓗ Degree Accepted _____ Ⓘ Duties _____ Ⓙ Experience _____ Ⓚ Citizenship Restriction _____

Ⓛ Available for Interviews **Session 1 ( ) Thurs. AM, 9:30-11:45** **Session 2 ( ) Thurs. PM, 1:15-5:00** **Session 3 ( ) Fri. AM, 9:30-11:45** **Session 4 ( )* Fri. PM, 1:15-5:00**

Ⓜ Number of Interviewers: _____ **Interviewers** _____ **Interviewers** _____ **Interviewers** _____ **Interviewers**

Institution, City, State, Ⓐ Title of position, Ⓑ No., Ⓒ Start mo. / yr.

Ⓓ, Ⓔ, Ⓕ Specialties sought, Ⓖ, Ⓗ, Ⓘ Duties, Ⓙ Experience, Ⓚ, Ⓛ Sessions

NOTES: Ⓐ Inst, Lect, Asst Prof, Asso Prof, Prof, Dean, Open, MTS (Member Technical Staff), OPAN (Operations Analyst), PREN (Project Engineer), RESC (Research Scientist); Ⓒ Date 01/88, e.g.; Ⓔ Possible=P, Impossible=I; Ⓕ 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; Ⓖ Ⓗ Bachelor=B, Master=M, Doctor=D; Ⓘ Ⓙ Teaching=T, Undergraduates=U, Graduates=G, Research=R, Consulting=C, Administration=A, Supervision=S, Industry=IND, Government=GOV, Date Processing=DP, No experience required=N; Ⓚ U.S. Citizen=C, U.S. Citizen or permanent resident=CP, No restriction=NR; Ⓛ Periods available for interviews: List 1, 2, 3, and/or 4, see the FORM above.

* Interviews are scheduled in this session on the basis of employers request only.

AMERICAN MATHEMATICAL SOCIETY

Please read the reverse side of this form to determine what membership category you are eligible for. Then fill out this application and return it as soon as possible. Your name will be added to our mailing lists upon our receipt of your completed application, and payment for member dues.

Subscriptions to the Notices *and the* Bulletin *(New Series) are included as part of your membership.*

Family Name ***First*** ***Middle***

Please indicate below the way your name should appear in the Combined Membership List.

. . . .

Family Name ***First*** ***Middle or Initial***

Place of Birth . . . .

City ***State*** ***Zip Country***

Date of Birth . . . .

Day ***Month*** ***Year***

If formerly a member of AMS, please indicate dates . . . .

Check here if you are now a member of either MAA or SIAM ◯

Degrees, with institutions and dates . . . .

. . . .

. . . .

Present position . . . .

Firm or institution . . . .

. . . .

City ***State*** ***Zip Country***

Primary Fields of Interest (*choose five from the list at right*)

. . . .

Secondary Fields of Interest (*choose five from the list at right*)

. . . .

Address for all mail

. . . .

. . . .

. . . .

. . . .

Signature

Prepayment Methods and Mailing Addresses

All payments must be in U.S. Funds.

Send checks, money orders, UNESCO coupons to American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-9930

To use VISA or MasterCard, fill in information requested and mail to American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

For Foreign Bank Transfers: The name and address of the AMS bank is Rhode Island Hospital Trust National Bank, Account #000-753-111, One Hospital Trust Plaza, Providence, RI 02903, U.S.A.

VISA ◯ *MasterCard* ◯ . . . .

Account number ***Expiration date***

Application for Membership 1988

Date . . . . 19 . . . .

Fields of Interest

If you wish to be on the mailing lists to receive information about publications in fields of mathematics in which you have an interest, please consult the list of major headings of the 1980 Mathematics Subject Classification below. Select no more than five category numbers and fill in the numbers where indicated on the left. These categories will be added to your computer record so that you will be informed of new publications or special sales in the fields you have indicated.

00	General
01	History and biography
03	Mathematical logic and foundations
04	Set theory
05	Combinatorics
06	Order, lattices, ordered algebraic structures
08	General mathematical systems
11	Number theory
12	Field theory and polynomials
13	Commutative rings and algebras
14	Algebraic geometry
15	Linear and multilinear algebra; matrix theory
16	Associative rings and algebras
17	Nonassociative rings and algebras
18	Category theory, homological algebra
19	K-theory
20	Group theory and generalizations
22	Topological groups, Lie groups
26	Real functions
28	Measure and integration
30	Functions of a complex variable
31	Potential theory
32	Several complex variables and analytic spaces
33	Special functions
34	Ordinary differential equations
35	Partial differential equations
39	Finite differences and functional equations
40	Sequences, series, summability
41	Approximations and expansions
42	Fourier analysis
43	Abstract harmonic analysis
44	Integral transforms, operational calculus
45	Integral equations
46	Functional analysis
47	Operator theory
49	Calculus of variations and optimal control; optimization
51	Geometry
52	Convex sets and related geometric topics
53	Differential geometry
54	General topology
55	Algebraic topology
57	Manifolds and cell complexes
58	Global analysis, analysis on manifolds
60	Probability theory and stochastic processes
62	Statistics
65	Numerical analysis
68	Computer science
70	Mechanics of particles and systems
73	Mechanics of solids
76	Fluid mechanics
78	Optics, electromagnetic theory
80	Classical thermodynamics, heat transfer
81	Quantum mechanics
82	Statistical physics, structure of matter
83	Relativity
85	Astronomy and astrophysics
86	Geophysics
90	Economics, operations research, programming, games
92	Biology and behavioral sciences
93	Systems theory; control
94	Information and communication, circuits

M8NO

Membership Categories

Please read the following to determine what membership category you are eligible for, and then indicate below the category for which you are applying.

*For **ordinary members** whose annual professional income is below $30,000, the dues are $66; for those whose annual professional income is $30,000 or more, the dues are $88.*

*For a **joint family membership,** one pays ordinary dues, based on his or her income, and the other pays ordinary dues based on his or her income, less $20. (Only the member paying full dues will receive the* Notices *and the* Bulletin *as a privilege of membership, but both members will be accorded all other privileges of membership.)*

*Minimum dues for **contributing members** are $132.*

*For either **students** or **unemployed individuals,** dues are $22, and annual verification is required.*

*The annual dues for **reciprocity members** who reside outside the U.S. and Canada are $44. To be eligible for this classification, members must belong to one of those foreign societies with which the AMS has established a reciprocity agreement, and annual verification is required. Reciprocity members who reside in the U.S. or Canada must pay ordinary member dues ($66 or $88).*

*The annual dues for **external members**, those who reside in developing countries which do not have any mathematical society, are $47.*

*Members can purchase a **multi-year membership** by prepaying their current dues rate for either two, three, four or five years. This option is not available to either unemployed or student members.*

1988 Dues Schedule

For any category of membership where no dues prices are given, the higher one is to be paid by persons whose annual professional income is $30,000 or more.

Ordinary member	○ $66	○ $88	
Joint family member (full rate)	○ $66	○ $88	
Joint family member (reduced rate)	○ $46	○ $68	
Contributing member (minimum $132)	○		
Student member (please verify)[1]	○ $22		
Unemployed member (please verify)[2]	○ $22		
Reciprocity member (please verify)[3]	○ $44	○ $66	○ $88
External member	○ $47		
Multi-year membership	$	for	years

1 Student Verification (sign below)

I am a full-time student at .....

..... *currently working toward a degree.*

2 Unemployed Verification (sign below) *I am currently unemployed and actively seeking employment. My unemployment status is not a result of voluntary resignation or of retirement from my last position.*

3 Reciprocity Membership Verification (sign below) *I am currently a member of the society indicated on the right and am therefore eligible for reciprocity membership.*

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
- ○ Islenzka Staerdfraedafelagid
- ○ Israel Mathematical Union
- ○ Korean Mathematical Society
- ○ London Mathematical Society
- ○ Malaysian Mathematical Society
- ○ Mathematical Society of Japan
- ○ Mathematical Society of the Philippines
- ○ Mathematical Society of the Republic of China
- ○ New Zealand Mathematical Society
- ○ Nigerian Mathematical Society
- ○ Norsk Matematisk Forening
- ○ Österreichische Mathematische Gesellschaft
- ○ Polskie Towarzystwo Matematyczne
- ○ Punjab 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 Ciències Fisiques, Quimiques i Matemàtiques
- ○ Société de Mathématiques Appliquées et Industrielles
- ○ Société Mathématique de Belgique
- ○ Société Mathématique de France
- ○ Société Mathématique Suisse
- ○ Southeast Asian Mathematical Society
- ○ Suomen Matemaattinen Yhdistys
- ○ Svenska Matematikersamfundet
- ○ Union Matemática Argentina
- ○ Unione Matematica Italiana
- ○ Vijnana Parishad of India
- ○ Wiskundig Genootschap

.....

Signature

EMPLOYMENT INFORMATION IN THE MATHEMATICAL SCIENCES

The American Mathematical Society, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics publish *Employment Information in the Mathematical Sciences* six times a year. The following resolution was passed on October 25, 1974, by the Council of the American Mathematical Society: "The Council of the AMS adopts principles that all positions in the mathematical sciences shall insofar as practicable be advertised, and that the standard place for the advertisements to appear is the publication *Employment Information*." A similar resolution was subsequently approved by the Board of Governors of the Mathematical Association of America.

The November, January, March, May, and August issues contain listings of open positions, information for which has been provided by heads of mathematics departments of colleges and universities in the United States, Canada, and overseas. In addition, these issues contain descriptions of open positions within government, industry, and other nonacademic areas. The December issue contains résumés of job applicants who will be participating in the Employment Register at the January Annual Meeting.

Subscription rates include first-class delivery in North America and airmail delivery elsewhere. The 1988 subscription starts with the November 1987 issue and ends with the August 1988 issue. All subscribers receive all six issues regardless of when the order is received.

Subscription Order Form

Check one: ☐ Institution, $117; ☐ Individual, $70; ☐ Student or unemployed, $29*

Ordered by _____ Mail to (if different) _____

*To qualify for this rate, please complete one of the following:

☐ I am currently unemployed and actively seeking employment. My unemployed status is not the result of voluntary resignation or retirement from my last position. I am not enrolled in a graduate study program.

☐ I am a full-time student in a program leading to a degree or diploma at _____.

_____
(signature)

Prepayment is required. Make checks payable to the American Mathematical Society and mail to P.O. Box 1571, Annex Station, Providence, RI 02901-9930.

Change of Address Form

Old address _____ New address _____

Please check one:

☐ Use my new address only for my EIMS subscription.

☐ Use my new address for all mailings from the American Mathematical Society.

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Annex Station
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Providence, RI 02901-9930

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Order Form

American Mathematical Society
P. O. Box 6248
Providence, Rhode Island 02940
(401) 272-9500

Charge by Phone
800-556-7774

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Mail to (if different) _____

Use your peel-off *Notices* label.

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		Shipping and Handling ☐ Surface ☐ Air	
		Total due (**All orders must be prepaid**)	$

√ Check Method of Payment

☐ Check or Money Order ☐ VISA ☐ MasterCard

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