NOTICES OF THE AMERICAN MATHEMATICAL SOCIETY

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Calendar of AMS Meetings and Conferences

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

Abstracts of papers presented at a meeting of the Society are published in the journal *Abstracts of papers presented to the American Mathematical Society* in the issue corresponding to that of the *Notices* which contains the program of the meeting. Abstracts should be submitted on special forms which are available in many departments of mathematics and from the headquarters office of the Society. Abstracts of papers to be presented at the meeting must be received at the headquarters of the Society in Providence, Rhode Island, on or before the deadline given below for the meeting. Note that the deadline for abstracts for consideration for presentation at special sessions is usually three weeks earlier than that specified below. For additional information, consult the meeting announcements and the list of organizers of special sessions.

Meetings

Meeting #		Date	Place	Abstract Deadline	Program Issue
848	*	April 15–16, 1989	Worcester, Massachusetts	Expired	March
849	*	May 19–20, 1989	Chicago, Illinois	Expired	April
850	*	August 7–10, 1989 (92nd Summer Meeting)	Boulder, Colorado†	May 16	July/August
851	*	October 21–22, 1989	Hoboken, New Jersey	August 16	October
852	*	October 27–28, 1989	Muncie, Indiana	August 16	October
853		November 18–19, 1989	Los Angeles, California	August 16	November**
854		January 17–20, 1990 (96th Annual Meeting)	Louisville, Kentucky	October 11	December
		March 16–17, 1990	Manhattan, Kansas		
		August 8-11, 1990 (93rd Summer Meeting)	Columbus, Ohio		
		November 2–3, 1990	Denton, Texas		
		January 16–19, 1991 (97th Annual Meeting)	San Francisco, California		
		August 8-11, 1991 (94th Summer Meeting)	Orono, Maine		
		January 8-11, 1992 (98th Annual Meeting)	Baltimore, Maryland		
		June 29-July 1, 1992 (Joint Meeting with the London Mathematical Society)	Cambridge, England		
		January 13-16, 1993 (99th Annual Meeting)	San Antonio, Texas		
		January 5-8, 1994 (100th Annual Meeting)	Cincinnati, Ohio		

* Please refer to page 294 for listing of special sessions.

** Please note a change in this date making it later than previously published.

† Preregistration/Housing deadline is June 1

Conferences

May 26–May 30, 1989: AMS Pure Mathematics Symposium on Complex Geometry and Lie Theory, Sundance Resort, Sundance, Utah

May 29–June 9, 1989: AMS-SIAM Summer Seminar on the Mathematics of Random Media, Virginia Polytechnic Institute and State University, Blacksburg, Virginia

June 3–August 5, 1989: Joint Summer Research Conferences in the Mathematical Sciences, Humboldt State University, Arcata, California

July 10–30, 1989: AMS Summer Research Institute on Several Complex Variables and Complex Geometry, University of California, Santa Cruz, California

August 6–7, 1989: AMS Short Course on Cryptology and Computational Number Theory, Boulder, Colorado

August 7, 1989: AMS-SIAM-SMB Symposium on Some Mathematical Questions in Biology, Sex Allocations and Sex Change: Experiments and Models, University of Toronto.

Deadlines

	May/June Issue	July/August Issue	September Issue	October Issue
Classified Ads*	April 21, 1989	June 12, 1989	July 31, 1989	Aug 28, 1989
News Items	April 27, 1989	June 12, 1989	Aug 3, 1989	Aug 29, 1989
Meeting Announcements**	April 20, 1989	June 5, 1989	July 27, 1989	Aug 22, 1989

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

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

NOTICES
OF THE
AMERICAN MATHEMATICAL SOCIETY

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

The paper used in this journal is acid-free and falls within the guidelines established to ensure permanence and durability. ♾

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Inside the AMS

Since *Notices* has taken on its new format, the Managing Editor has been responsible for the various commentaries which have appeared in this section, referred to in-house as "page 2." The Managing Editor then was James A. Voytuk, who in January took a new position as Director of Project MS 2000 at the National Academy of Sciences. For the next few issues, I will be providing commentaries for "page 2."

While thinking about the various items I might bring to the attention of the readers of *Notices*, I kept returning to a fact that has made a very big impression on me in the short time I have been working with the Society. I have been a member of the Society for many years and have served on some of the more active Society committees; however, I had no perception of the breadth of the Society's activities nor the scope of the operations of the Providence and Ann Arbor offices. Also, there is the "Washington presence of the Society" through the activities of the Joint Policy Board for Mathematics and its Office of Governmental and Public Affairs. Most members are aware of the "Washington presence" but may not be familiar with the exact nature of the Society's involvement in these activities. In sharing these early impressions with colleagues and the staff, it was clear that my experience as a member was not unique.

To better acquaint members with the Society, the *Notices* column "Inside the AMS" will begin a series of articles about the operations and plans of the Society. Readers of *Notices* can expect to see articles giving an overview of the publication program as well as articles detailing some of the most important operations in the publication area. If you have ever wondered what was involved in the production of *Mathematical Reviews* and the creation of the *MR* Database, you will find this in future *Notices* articles, and I think you will be very pleased with the efforts of the Society in the development and maintenance of this important bibliographic data base. In the latter stages of planning is a system for the electronic exchange of information among mathematicians. I find the Society's plans for this system very exciting.

I could go on listing activities of the Society in which members have expressed interest and which will be reported on in future articles in *Notices*; however, I think I will close by saying that we do want the members to know about the Society and to be involved in its activities. I hope that future articles featured in the column "Inside the AMS" will help in our communication with members and the readers of *Notices*.

William Jaco
Executive Director

Letters to the Editor

Assistantships and Fellowships in *Notices*

I wish to protest the decision to no longer include the listing of "Assistantships and Graduate Fellowships in the Mathematical Sciences" in the December issue of *Notices*. By publishing this listing separately and charging $9 or $15 for it the Society is doing a major disservice to the mathematical community by limiting access to this information. With the current and projected shortage of mathematicians, the American Mathematical Society should be at the forefront of the effort to attract and encourage talented undergraduates to pursue graduate studies in mathematics. The one avenue most undergraduates have to receive information and advice on a career in mathematics is through their college professors. If we do not receive information on what's available, we cannot pass it on to our students.

It is ironic that the same issue of *Notices* [November 1988] which announces this change in format also contains the AMS-MAA Annual Survey. This article by Edward A. Connors contains the statement: "We again express our deep concern at the low number of American citizens receiving doctorates in the mathematical sciences. Tables 4 and 5, and the accompanying graphs, provide cause for alarm within the mathematical community and the many groups it services. American business, industry, government, and academe must be prepared for the severe effects of this drought." [pg. 1306]

Edward David's Keynote Address given at the Centennial Meeting and printed in the October issue of *Notices* listed an agenda of items the mathematical community should pursue. One of these items is to "find better ways to attract the young" to mathematics. While it is true that money alone will not suffice, I have found that students have been very surprised and impressed with the amount of financial assistance available to graduate students. We need to continue to make this information readily available to interested undergraduates.

In the last several years I have lent my copy of the December *Notices* to a number of undergraduates, both to seniors who have already decided to pursue the study of mathematics and to sophomores who were uncertain but perhaps interested in mathematics as a career. It think that this information on the available levels of financial assistance encouraged them to seriously consider mathematics as a career. I hate to think that a shortsighted decision on the part of the Society to decrease circulation and increase revenue will have a negative impact on the future supply of mathematicians.

David G. Hartz
College of Wooster
(Received November 28, 1988)

EDITOR'S NOTE: "The decision to remove the information on assistantships and fellowships from *Notices* was made by the Executive Committee of the Council and the Board of Trustees (ECBT) at their joint meeting in May 1987, and was part of their general consideration of changes in *Notices*. The ECBT felt that the information on assistantships and fellowships was of serious interest to only a fraction of the full membership, primarily those engaged in advising undergraduate mathematics majors interested in graduate study in mathematics. The consensus was that the December issue of *Notices* would be more valuable to the full membership if it were a regular issue and carried the standard features, columns, and news items. Furthermore, they felt that those interested in the information could be equally well served by an independent publication. The intention of the ECBT in approving this change was not to raise revenue nor to reduce significantly the general availability of the information.

This year's distribution arrangement provides for five free copies to the mathematics department at colleges and universities which are institutional members, two free copies to each department listing its program in the publication, and from three to five free copies to each department advertising its program in the publication. The motivation for this particular distribution arrangement was to provide copies to institutional members as a benefit of their memberships, to offer an incentive for participation in the survey which gathers the data needed to produce a departmental listing, and to encourage advertising in the publication."

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. All published letters must include the name of the author.

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

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

More on Typesetting

This is an open reply to a Letter to the Editor, printed in the November 1988 AMS *Notices* on p. 1299.

I found George Bergman's letter on *Uniform Style for Papers* most interesting. However, I don't share all his views in these matters.

I have been using TEX for seven years now, writing a big book, some journal articles and lots of smaller papers with it.

On point (1), having your formulas distorted by an ignorant typesetter, he is perfectly right of course! I think one of the advantages of using TEX or some similar system is that your formulas appear in print *exactly as* you *want them*, and not differently.

On point (2), if equations should be numbered on the right or on the left, I disagree with him. I don't think it matters at all, and since there are provisions to get the numbering at any side, I think it is wiser to let people have the equation numbers where they want to!

(3), the use of unreasonably small second order subscripts and superscripts: Agreed on this one!

(4), the use of very thin strokes in some calligraphic letters. He is right again!—But I would like to comment a little more here. I think that a quite bad habit has evolved, trying to mimic in fonts various notations used in *handwriting* or in *ordinary typing*. I am aiming at the doubly written letters, which in type preferably could be replaced by boldface. Nowadays you can even see underscored portions of computer typeset, printed text, instead of italicized. If a sort of standard recommendation could be issued, covering some such cases of text editing, I think a certain effort to achieve this would be worthwhile.

(5), the influence of stubborn text editors on the author's choice of particularly marked words, such as THEOREM. Of course it is the author, who should decide which words should be marked like this!

(6) the use of extra space around formulas in text. I very strongly disagree on this one! I think it is covered by my comment on point (4) above; it is just a habit from typewriting, where you cannot distinguish between a one-letter word, such as 'I' or 'a' and a math symbol I or a. But in typesetting, the latter are italicized, and so the difference is noticeable to the reader. I think an extra space here disturbs the reading more than it helps the reader!

(7). The adding of your electronic mail address is a good idea!

Hans Riesel
Royal Institute of Technology,
Stockholm
(Received December 30, 1988)

MARSHALL HARVEY STONE
1903-1989

Marshall Stone was born in New York City on April 8, 1903. He was the son of Harlan Fiske Stone and Agnes Harvey Stone. Harlan Stone was a prominent jurist who served on the U.S. Supreme Court from 1925 to 1946 and as chief justice from 1942 to 1946. The family lived in Englewood, New Jersey, during Stone's school days and he attended the local public schools. In 1919 at the age of only 16 he entered Harvard University from which he was graduated, summa cum laude, in 1922.

Although it had been assumed that Marshall would follow his father into the law, a growing fascination with mathematics led to an extraordinary arrangement in which he spent the academic year 1922-1923 as a part time instructor at Harvard to find out whether he liked teaching. It turned out that he did and proceeded quickly to write a Ph.D. thesis under the direction of G.D. Birkhoff. The degree was awarded in 1926 but the work was completed rather earlier. The very distinguished mathematical career of Marshall Stone was under way.

Before settling down at Harvard for the thirteen year period 1933–1946 Stone held a variety of positions. He was at Columbia from 1925 to 1927, at Harvard from 1927–1931, at Yale from 1931 to 1933 and at Stanford for the summer of 1933. He became a full professor at Harvard in 1937. These early years were enormously fruitful ones for Stone's career as a research mathematician—so much so that he was elected a member of the National Academy of Sciences in 1938 at the unusually early age of 35.

His first paper was a short note on normal orthogonal sets of functions published in 1925 and by 1928 had published ten more papers on various aspects of the theory of orthogonal expansions—special emphasis being placed on expansions in terms of eigenfunctions of linear differential operators. This was one of the principal interests of G. D. Birkhoff and Stone's work was in the same tradition. Then in 1929 he began to work on the abstract theory of possibly unbounded self adjoint operators in Hilbert space, announcing his results with three notes published in the *Proceedings of the National Academy of Sciences* in 1929 and 1930. This work culminated in a six hundred page book which is now one of the great classics of twentieth century mathematics. It was entitled "Linear transformations in Hilbert space and their applications to analysis". This comprehensive and beautifully written book has been enormously influential. Modern functional (or abstract) analysis began with the ideas of Volterra on "functionals" in the late nineteenth century and was transformed and given considerable impetus in the first two decades of the twentieth century by the work of Hilbert and F. Riesz. The very different books of Banach (1922) and Stone set the stage for the extensive developments of the past half century.

In his introduction Stone freely acknowledges his scientific debt to J. von Neumann. Von Neumann published a long paper on the same subject in 1929 and it is not easy to disentangle their respective contributions. What is clear is that Stone was originally stimulated by

preliminary work of von Neumann but had many key ideas quite independently. Moreover the whole last half of the book, including the chapter on spectral multiplicity theory and the extensive applications to differential and integral operators, has no counterpart in von Neumann's writings. The central point of the work of both men was the extension of Hilbert's spectral theorem from bounded to unbounded operators. This extension was made necessary by the problem of making mathematically coherent sense of the newly discovered refinement of classical mechanics known as quantum mechanics. Here an important part of the problem was discovering the "correct" definition of self adjointness for unbounded operators. This correct definition is rather delicate and the extension of the older theory of Hilbert and others was a major task.

The last of the three notes mentioned above was entitled "Linear transformations in Hilbert space III. Operational methods and group theory". The material it summarized was originally meant to be included as an extra chapter of the book but was omitted for reasons of space. The two theorems it announces are of sufficient importance to be discussed here in some detail.

Three years earlier, in 1927, Hermann Weyl and Eugene Wigner had introduced group theoretical methods into the new quantum mechanics in quite different ways. Weyl's idea was to use group theory to help clarify the foundations. His paper, written in physicists' language, implicitly conjectured two theorems about one parameter groups of unitary operators in Hilbert space. Stone's note states these conjectures as carefully formulated theorems, announces that he is in possession of proofs and gives some indication of their nature. Detailed proofs of both theorems were published in 1932—one by Stone and one by von Neumann. Both theorems were not only important for quantum mechanics, in the manner indicated by Weyl, but were also highly significant early steps in the then nascent unitary representation theory of non compact locally compact groups. One of them also played an important role in the chain of events leading through a note of B.O. Koopman to the ergodic theorems of von Neumann and Birkhoff and on to modern ergodic theory.

At this point it is useful to distinguish between two versions of one of Stone's theorems. The version suggested by Weyl's paper (and which stimulated Koopman) asserts that for every one parameter unitary group $t \to U_t$ there is a unique self adjoint operator H such that $U_t \equiv e^{iHt}$. The version emphasized in Stone's note is an analogue of the spectral theorem for one parameter unitary groups. This version has the great advantage that it can be generalized almost verbatim to arbitrary (separable) locally compact commutative groups.

The other theorem—the celebrated Stone-von Neumann uniqueness theorem—states the uniqueness of the irreducible solutions of the Heisenberg commutation relations in integrated form. It may be interpreted as giving a complete determination of all unitary irreducible representation of a certain non compact non commutative locally compact group—now well known as the Heisenberg group. So interpreted, it is the first example of such a determination by about a decade. Finally a series of natural generalizations of the Stone-von Neumann uniqueness theorem culminated in the imprimitivity theorem and the extension of the notion of induced representation from finite groups to general locally compact groups.

In 1934 and 1935 Stone published two more notes in the *Proceedings of the National Academy* which seemed at first to represent a completely new departure. They were entitled "Boolean algebras and their applications to topology" and "Subsumption of Boolean algebras under the theory of rings". Actually, just as Stone's work on spectral theory may be regarded as a natural outgrowth of his earlier work on concrete eigenfuntion expansions, so can his work on Boolean algebras be regarded as a natural outgrowth of his work on spectral theory. This is because of the role played in spectral theory by Boolean algebras of projections. In an entirely characteristic attempt to get to the bottom of things Stone undertook a thoroughgoing study of Boolean algebras and made a number of far reaching discoveries relating Boolean algebras to general topology on the one hand and to the theory of rings and ideals on the other.

The discovery of these connections has had significant consequences for all three subjects. One beautiful result is the celebrated Stone-Weierstrass theorem vastly generalizing the theorem of Weierstrass concerning the uniform approximability of arbitrary continuous functions on a finite interval by polynomials. Another is the natural one to one correspondence between all compact Hausdorff spaces on the one hand and certain rings on the other. Stone's studies of the relationship between compact spaces and rings of continuous funtions anticipated important elements in the modern theory of commutative Banach algebras. The detailed development of Stone's ideas on Boolean algebras, general topology, etc. were published in three lengthy papers in 1935, 1936 and 1937 respectively. The first appeared in the *American Journal of Mathematics* and the second and third in the *Transactions of the American Mathematical Society*. Applications of the new ideas to spectral theory were announced in notes published in 1940 and 1941.

Soon after the entry of the United States into World War II the character of Stone's work underwent a considerable change. For several years he was engaged in secret work for the U.S. government. A year after the end of the war he resigned his position at Harvard to take on the chairmanship of the mathematics department at the University of Chicago. This once great department

had been declining in quality and Stone's mission was to strengthen it and bring it up to its former stature. In this he succeeded admirably. Before very long it was regarded by many as the best mathematics department in the country and, while a position like that is hard to keep indefinitely, it has remained one of the strongest departments ever since. He brought in André Weil, S.S Chern, Saunders Mac Lane and a number of promising younger men. Moreover in the words of one of the latter "Marshall devoted himself with both intensity and breadth,—from the largest issues to the smallest details—to the Department's welfare and development".

In 1952, Stone turned the chairmanship of the Chicago department over to Saunders Mac Lane but continued to be occupied with administrative matters. He was a strong force in reestablishing the International Mathematical Union—was much involved in the drafting of its constitution and served as its president from 1952 to 1954. He also interested himself actively in the problems of mathematical and scientific teaching—especially at the international level—and served on various boards and commissions.

While his various administrative concerns and activities prevented him from working on mathematical problems with his former intensity Stone continued to work and to publish results rather steadily until the early 1960's. At the same time his mathematical interests tended more and more toward the elucidation of questions of great generality and and profundity about the true nature of mathematics and mathematical concepts. There is reason to believe that his publications of the last thirty years give a very incomplete picture of his mathematical activity. At a conference in honor of his second retirement (see below) Stone gave a remarkable two hour lecture outlining his rather unusual and original views on the nature and structure of mathematics.

Stone remained at the University of Chicago until he retired as Professor Emeritus in 1968. At this time there was a week long conference in his honor the proceedings of which were published in 1970 by Springer-Verlag. Felix Browder was the editor. He did not wish to stop teaching however and forthwith began a new career as George David Birkhoff professor of mathematics at the University of Massachusetts in Amherst. No doubt the fact that Amherst, Massachusetts had been his father's childhood home added to the attractiveness of this move. He taught there for the next twelve years and among other activities supervised two Ph.D. theses. During his final year he was honored with a second retirement conference.

One of the many striking accomplishments of Marshall Stone was a truly extraordinary command of the English language. This gave a special flavor to his book, his mathematical papers and his many writings on other subjects.

His skill with the English language also manifested itself in his lectures which were models of clarity and organization. Stone was only moderately active in supervising Ph.D. theses. Indeed there are anecdotes about his reluctance to do this sort of teaching. On the other hand he did turn out a respectable number of new Ph.D.s and influenced many other young mathematicians by his writings and through informal personal contact.

Stone married young (in 1927) and he and his first wife Emmy raised three daughters. Reports have it that he was serious about fatherhood in a rather old fashioned way. His daughters had regular chores to do and in financial matters were kept on strict allowances. On the other hand he also believed in family fun and one of his many side interests was gourmet cookery. This marriage dissolved in divorce in 1962 but Stone soon remarried. His second marriage, to Ravijojla Kostic, lasted the rest of his life.

Of all Stones's many interests his love of travel was surely dominant. He began to travel when he was quite young and was on a trip to India when he died. He travelled frequently and extensively and was interested in seeing *all* parts of the globe. For example he visited the Pacific islands and (while travelling with Ravijojla) was shipwrecked in Antartica. It is very hard to think of a place that he has not come fairly close to at some time or another.

Stone, of course, was the recipient of many honors. We have mentioned his early election to the National Academy of Sciences. He was also elected, at an early age to the American Academy of Arts and Sciences and to the American Philosophical Society. He was president of the American Mathematical Society (1943-1944) and received many honorary doctorates, both domestic and foreign. In 1982 he was awarded the National Medal of Science. According to Edwin Hewitt, two extra honors that gave him special pleasure were his election to an Honorary Professorship at Columbia Teachers College and to membership in the Explorers Club of New York City.

Marshall Stone was a man with a very broad outlook and wide range of interests who seems to have thought rather deeply about a number of issues. One had only to talk to him at length or read his non mathematical writings to come away with the impression that here was an unusually thoughtful man with a high degree of penetration and insight. More than most he seemed well endowed with a quality which I can only describe as wisdom.

While on a visit to Madras, India he died quickly of a sudden illness on January 9, 1989.

George W. Mackey
Harvard University

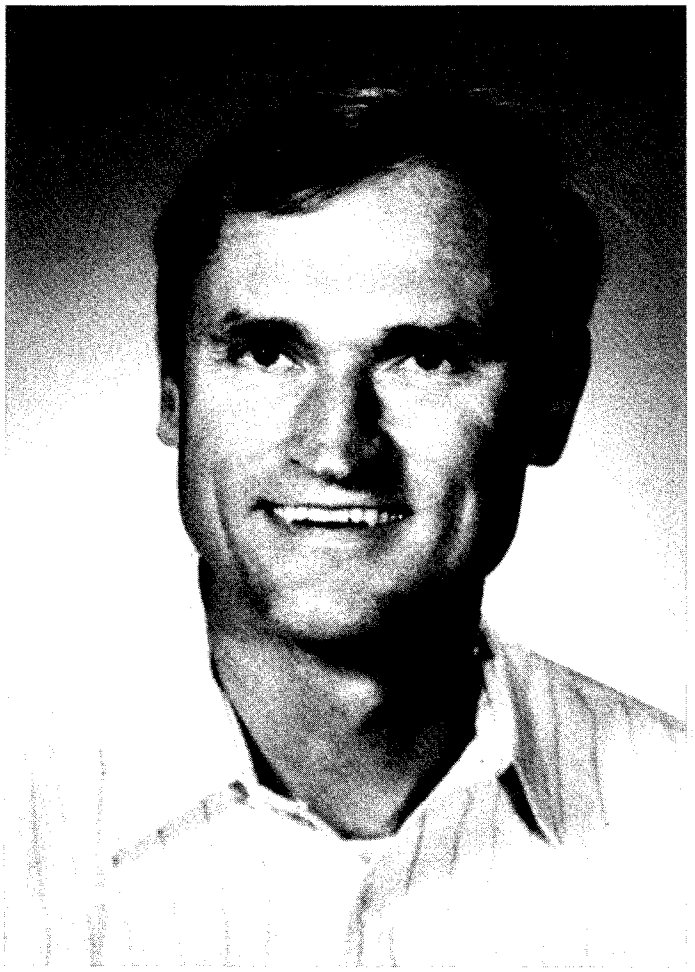
RICHARD M. SCHOEN AWARDED 1989 BÔCHER PRIZE

The Bôcher Prize is awarded every five years for a notable research memoir in analysis which has appeared in the previous five years. The prize honors Maxime Bôcher (1867–1918) who was the Society's second Colloquium Lecturer (1896) and tenth President (1909, 1910), and one of the founding editors of the *Transactions*. The sixteenth award was made at the Society's ninety-fifth Annual Meeting, in Phoenix, Arizona, on January 12, 1989.

The 1989 recipient is RICHARD M. SCHOEN of Stanford University. The Bôcher Prize is augmented by awards from the Leroy P. Steele Fund and currently amounts to $4,000.

The Prize was awarded by the Council of the Society acting on the recommendation of the Committee to Select the 1989 Recipient of the Bôcher Prize, consisting of Paul J. Cohen, Richard B. Melrose, Chairman, and Louis Nirenberg.

The text below includes the Committee's citation, the recipient's response on presentation of the award and a brief biographical sketch of the recipient.



Citation

The 1989 Bôcher Prize is awarded to Richard M. Schoen of Stanford University for his work on the application of partial differential equations to differential geometry, in particular his completion of the solution to the Yamabe Problem in "Conformal deformation of a Riemannian metric to constant scalar curvature". *Journal of Differential Geometry* **20** (1984) pages 479-495.

Response

It is a great honor for me to receive the Bôcher prize of 1989, and I thank the A.M.S. and the Bôcher Committee for recognizing my work in this way. There is a long tradition of interaction between the cited areas of Differential Geometry and Partial Differential Equations. I will discuss the interaction which centers around *nonlinear* problems. An early example which illustrates this tradition is H. Weyl's formulation, in 1916, of the isometric embedding problem for closed surfaces of positive curvature. The geometric problem was reduced to certain estimates which were later obtained by Nirenberg and Pogorelov for smooth metrics. In the meantime Lewy had solved the problem for analytic metrics. This example is typical in that it often happens that a geometric problem can be formulated as a specific problem in P.D.E.; thus from the geometer's point of view P.D.E. often provides the framework necessary to attempt a solution as well as a body of knowledge (estimates, regularity results, and such) and more importantly methods of attack. The interaction benefits both areas because

Differential Geometry provides a rich class of nonlinear problems which serve as model problems from which a body of knowledge may emerge. The geometric meaning of the solution may lead one toward the correct analytical estimates and theorems.

The Yamabe Problem should be viewed as a part of the variational theory for the Einstein-Hilbert variational problem; the elliptic version of the action principle governing the motion of the gravitational field in General Relativity. Yamabe viewed this general problem as an analytic approach to solving the three dimensional Poincaré conjecture. He formulated the problem which bears his name as a semilinear scalar P.D.E. around 1960 and it was solved in special cases by Trudinger and Aubin over the next 15 years. In its strongest form the solution asserts that critical points of the variational problem which are predicted by Morse theory do, in fact, exist. The proof of this general result involves consideration of large energy solutions, and, in fact, one must consider singular weak solutions of the P.D.E. The structure of weak solutions is an intricate topic about which we have limited knowledge. Additionally, an important role in the derivation of the necessary estimates is played by results from General Relativity involving gravitational energy. Thus we return full circle to the origins of the problem.

Another problem which arises from Differential Geometry and has had substantial impact on the development of P.D.E. is the Plateau problem, or the study of minimal submanifolds. The nonparametric minimal surface equation provided a strong impetus for the development of the theory of quasi-linear elliptic equations in the fifties and sixties. A successful higher dimensional parametric theory was begun approximately 30 years ago through the work of DeGiorgi, Federer, and Fleming. A major outgrowth of this work was the introduction of partial regularity theory into P.D.E. The partial regularity method has become a powerful tool applicable to a variety of nonlinear problems. Finally, the theory of minimal hypersurfaces has been applied to obtain results about manifolds of positive scalar curvatures by S.T. Yau and myself. This application uses the analytic theory (existence and regularity) in an important way. Thus the theory of minimal submanifolds is of substantial importance for both geometry and P.D.E.

A common feature of both the fields of nonlinear P.D.E. and global Differential Geometry is that our knowledge in both areas is very primitive, and there are many more unsolved problems than there are theorems. Specific areas in which new results would be important are quasi-linear elliptic systems (hopefully including the elliptic Einstein equations), nonlinear parabolic and hyperbolic evolution equations, and singularities of nonlinear equations. The problems involving singularities which are important include the study of singular sets for elliptic problems such as those of least area submanifolds as well as singularity development in nonlinear evolution equations. I am confident that the long tradition of interaction between Differential Geometry and nonlinear P.D.E. will continue to be fruitful to both fields for many years to come.

Biographical Sketch

Richard M. Schoen was born October 23, 1950, in Celina, Ohio. He received his B.S. degree from the University of Dayton in 1972 and his Ph.D. from Stanford University in 1976 under the direction of Leon Simon and Shing-Tung Yau. He was a lecturer at the University of California, Berkeley from 1976–1978 and an assistant professor at the Courant Institute from 1978–1980. From 1980–1987 he was a professor at the University of California; in Berkeley from 1980–1985 and in San Diego from 1985–1987. Since 1987 he has been Professor of Mathematics at Stanford University.

Professor Schoen has been a visiting member at the Institute for Advanced Study on two occasions, during the 1979–1980 academic year and during the spring semester of 1984. He was a visiting professor at the University of Melbourne in Australia during the fall of 1980 and a visiting professor at Stanford University during the fall of 1983. In the fall of 1985 he was a visitor at the Mittag-Leffler Institute in Sweden and at the Institut des Hautes Études Scientifiques in France.

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EVERYBODY COUNTS

A Report to the Nation on the Future of Mathematics Education
Summary

In January, the National Research Council (NRC) released a major authoritative report on the state of U.S. mathematics education. Presenting a compelling analysis of the problems and challenges in this area, "Everybody Counts: A Report to the Nation on the Future of Mathematics Education" treats mathematics education as all one system, from kindergarten to graduate school. Not merely a plea for reform, "Everybody Counts" charts a bold agenda for change over the next two decades. The report, three years in preparation, is the joint work of two NRC boards, the Mathematical Sciences Education Board and the Board on Mathematical Sciences, together with the Committee on the Mathematical Sciences in the Year 2000, a joint activity of the two Boards.

What follows is the official NRC summary of "Everybody Counts," consisting of a condensation of the last two chapters of the report, which delineate the challenges of mathematics education, current responses to those challenges, and a national plan of action. The quotes appearing in the body of the summary are extracted from the report. The NRC produced only a limited number of copies of this summary, but reprints of it are available from the AMS. The summary is reprinted in *Notices* with the permission of National Academy Press, Washington, DC.

Notices readers are urged to obtain copies of the full report, which are available from National Academy Press, 2101 Constitution Avenue, Washington, DC 20418; telephone 202-334-3313. Prices are as follows: $7.95 for a single copy, $6.50 each for 2-9 copies, and $4.95 each for 10 or more copies. No other discounts apply. Shipping and handling are included, and orders must be prepaid.

Opportunity . . . *tapping the power of mathematics*

"Changing demographics have raised the stakes for all Americans. Never before have we been forced to provide true equality in opportunity to learn. The challenge we face today is to achieve what we believe."

As the 1980s began, an inattentive nation began stirring in response to alarming problems in its educational system. Since then, dozens of reports have analyzed virtually every aspect of U.S. education. Some call for changes in curricula, others for changes in the structure of schools; some cite deficiencies in the ways that teachers are educated, while others examine signs of decay in the social and economic structures of society. All agree that the present educational system must change.

The concern here is with mathematics, which is—apart from English—the most widely studied subject in our nation's schools and colleges. Mathematics education is an immense enterprise involving 35 million students and over a million and a half teachers, accounting for more than 10 percent of the nation's educational expenditures—about $25 billion annually. It is an enterprise rooted in antiquity, with some of today's curricula matching very closely educational patterns of 500 years ago. **Yet, paralleling the larger system of which it is a part, mathematics education has entered a period of significant change, certain to last well into the next century.**

National Needs

Not only in mathematics but also in every other school subject, educators are faced with significant demographic changes and rising expectations for preparing the kind of work force the country will need in the future. Information-age technology will continue to grow in importance. Pressed by rising international competition, American industry will demand improved quality and increased productivity. The world of work in the twenty-first century will be less manual but more mental; less mechanical but more electronic; less routine but more verbal; and less static but more varied.

Communication has created a world economy in which working smarter is more important than just working harder. Jobs that contribute to this world economy require workers who are mentally fit—workers who are prepared to absorb new ideas, to adapt to change, to cope with ambiguity, to perceive patterns, and to solve unconventional problems. It is *these* needs, not just

the need for calculation (which is now done mostly by machines), that make mathematics a prerequisite to so many jobs. **More than ever before, Americans need to think for a living; more than ever before, they need to think mathematically.**

Schools

Historically, schools in the United States were designed with a dual mission: to teach all students the basic skills required for a lifetime of work in an industrial and agricultural economy and to educate thoroughly a small elite who would go to college and then pursue professional careers. As the needs of society have changed, the balance of these two goals has shifted. Although schools have adapted somewhat, today's schools continue to labor under the legacy of a structure designed for the industrial age misapplied to educate children for the information age.

The changing nature of work will make continuing education a lifelong reality for adults. Schools, therefore, will have to provide all students with a strong foundation for continuous learning; colleges and universities will have to educate both young adults and older workers; and industry will have to focus its continuing education on areas that extend, rather than repeat, what schools provide. **Education in the future must build continually, from childhood to retirement, on a versatile and unbroken foundation provided by school education.**

Literacy and Numeracy

Literacy and numeracy—that is, proficiency in language and in mathematics—are the primary sources of strength and versatility in school education. Schools and colleges will have to meet goals now widely held to be unattainable:

- The level of literacy formerly associated with the few who entered college must become a goal for all.
- The degree of facility with mathematics formerly required only of those preparing for scientific careers is now an essential ingredient in the foundation for working careers in the information age.

Mathematical and scientific literacy form the basis of technological expertise in the workplace. In tomorrow's world, the best opportunities for jobs and advancement will go to those prepared to cope confidently and competently with mathematical, scientific, and technological issues. **As the foundation of science and technology, mathematics provides the key to opportunity.**

Opportunity for the Nation

The focus in what follows is on a bold but realistic approach to reforming mathematics education as schools and colleges work toward the demanding objectives now before them. Means must be found for significantly improving student achievement while simultaneously making changes in mathematics education in response to the demands of an increasingly mathematical society. The changes proposed here are:

- rooted in traditional values, yet reflect the greatly increased applicability of mathematics to problems faced almost daily by scientist, engineer, worker, and citizen;
- guided by national goals, but respect state and local autonomy;
- built on the educational reform effort already under way;
- to be carried out locally by the only people who can bring about meaningful and lasting reform—the teachers.

Among the several insights and messages that this report is intended to convey is this uniquely important one: because of emerging general agreement within the mathematics, mathematics education, and related professional communities on the goals for mathematics education and the means for achieving them, the stage is set for the nation to push ahead boldly in this area of education. **In the next decade, the United States has a historic opportunity to revitalize mathematics education.**

Change . . . *mobilizing for reform*

"As technology has 'mathematicized' the workplace and as mathematics has permeated society, a complacent America has tolerated underachievement as the norm for mathematics education. We have inherited a mathematics curriculum conforming to the past, blind to the future, and bound by a tradition of minimum expectations."

Mathematics education in the United States is facing major challenges on nearly every front:

- Far too many students, including a disproportionate number from minority groups, leave school without having acquired the mathematical power necessary for productive lives.
- The shortage of qualified mathematics teachers in this country is serious, more serious than in any other area of education, and affects all levels from elementary school to graduate school.

- At a time when the percentage of minority students is increasing, the shortage of new minority teachers of mathematics is particularly acute.
- On average, U.S. students do not master mathematical fundamentals at a level sufficient to sustain our present technologically based society.
- When compared with students of other nations, U.S. students lag far behind in level of mathematical accomplishment; the resulting educational deficit reduces our ability to compete in international areas.
- Public attitudes, which are reflected and magnified by the media, encourage low expectations in mathematics. Only in mathematics is poor school performance socially acceptable.
- Curricula and instruction in our schools and colleges are years behind the times; they reflect neither the increased demand for higher-order thinking skills, nor the greatly expanded uses of the mathematical sciences, nor what we now know about the best ways for students to learn mathematics.
- Calculators and computers have had virtually no impact on mathematics instruction in spite of their great potential to enrich, enlighten, and expand students' learning of mathematics.
- Commonly employed methods of evaluation—especially standardized, paper-and-pencil, multiple-choice tests of "basic skills"—are themselves obstacles to the teaching of higher-order thinking skills as well as to the use of calculators and computers.
- Undergraduate mathematics is intellectually stagnant, overgrown with stale courses that fail to stimulate the mathematical interests of today's students.

Counterproductive Beliefs

"As mathematics is more than calculation, so education in mathematics must be more than mastery of arithmetic."

It is mistakenly thought by many otherwise well-informed adults that the mathematics they learned in school is adequate for their children. But mathematics has changed. It is significantly more diverse than it was several decades ago when most of today's adults went to school. The mathematics commonly used today goes far beyond arithmetic and elementary geometry. Members of the armed forces as well as workers in manufacturing and the burgeoning service sector are called upon regularly to operate complex machines and to interpret graphs, data, and probabilities.

Parental and legislative pressures in the past few years, driven largely by frustration over declining test scores, have led to some rash actions:

- Increased numbers of required courses—where there is no agreement on what the added courses should contain or where capable teachers are to be found to teach them.
- Increased reliance on standardized tests—where there is very little understanding of what the tests contain or what they are capable of testing.
- Increased use of test scores, especially for teacher and school accountability—where there is little recognition that the tests reflect only a small part of curricular objectives.

Too often, the results of such actions are unreliable tests, watered-down curricula, and diminished morale. The nation is in the grip of a testing mystique that has led to widespread misuse of standardized tests. **Public pressures for "back-to-basics" stem from a very limited understanding of the challenges we face. Carried to the extreme, these pressures could rob our children of the opportunity to learn what they will need to know of mathematics in their adult lives.**

Public Understanding

"As children become socialized by school and society, they begin to view mathematics as a rigid system of externally dictated rules governed by standards of accuracy, speed, and memory. Their view of mathematics shifts gradually from enthusiasm to apprehension, from confidence to fear."

Appropriate response to the challenges of mathematics education will require a systematic effort to develop in the public a deeper understanding of the changes and the improvements needed. This will be a formidable task.

Often, public discussion about mathematics education masks a hidden agenda of values that have traditionally been carried forward by the school study of mathematics. Since the demise of Latin as a required school subject, it is to mathematics that many look as a vehicle to instill such qualities as precision, discipline, neatness, and accuracy. Mathematical truth—in popular caricature—is certain, absolute, unchanging, eternal. Mathematics appears to many to be a safe harbor of calm in a turbulent sea of social and educational change.

In spite of the fact that it is constantly expanding and changing, mathematics more than any other science has been taught as an ancient discipline. **A nation that persists in this antiquated view of mathematics is destined to fall behind scientifically and economically. Parents who persist in this view are denying their children the opportunity to develop and prosper in the information age.**

The American Way

"Why Not Just Imitate Japan? International studies of mathematics and science education show that, when compared with students in other countries, U.S. students do very poorly while Japanese students do very well. One natural response, therefore, is to think that we could improve our educational system by imitating Japan.

These same studies, however, document that the social context of education has a greater influence on student performance than does actual classroom practice. Parental attitudes, student expectations, and teacher self-respect are among the most significant factors in quality education and they depend uniquely on culture.

Imitating others is no solution. The United States must find a strategy that builds on the traditions of this country, one whose strength lies in this nation's unique tradition of local initiative and decentralized authority."

The development of more effective strategies for revitalizing mathematics education must be based in part on an understanding of why it is so difficult to bring about change in education in the United States. The truth we shrink from confronting is that most previous reform efforts have failed. A skeptical public will rightly ask why any new effort is more likely to succeed. Part of the difficulty we face in mathematics education is a natural reflection of our constitutional dilemma: how to reconcile local authority with national need.

In many countries, all children in the same grade study essentially the same material in almost the same way. Such practice, common around the world, reveals a strong tradition of a "top-down" approach in education.

The process of curricular reform prevalent in America might be described as a weak type of grass-roots approach. With little or no outside help, teacher teams at the local level work over the summer in efforts to keep mathematics curricula up to date.

In static times, in periods of unchanging demands, perhaps our grass-roots efforts could suffice to keep curricula current. In today's climate, in which technology and research are causing unprecedented changes in the central methods and applications of mathematics, present U.S. practice is totally inadequate. **International comparisons of student performance in mathematics show that U.S. students lag far behind their counterparts in other industrialized countries. The "top-down" systems have beaten us hands down.**

Lessons from the Past

Because of vast differences in both tradition and constitution, a "top-down" approach will not work in the United States. Experience has much to teach us on that score.

Few traces remain of the expensive, major curriculum development projects so prominent in the 1960s and 1970s. These projects tried to develop, on a national scale, complete curricula (including instructional materials) that could be adopted as a whole by school districts. But the theorists and planners who developed these curricula were naive about the process of change; big curricular projects failed to take root in American schools because they were transplanted fully grown into an environment better suited to locally grown methods.

Where teachers were not directly involved in development, where their identification with the product was not ensured, where they considered district acceptance of new curricula as a "top-down" imposition, the revised programs did not last. **Where parents could not (or did not) understand the need for change or the reasons new curricular emphases were chosen, resentment and anger resulted and a conviction set in that if "the old math" was good enough for them, it was good enough for their children.**

A New Approach

As our country enters a new period of change in mathematics education, we can benefit from several lessons drawn from these previous attempts:

- Free-standing, full-service curriculum development projects adopted intact by school districts do not work.
- A superficial, district-by-district approach to curricular overhaul is potentially disastrous, given the demanding nature of what schools face in mathematics education today.
- Any successful effort to improve mathematics curricula and instruction in the schools will require an extensive public information campaign that reaches all the varied constituencies of mathematics education.

Effective change requires a great deal of the public:

- conviction of the need for change;
- consensus on the importance of high-quality mathematics education for everyone;
- skepticism about "quick fixes" and simplistic solutions;
- awareness of the general nature of the changes needed;
- support for investment of the necessary resources;
- recognition of the need for continuing leadership at the national level.

The time is ripe for a new approach to curricular reform in the United States—one that establishes appropriate national expectations based upon broad public support by all of the constituencies concerned.

Transitions . . . *bridges to the 21st century*

In order to meet the challenges of our time, mathematics education is beginning already to negotiate several difficult transitions that will dominate the process of change during the remainder of this century.

Transition 1: *The focus of school mathematics is shifting from a dualistic mission—minimal mathematics for the majority, advanced mathematics for a few—to a singular focus on a significant common core of mathematics for all students.*

"Everyone depends on the success of mathematics education; everyone is hurt when it fails. Mathematics must become a pump rather than a filter in the pipeline of American education."

The needs of industry for a mathematically and technically literate work force compel schools to provide more mathematical education to more students than ever before. Accomplishing this will pose significant challenges to:

- develop a core of mathematics appropriate for all students throughout each year of school;
- educate well a significantly larger proportion of the population;
- stimulate able students with the excitement and challenge of mathematics;
- differentiate instruction by approach and speed, not by curricular goals;
- select topics and approaches of broad interest and effectiveness.

Transition 2: *The teaching of mathematics is shifting from an authoritarian model based on "transmission of knowledge" to a student-centered practice featuring "stimulation of learning."*

In both schools and colleges, classrooms of passive students who are expected to sit and absorb rules that appear as arbitrary dicta are gradually giving way to learning environments that:

- encourage students to explore;
- help students to verbalize their mathematical ideas;
- show students that many mathematical questions have more than one right answer;
- provide evidence that mathematics is alive and exciting;
- teach students through experience the importance of careful reasoning and disciplined understanding;
- build confidence in *all* students that they can learn mathematics.

Transition 3: *Public attitudes about mathematics are shifting from indifference and hostility to recognition of the important role that mathematics plays in today's society.*

Although the burden of unfavorable school experiences continues to color public opinion about mathematics, contemporary events are sending different messages which are gradually being heard:

- in other nations where more is expected, more mathematics is learned;
- as the roles of science and technology expand, so does the importance of mathematics;
- for an informed citizenry, mathematical literacy is as important as verbal literacy.

As attitudes about the importance of mathematics improve, so will expectations for mathematics education.

Transition 4: *The teaching of mathematics is shifting from preoccupation with inculcating routine skills to developing broad-based mathematical power.*

"Evidence from many sources shows that the least effective mode for mathematics learning is the one that prevails in most of America's classrooms: lecturing and listening."

Broad mathematical power requires that students be able to discern relationships, reason logically, and use a range of mathematical methods to solve a wide variety of nonroutine problems. The repertoire of skills which now

undergird mathematical power includes not only some traditional paper-and-pencil skills, but also many broader and more powerful capabilities. Today's students must be able to:

- perform mental calculations and estimates with proficiency;
- decide when an exact answer is needed and when an estimate will serve the purpose;
- know which mathematical operations are appropriate in particular contexts;
- use a calculator correctly, confidently, and appropriately;
- estimate orders of magnitude to confirm mental or calculator results;
- use tables, graphs, spreadsheets, and statistical techniques to organize, interpret, and present numerical information;
- judge the validity of mathematical and technical information presented by others;
- use computer software for mathematical tasks;
- formulate specific questions from vaguely defined problems;
- select effective problem-solving strategies.

Transition 5: *The teaching of mathematics is shifting from emphasis on preparation for future courses to greater emphasis on topics that are relevant to students' present and future needs.*

Most mathematics should be presented in the context of its uses, with appreciation of mathematics as a deductive logical system built up slowly through the rising levels of education. Examples of areas deserving greater emphasis are:

- probability, which facilitates reasoning about uncertainty and assessment of risk;
- exploratory data analysis and statistics, which facilitate reasoning about data;
- model-building, which facilitates systematic structured understanding of complex situations;
- operations research, which facilitates planning complex tasks and achieving performance objectives;
- discrete mathematics, which facilitates understanding of most applications of computers.

These new topics imply that observation and experimentation will be important in future mathematics programs and that school mathematics will draw closer to other school subjects, especially to science.

Transition 6: *The teaching of mathematics is shifting from primary emphasis on paper-and-pencil calculations to full use of calculators and computers.*

"As a practical matter, mathematics is a science of pattern and order. Its domain is not molecules or cells, but numbers, chance, form, algorithms, and change."

Mathematics teachers at all levels—from elementary school to university—are adapting their teaching methods to include both new approaches to instruction and new subject matter appropriate to future-oriented curricula. Calculators and computers make new modes of instruction feasible at the same time that they inject into the learning environment the special sense of wonder which goes with the healthy development of mathematical power.

Calculators and computers should be used in ways that anticipate continuing rapid change due to technological developments. Technology should be used not because it is seductive, but because it can improve mathematical learning by extending each student's mathematical power. Calculators and computers are not substitutes for hard work or precise thinking, but challenging tools to be used for productive ends.

Transition 7: *The public perception of mathematics is shifting from that of a fixed body of arbitrary rules to a vigorous active science of patterns.*

Mathematics is a living subject that seeks to understand patterns which permeate both the world around us and the mind within us. Although the language of mathematics is based on rules that must be learned, it is important that students move beyond rules to be able to express things in the language of mathematics. This transformation suggests change in both curricular content and instructional style. It involves renewed effort to focus on:

- searching for solutions, not just memorizing procedures;
- exploring patterns, not just learning formulas;
- formulating conjectures, not just doing exercises.

As teaching begins to reflect these emphases, students will have opportunities to study mathematics as an exploratory, dynamic, evolving discipline rather than as a rigid, absolute, closed body of laws to be memorized. They will be encouraged to see mathematics as a science, not as a canon, and to recognize that mathematics is really about patterns and relationships and not merely about numbers.

Action . . . *a new national strategy*

"All students should study mathematics every year they are in school. Secondary school mathematics should provide for all students a core of mainstream mathematics in which different student groups are distinguished not by curricular goals, but only by speed, depth, and approach."

Over the next two decades, all of the major components of mathematics education—curricula, teaching, teacher education, testing, textbooks, and software—must change significantly and in some reasonably coordinated manner. National leadership is needed to coordinate efforts by the primary agents for change and to garner support for them by government, business, industry, and the public.

National Goals

Our national goal must be to make U.S. mathematics education the best in the world. Nothing less will be adequate to fulfill American aspirations. To achieve this goal will require significant actions in response to a three-tiered challenge to:

- make mathematics education effective for all Americans;
- improve significantly students' mathematical achievement;
- put in place new curricula appropriate to the mathematical needs of the twenty-first century.

Actions taken to achieve these broad goals must be based upon an understanding of the total American system of mathematics education, especially understanding of the nature of the changes under way. Unless action is based upon a systematic overview of all of the pertinent issues, it will have very little chance of achieving national impact.

National Strategy

"Few teachers in today's schools have the authority or resources necessary to carry out this agenda. But as schools evolve from a model with teachers as hired hands to one in which teachers function as professional educators, schools should welcome the challenge to implement national standards for mathematics education."

New plans for the renewal of school mathematics must be founded on what we have learned about making changes in the extremely decentralized U.S. system in which local and state agencies control education. Two special strengths of American mathematics education should underpin any movement for renewal:

- The creative efforts of many individuals, schools, and projects around the country, which have begun to move mathematics education through the transitions just described here.
- The unique form of coordinated national leadership, which has evolved within the communities of mathematicians and mathematics educators.

Together, these resources provide an "augmented grass-roots" model of curricular development, coupling national leadership with the flexibility and initiative of the decentralized U.S. tradition.

A national strategy for revitalization which is well suited to the unique strengths and weaknesses of U.S. mathematics must have several major components:

National goals and local implementation. The key to success is voluntary acceptance by school districts of common goals that provide a framework to guide local choices and the construction of detailed programs.

- *National Standards.* School mathematics programs across the nation need to share a common philosophy and framework—a universal set of interrelated concepts and methods held together by a simple workable philosophy, yet flexible enough to allow for local and regional variations. In a highly mobile society, the basic framework should be transportable and adaptable.
- *Local Implementation.* Changes in mathematics curricula must be proposed and undertaken freely by those who bear direct responsibility for curricula in the schools. A deep sense of identification with those changes must be developed within the entire school community. In particular, local teachers and parents need to be involved in adaptation and decision-making in a thorough and comprehensive way.

National discipline-based leadership, such as that now being supplied by the mathematics and mathematics education communities—working with leaders from the diverse constituencies of mathematics education—is needed to:

- lay out the consensual framework, including proposed national standards;
- coordinate an effort to build and sustain national consensus on goals and the approach to be used to achieve them;

- provide a continuing national overview and assessment capability for mathematics education.

State and local coalitions, collaboratives, and teacher support networks will be needed to provide similar leadership at these levels.

National, state, and local leadership—provided by the President, Congress, federal officials, governors, chief state school officers, mayors, legislators, school boards, school superintendents, principals, teachers, and college and university faculty and administration—will be of critical importance to the consensus-building effort and to local adoption of the national standards. National and state education-related organizations, parent groups, business, and industry can also play important leadership roles.

National support structures are needed to enable the primary participants—teachers, schools, state and local education authorities—to work successfully toward national goals in their continuous efforts to upgrade mathematics programs. Local, state, and federal resources should be used cooperatively to provide the variety of materials, teacher support, and increased public awareness necessary to enable teachers to adapt curricula and instructional practices within the nationwide consensual framework.

Teacher professionalism must be strengthened through a concerted national effort. This is an essential element of any effective strategy for reforming mathematics education in the United States. It is the teachers on whom the real burden of reform rests. The task we are setting before them is very demanding and will take many years. Teachers need to approach this task in a highly professional way and they need to be given the sustained support and working environments that will make it possible for them to carry out their vital mission. Initiation of the National Board for Professional Teaching Standards is an important step toward enhancing teacher professionalism. Criteria for excellence in mathematics teaching being developed by the mathematics education community should provide part of the foundation for the standards developed by the board as it undertakes the certification of professional teachers.

Leadership in assessment is needed to align state and national testing programs with the goals of mathematics education and enable assessment to be a constructive force in the national revitalization effort. Test designers and test-makers are well aware of the general problems in this area. They need to join together with the leadership of mathematics education in support of a cooperative national board or other mechanism for promoting use of significantly improved types of assessment by localities, states, and national assessment organizations.

A national plan for college and university mathematics must be developed, one which is closely allied with the plan for school mathematics. This is needed not only because there must be consistency at the school-college interface, but also because college and university faculty influence heavily who become teachers, how they teach, and what they teach. Undergraduate mathematics is the bridge between research and the schools and holds the power of reform in mathematics education. The National Research Council (NRC) Committee on the Mathematical Sciences in the Year 2000 (Project MS 2000) is developing such a plan.

Significant movement to implement this seven-part national strategy is under way through the combined efforts of national organizations, including those concerned directly with mathematics and mathematics education, as well as foundations, national education organizations, parent groups, and agencies of government.

Building Consensus

The *Curriculum and Evaluation Standards for School Mathematics*, developed by the National Council of Teachers of Mathematics (NCTM) and being released in March 1989, is the linchpin of the strategy. It focuses national attention on specific objectives for school mathematics in the 1990s. These standards from the teaching profession provide guides to what constitutes excellence in school mathematics programs designed to serve *all* students, from kindergarten through high school. Already reviewed extensively in draft form by mathematics teachers and the public, the standards have received widespread support in the mathematical and educational communities. They represent the very first effort to establish national goals for school mathematics. The nation has a unique opportunity to build consensus around these goals.

Generating Dialogue

"Implementation will require more than good will and community dialogue; it will need professional leadership of teachers operating in a transformed school environment. No one should underestimate the complexity of the challenge; effective reform will be truly difficult to accomplish."

The development and publication of the NCTM *Standards* are part of the national, discipline-based leadership referred to in the strategy. The NRC took two other steps: the establishment in 1985 of the Mathematical Sciences Education Board (MSEB), to provide continuing national oversight and coordination in mathematics education at all levels, and the formation in 1988 of the Committee

on the Mathematical Sciences in the Year 2000, to recommend a revitalization plan for college and university mathematics. Both of these steps were taken at the request of the professional societies in mathematics and mathematics education in the United States.

The NCTM *Standards* report is one of a series of major reports appearing in 1989, to which *Everybody Counts* is a public preface. Others are MSEB's *Philosophy and Framework for School Mathematics* and *Strands of the Mathematics Curriculum.*

A related report comes from the American Association for the Advancement of Science's Project 2061. Called *Science for All Americans,* it sets forth a vision of what every young person should learn about mathematics, science, and technology.

These reports could join hundreds of other well-meant reports on the nation's bookshelves or they could make a difference. To bring their messages to the many "attentive publics" of mathematics education and help build consensus on their goals, the Mathematical Sciences Education Board plans to coordinate an intensive Year of National Dialogue that will accompany publication of these reports—a dialogue carried directly to teachers, administrators, policymakers, business, industry, government, and the general public. Professional organizations in the mathematical sciences are making plans for active involvement in this dialogue. Numbers of other national, state, and local organizations will participate.

Taking Action

Current efforts to forge national consensus will not in themselves transform what happens in schools or colleges. Change in the institutions of education must come about as the result of intensive debate within each institution. There is plenty of work for everyone:

Students

- Study mathematics every school year.
- Discover the mathematics that is around us all.
- Use mathematics in other classes and in daily life.
- Study a broad variety of mathematical subjects.

Teachers

- Talk with each other about mathematics.
- Examine current practice and debate new proposals.
- Engage students actively in the process of learning.

Parents

- Demand that schools meet the new NCTM *Curriculum and Evaluation Standards for School Mathematics.*
- Encourage children to continue studying mathematics.
- Support teachers who seek curricular improvements.
- Expect homework to be more than routine computation.

Principals

- Provide opportunities for teachers to work together.
- Become educated on issues in mathematics education.
- Support innovation.
- Encourage paired teaching in elementary school.

Superintendents

- Stimulate public discussion of mathematics education.
- Provide resources for curricular innovation.
- Support a climate of change.

School Boards

- Establish appropriate standards for mathematics.
- Align assessment with curricular goals.
- Support innovation and professional development.

Community Organizations

- Enrich mathematical opportunities for all students.
- Support local efforts to improve mathematics education.
- Explain to the public the need for change.

State School Officers

- Promote adoption of NCTM's *Curriculum and Evaluation Standards for School Mathematics.*
- Encourage use of elementary mathematics specialists.
- Speak out publicly about mathematics education.
- Stress assessment of higher-order thinking.

College and University Faculty

- Make introductory courses attractive and effective.
- Restore integrity to the undergraduate program.
- Lecture less; try other teaching methods.
- Link scholarship to teaching.

College and University Administrators

- Reward curricular innovation and good teaching.
- Recognize that mathematics classes need computer laboratories.
- Diminish reliance on underprepared, part-time faculty.
- Emphasize and improve teacher education.

Business and Industry

- Encourage students to study mathematics and science.
- Do not steal good teachers by hiring them away.
- Support local efforts to secure funds for education.
- Support strong continuing education, not remediation.
- Provide internship opportunities for teachers.

State Legislators

- Work with school leaders to support effective programs.
- Recognize that mathematics education is an investment.
- Resist pressures for simplistic cures.

Governors

- Provide resources to encourage change.
- Demand new standards for mathematics education.
- Lead the public to make wise choices among priorities.
- Create enrichment programs for able students.

Congress

- Stress education as an essential investment.
- Support mathematics education at all levels.
- Reward effective programs.

The President

- Meet with state governors to affirm the national agenda.
- Focus public attention on mathematics education.
- Stress education as crucial to national security.

Conclusion . . . *it is time to act*

This is just the beginning. Several decades of work lie ahead if we are to translate the ideas put forth here into classroom practice. During that time, continuous change in mathematics programs should be the norm in most of the nation's school districts. Strong national, state, and local leadership will be needed all along the way.

Efforts to bring about lasting change must proceed steadily for many years, on many levels simultaneously, with the broad involvement of all of the constituencies at each stage. First comes serious discussion; then, compromise and consensus; finally, action and change. At national, state, and local levels, significant efforts are under way to improve curricular standards, the teaching profession, and assessment practices. Major projects are being started to help the diverse efforts of business, industry, government, volunteer groups, and educational organizations to focus on common objectives. As there is no royal road to geometry, so there are no "quick fixes" for mathematics education.

Both for reasons of international competitiveness and scientific leadership, the United States must move quickly to improve the state of mathematics education. It takes a generation to complete the mathematical education of a single individual. The first high school graduates of the next century entered elementary school in 1988. No longer can we afford to sit idly by while our children move through school without receiving the mathematical preparation appropriate for the twenty-first century.

The challenges are clear. The choices are before us. It is time to act.

MATHEMATICS: A CHALLENGE FOR BUSINESS, GOVERNMENT, AND ACADEMIA

The following is the text of the talk given by Vice Admiral William O. Studeman, Director of the National Security Agency, at the Thursday evening, January 12, open session entitled "Mathematics in the American Agenda", at the Joint Mathematics Meetings in Phoenix, Arizona. The event, which was preceded by an open reception with a Southwestern theme, was sponsored by the American Mathematical Society, the Mathematical Association of America, and the Mathematical Sciences Education Board of the National Research Council.

After six months in my job, I can honestly say that I am extremely humbled to be present in this assemblage of august intellectual ability. To paraphrase President Kennedy: No Director of NSA has been with this much mathematical talent in one room, since our first Director met privately with John von Neumann.

I almost changed the topic of my talk this afternoon. As I was studying my notes and flying to Phoenix, along with other NSA employees, we suddenly had a great idea to patch up Miyaoka's recent attempted proof of Fermat's Last Theorem, but it fit in the margin of the notes, so we didn't think it could be correct.

Thank you for inviting me to speak to you this evening. It is a privilege for me to be at the annual meetings of the math societies, and a wonderful opportunity for me to share with you some issues and concerns on the role of mathematics in the future of American business, government, academia, and, of particular interest to me, its role in the future of American defense.

Many of you are concerned about the proper role of mathematics in defense-supported research. This is an important topic that has been debated at length and which can be divisive, but it is one which I will leave for another time. Tonight I want to tell you about NSA's role in mathematics and to discuss issues which I believe should unite all who are interested in the future of American mathematics.

NSA's Role in Mathematics

Years of military training have prepared me for many complex operational and management roles, but it was still surprising to become the leader of the largest and perhaps the most diversely talented group of mathematicians in the United States. As you may know, mathematics is the fundamental basis of our work at NSA, the *sine qua non* fundamental foundation bedrock of our business. Mathematics is the one aspect of NSA which makes us different from other Defense and executive branch departments and agencies, and we are proud of both the documented and unrecorded contributions which our mathematicians (our invisible heroes) have made to the history of national and alliance security over the past half a century and longer. We are America's largest employer of mathematicians, and we really are employing mathematicians to be mathematicians. We use your theorems, not just your problem solving abilities. NSA must provide more care, feeding, attention, and job satisfaction (particularly job satisfaction) for mathematicians than anyone else, and I believe that this gives us a unique perspective and responsibility on the future of mathematics in the U.S.

The Evidence of Decline

Two recent publications have emphasized the decline that has occurred in American mathematics research and education. The National Academy of Sciences 1984 study, *Renewing U.S. Mathematics* (popularly known as the "David Report"), pointed out the dangerous decline in support to university mathematics research, a decline that may soon drive our nation's most able researchers into other disciplines that provide adequate resources for their work. The "David Report" spurred my predecessor, General Odom, to make a commitment to mathematics research through the expansion and redirection of our grants program, and by the encouragement of greater involvement on the part of our mathematicians in the national community. This is a commitment I firmly

support and would like to build upon. In fact, I am proud that the NSA Mathematical Sciences Program has agreed to help support the following study, known colloquially as "David II."

The 1987 report, *The Underachieving Curriculum*, highlighted the poor achievement of 8th and 12th grade American students in an international comparison. It is ironic that the United States attracts the brightest minds from around the world to study mathematics at our universities, and yet we fail so miserably in providing a basic mathematics education to our own high school students. We have become a Mecca for international students seeking the finest training possible, but we cannot seem to motivate and propel our own citizens into pursuing research in mathematics. I am deeply concerned over the implications of these trends, not only for national security reasons, but also for their portents for American technological research and applications.

The Need for Mathematics

Changes, Challenges, and Opportunities

We are now in a period of vast global, political, economic, military and technological change; change that presents NSA with unique challenges and opportunities. Secure data systems and communications, the availability of timely, accurate intelligence, and information handling and display capabilities are essential to maintaining the fragile peace. Consumer-driven capitalism seems again to have passed the test of time, as countries have become superpowers on the basis of economics alone, and as the economic engines of one after another communist state have failed miserably. Much of this change is driven by or itself influences the pace and direction of technology.

Of particular interest to NSA and defense, the nature of the modern military battlefield is changing. Low intensity conflicts are more likely than superpower war, and the technology of war itself is rapidly changing. These changes include the increasing availability of long range (even short time of flight) precision guided munitions supported by highly accurate targeting means, new and renewed forms of threatening lethality, and other complex factors which impact significantly on the kinematics of modern battle space. The application of stealth is but one example of these modern technologies–but in its purest form, it is a modern warfare approach wherein partial or periodic invisibility nets advantages in surprise, tempo, and timing and creates highly stressful threat detection and response problems. Stealth systems such as today's modern submarine or airplane are the technical analogues of the guerrilla or terrorist which have had such a powerful impact on today world stage.

Similarly, the world geo-political polarity is shifting. Old alliances are moderating on both the Soviet and U.S. sides, new forces are emerging, overpowering military force is appearing less useful than before, and communist countries are clearly concerned about what their poor economic condition holds for their long term power and status. The American system is coping with complex fiscal and technical efficiency problems which challenge our work and market ethics and our competitive abilities.

The challenges NSA face are no less daunting. They include dealing with vast quantities of data in an efficient manner, pulling targets out of complex backgrounds, distinguishing the important from the unimportant, supporting decision making in time-critical environments, converting complex situations and problems into simplified, understandable ideas, and improving the security of communications and information management.

These changes cannot be understood nor these challenges met by relying solely on the theories of the past, but rather we must have fresh insights, new ideas, and a deeper understanding of the way the world works. These, I propose, are tasks uniquely suited for the mathematically trained mind.

Achievements of Mathematicians

The ability to deduce the rules of nature from empirical observation has been the hallmark of mathematicians for millennia. From Euclid's axioms of geometry to Newton's laws of motion and gravity to Einstein's theories of relativity–all have contributed in bringing order from chaos. And yes, there are the elite disciplines of mathematical cryptanalysis and crytography–for cryptanalysis, finding the order of human communications from the chaos of encrypted signals, and for cryptography, creating and reconstructing chaos for secure transmissions. These are vital disciplines that have served our country in peace, have helped save it in war, and could equally doom the nation if their respective successes were to become the order of the day for the other side (as was the case in the heyday of the recent espionage cases).

The Mathematical Workplace

The American workplace has become more mathematical in recent years, and this change can only accelerate. Modern technology and an effective, informed voting public demand a comfortable command of discrete mathematics, statistics, and mathematical modeling–and these are just the entry-level requirements. When we cannot find mathematically literate entry-level workers, when American government and high technology can no longer recruit the mathematically skilled, and when we must finally rely on the scientific insights and advances of other nations, then we will have entered a sad period of technological stagnation and decline.

The Blurring of Pure and Applied Math

There is a great need to move beyond the artificial divisions of mathematics: pure versus applied; defense versus civilian; industrial versus academic; research versus teaching. We must realize that what is good for mathematics in its broadest sense benefits every user, no matter how narrowly focused their application may be.

As an example of the broad application of mathematics, my staff assures me that the solution to one of our important problems critically depended upon an application of Tychonoff's Theorem.

A little over 40 years ago G. H. Hardy wrote in his masterful book, *A Mathematician's Apology.*

> I have never done anything 'useful.' No discovery of mine has made, or is likely to make, directly or indirectly, for good or ill, the least difference to the amenity of the world.

I wonder how surprised Hardy would be to learn that his beloved Number Theory, which he was so proud to say had done nothing 'useful,' is today one of the foundation stones of computer science, cryptography, and communications? Just as the true utility of the *Conics* of Appolonius was not appreciated until centuries later, so too the pure mathematics of yesterday becomes the foundation of new applications tomorrow.

Mathematics at NSA

The National Security Agency has a long history of demonstrating that mathematicians are the best people to employ in new interdisciplinary initiatives, especially when the problems are very technical, very new, very hard, and not very well understood. For example, our mathematicians have provided fundamental ideas for our work in communications, engineering, speech research, signals processing, and the design and implementation of powerful, specialized computers. But for our primary mission, it is most important that our mathematicians be mathematicians.

The "tools" that we employ to do our job are mathematical. The theories that we need to develop to understand what we are doing are mathematical. NSA has scaled to a vast plateau where there are more application problems than ever before. There is a great need for us to develop new theoretical frameworks for a number of broad, complex problems that we face, and this need is not unique to us.

From a Defense resources and manpower point of view, we are heading into a significant austerity period where no growth at NSA will be the order of the day. Nevertheless, as the largest employer of mathematicians in the United States, I have instructed my personnel office to hire 100 new mathematicians this year, with priority at the masters and doctoral level, if this can be done without lowering our standards. Overall, mathematics is becoming even more essential to our defense, to our industrial competitiveness, and to our nation's unquestioned leadership in academic research.

The Challenge for Action

The Decline Must Stop

The role of mathematics in the future of American business and government will be central, crucial, and inescapable. Mathematics will be one of the skills that separates service careers from those requiring imagination, creativity, and originality. Supporting and improving mathematics can no longer be merely a slogan, goal or platitude, but rather it must now be an essential objective of any enterprise–business, government, or academia–that expects to remain competitive for the future. We simply must insure that adequate support for mathematics research is an accepted norm, that our standards for pre-college education are equal to our capabilities and needs, and that the definition of "acceptable mathematics activity" is expanded at our universities and even at our high schools to include mathematics education. The decline must stop now , and we *each* have a role to play.

The Role of Business and Government

American business and government have been accused, with some justification, of taking a limited, narrow approach to mathematics. If the work in question is not "mission oriented," if it does not increase the next quarter's profits, if it does not have an obvious application, then it is not worthy of support. We can fall back on the demands of the Congress or of the stockholders, but these answers beg the question. Pure mathematics research benefits everyone, because it creates a fertile field of ideas from which we can draw the solutions to our problems. Mathematics education is the only hope that we have to continue our work–if there is not a sufficient mathematically educated labor pool in the future, then our work today is for naught. Despite the restrictions we believe may limit our actions, we must insure the future of mathematics.

The Role of Academia

Business and government cannot alone face and solve the problems of American mathematics, academia must shoulder its share of the burden. For mathematicians to believe that they deserve unrestricted support simply because they prefer it that way is arrogance, and to think that some special federal dole is appropriate for mathematicians solely because they do good work is

conceit. If mathematics is to be properly supported by society, then mathematicians must not forget their obligations. Universities must move beyond measuring success only in terms of grants or publications, and researchers must recognize their larger obligations. These changes should not be seen as "add-ons" but rather must be an integral part of the job. If we cannot convince our greatest minds to tackle the vital problems of education and the government as well as business then society will invest elsewhere and everyone will be the loser in the long term.

Additionally, mathematics suffers from a significant public relations problem. American researchers yearly solve critical problems, advance theory on every frontier, and stretch the capabilities of the human mind, but the general public (and often the Congress) does not appreciate these achievements. To address this problem, you are supporting a successful public information effort in Washington which must be not only continued but also expanded. I might add that NSA's larger public participation in mathematics was greatly influenced by the Joint Policy Board on Mathematics. If you cannot convince the public that you are doing good work and are solving problems that directly affect them, then your other efforts will be in vain.

NSA's Response to the Challenge

It would not be fair for me to stand up here and suggest tasks for you without telling you what we have done to meet the challenge. In 1987 at NSA we held two very successful meetings with American mathematics leaders to explain our uses of and needs for mathematics. We explained, as best we could, what types of mathematics are important to us and we sought advice on how we could better participate in the larger math community. The technical presentations were published in the Proceedings of the NSA Mathematical Sciences Meetings, which is available from our grants office. At that time our grants program was expanded and redirected to support almost exclusively pure mathematics research. We believe that our grants program, the NSA Mathematical Sciences Program, will become an important source of funding for pure mathematics research in those areas that best support our mission.

Through our grants program, we are providing core support to the Mathematical Sciences Education Board for their study and revision of the K through twelve mathematics curriculum for American schools. Our mathematicians have actively participated in a number of national conferences in these areas: "Calculus for a New Century" last year, "Mathematics Education–A Wellspring of U.S. Industrial Strength" this past December, and, as previously stated, we are also supporting the follow-on study to the "David Report." NSA and affiliated mathematicians are attending this forum in some numbers as well.

For decades, NSA has worked closely, profitably, and quietly with university mathematicians–faculty and students, both graduate and undergraduate. We have formal sabbatical programs for visiting and for our own mathematicians. Our academic interactions are assisted by the Institute for Defense Analyses' Communications Research Division in Princeton, which works closely with us. In 1952 we started holding summer workshops for university mathematicians, and since 1959 they have been very successfully conducted in Princeton by C.R.D.

Our mathematicians have been actively supporting the Maryland State Department of Education's summer Gifted and Talented program in mathematics for students in elementary through high school. We are establishing a Speakers Bureau to bring the excitement of mathematics to local high school and middle school students. Finally, we are working with The George Washington University to conduct a summer workshop for regional high school mathematics teachers. It is not possible for us to support all mathematics everywhere, but we believe that we have a particular obligation to encourage mathematics in schools near us.

I hope that our first, halting steps to increase support to mathematics will be taken as a challenge by each institution represented here–a challenge that you will soon meet and surpass to insure that mathematics will indeed have a role in the future of American business, government, and academia.

Computers and Mathematics

Edited by Jon Barwise

Editorial notes

Computational Environments: a Tale that Wags the Dog
In 1983 I left the Mathematics Department at the University of Wisconsin, Madison, to direct the then new Center for the Study of Language and Information. CSLI is an interdisciplinary research institute devoted to mathematical and computational approaches to understanding language, meaning, information, and representation. I directed it for two years, before returning to research, teaching and less demanding administrative responsibilities. During that time, establishing a suitable computational environment for the Center was one of the responsibilities that weighed most heavily, absorbing countless hours of thought, worry, and discussion, and far too much money.

Last week was a poignant one in this regard. I came back from lunch one day to discover many of the workstations around which we had built our plans lined up by the back door, waiting to be taken off to computer heaven (we'll assume, for charity's sake). Five years after being state-of-the-art computers, these machines had become jokingly referred to as space heaters and door stops. And the uniform computational environment we worked so hard to create has gradually evolved into something quite different.

This experience has left me with a keen interest in the problems associated with establishing a computational environment for work in mathematics, and some pretty definite opinions on these matters. Indeed, one of my motives in agreeing to create and edit this column was to try to drag out of other mathematicians their experiences in creating such environments, so that we do not all have to make the same mistakes.

In this month's issue I present what I hope will be the first two of many articles addressing the questions associated with these problems. The first is by Gene Herman, and describes the computational environment in place in the mathematics department at Grinnell College. The second is a review by Mark Sands, of Augusta College, of a commercial product around which Augusta's mathematics department has built its local area network (LAN). At the end of this month's column, I exercise my editorial prerogative with a commentary on these models. This is not meant as a criticism of the decisions made in either department, but to point out a few of the decisions one might want to question, especially in a different sort of institutional setting. I hope that these articles and commentary will prompt others to write of their experiences, especially those that differ markedly from that of Grinnell. Write to me at:

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Another reason for running articles of this kind is to provide mathematicians around the country with ammunition. Take these articles to your administration and say "Look what the competition is up to. We are falling far behind." From this point of view, both models are quite useful since the computational environments they have established are ahead of what most departments have managed to create.

In addition to the two articles just mentioned, this issue contains a review, by Herbert Holden, of FITLIB by PC-Scientific, a program that generates splines for fitting given data. This is the first of several PC-Scientific programs that are in the works.

TEX, LATEX, and AMS-TEX
In spite of repeated disclaimers, many readers assume that I must be an expert in everything connected with computers and mathematics, or at least with *some* things so connected. In particular, over the past few months, I have been asked by several people around the country about the differences between TEX, LATEX, and AMS-TEX. These mathematicians were all somehow involved in choosing among these programs,

either at a personal or departmental level. I have tried unsuccessfully to find someone who would do a comparative review. So what I have done instead is to ask a number of people for their opinions on the relative merits of these three systems, mix this with my own experience, and write it up as a short note. I would like to express my thanks to Ilan Vardi and my other informants, who prefer to remain nameless, for advice and comments. And I should say, right off, that for the past four years my own mathematical writing has been done almost exclusively with LaTeX, though I have ventured out into TeX from time to time. I have never used AMS-TeX at all. Everything I know about it is from my informed sources.

TeX

In case there are any Rip van Winkles reading this column, TeX is Donald Knuth's typesetting program that has literally revolutionized the typesetting of mathematical text. The stress here is on *typesetting*. It is not an editor; rather it can be used with any editor. Nor is it a typographic designer. It leaves the decisions usually made by the typesetter (like how much space to put below a section heading) up to you. Nor does it generate particular document styles. Creating those is also up to the user. What it does is to provide a powerful set of computational tools that allow you to custom design and typeset your own mathematical documents. And it is a masterpiece.

Actually "TeX" is ambiguous. On the one hand it refers to the raw TeX program, which only knows about low-level typesetting primitives. Using this TeX to typset *anything* would be almost hopelessly difficult; somewhat akin to setting lead type by hand! To make TeX a convenient tool one must add to this primitive version of TeX a collection of so-called "macros" that teach it some of the higher level concepts of typesetting and also instruct it to use a particular output format style. Knuth has provided an excellent vanilla macro package that is variously refered to as "the basic control sequences", "the plain macro package", or "the plain TeX format". The second, more common usage of "TeX" is to refer to this enhanced "plain" version of TeX. This is what we will usually mean by TeX in what follows.

Many experienced TeX users find the plain format an ideal envoironment for most simple typesetting tasks; they can easily add themselves the few extra macros needed to adapt plain to the use at hand. However, for beginners, using even this enhanced TeX is hard going. And experienced TeX users too find plain insufficient when they are faced with more demanding typesetting tasks. For plain TeX does not provide good support either for complex mathematics or for the difficult task of preparing a long and complicated document (e.g. , a thesis or multi-chapter book with a table of contents, an index, a bibliography, and forward and backward references to numbered theorems and equations). And this is where other macro packages enter the picture.

LaTeX

LaTeX is a program written by Leslie Lamport on top of plain TeX. It adds to TeX a rich collection of macros which make using TeX easier in most situations. Rather than being a typesetting program, it is a full-fledged document preparation system. In fact, it was designed to implement a SCRIBE-like environment within TeX.

Its most important feature is that it provides a family of ready made document styles (article, report, book, letter, memo, etc.) for you to use, in the form of ".sty" files. Most of my own writing uses article.sty. These styles set a host of parameters for you, like the way things get numbered, spacing, margins, and the like. Most of these can be modified, though. For example, sections and subsections are usually numbers, but I can leave them unnumbered by simply adding an asterisk in the appropriate command. LaTeX excels in such things as automatic creation of tables of contents and indexes, footnotes, the handling of automatic forward and backward references to numbered text items (theorems, definitions, etc.), bibliographies, and so forth.

AMS-TeX

AMS-TeX is also a package of TeX macros. It was developed by Mike Spivak for the AMS. But its goals are quite different from LaTeX's. It is aimed at providing macros which simplify typesetting complex mathematics in TeX. Its forte is things like matrices and complicated alignments of equations. The AMS finds it very useful in this regard. But it does not provide the kinds of facilities provided by LaTeX described above.

Relative Advantages

Which of these programs should you learn and use? That will depend on your personality and the kind of mathematics you want to write. If you are a person who likes to build your own stereo, or write your own programs, then probably TeX is for you. It gives you maximum power and leaves you unconstrained by anyone else's design decisions. And it is maximally flexible. LaTeX, by contrast, is pretty rigid. This can be an advantage, in that it keeps you from making all

kinds of mistakes, but it can also feel like a straight jacket if you bump up against something it won't let you do easily, like turn footnotes into endnotes, or create a one page document without a page number.

But most mathematicians want a program that puts as little between them and writing mathematics as possible. For such mathematicians, I think LaTeX is the current system of choice. It takes care of so many details for you. Especially if you are writing a long article or book. In such cases AMS-TeX is not particularly useful and LaTeX has much to recommend it. On the other hand, if you are writing a short article with lots of displayed equations, AMS-TeX is probably more useful. In between it is a matter of taste.

Another main point in favor of LaTeX is the manual which is extremely well written and is designed to teach you about how to use the program, not to teach you all about typesetting. This is extremely helpful for anyone who wants to get something done within a short time of starting with the program. The AMS-TeX manual (The Joy of TeX) and the TeX manual (The TeXbook) are also very well-written, but the TeXbook suffers from trying to be both a users guide for plain TeX, but at the same time a reference manual for the extremely complex TeX program. These two rôles are often incompatible. There has long been a good elementary introduction to plain TeX available from TUG, the TeX Users Group, ("First Grade TeX: A Beginner's TeX Manual", by Arthur L. Samuel), but true to its name it will only barely get you going and has almost no information about typing mathematics. Very recently Michael Doob of the University of Manitoba (mdoob@uofmcc.bitnet) has written a first rate seventy page users manual for plain TeX (A Gentle Introduction to TeX), and very generously placed it in the public domain.

Macro packages such as AMS-TeXand LaTeX are almost always add-ons to plain TeX, that is they are built "on top" of it. But the author of any given package may either choose to remain compatible with plain TeX (as AMS-TeX does) or he may choose to redefine certain macros in ways incompatible with plain TeX (as LaTeX does). Aside from displaying really complicated mathematics, the one clear advantage of AMS-TeX over LaTeX is that the former is a strict extension of TeX, the latter is not. Lamport has removed part of TeX from LaTeX, so you cannot learn LaTeX first and then simply add various TeX commands as you need them. For very complicated things that can't be done in LaTeX, you have to figure out *which* TeXcommands you can use, and which you can not.

Why not simply combine the LaTeX and AMS-TeX macros? Unfortunately, two different macro packages as complicated as these are unlikely to be compatible with each other unless they were created with careful joint planning. And, sad to say, LaTeX and AMS-TeX were created independently and are incompatible. However, I understand that Spivak is at work on a package called AMS-TeX that combines the best features of LaTeX and AMS-TeX. This was demonstrated at the recent annual meeting in Phoenix, and although I missed it, I hear that it looks very promising.

In addition, AMS has chosen to create a LaTeX style file embodying AMS-TeX's mathematical formatting abilities while retaining LaTeX's easy-to-use document formatting strengths. The Society plans to make an AMS-TeX LaTeX style file available to the mathematical and TeX communities this spring. The AMS will continue to use AMS-TeX for its publications but it will also accept authors' electronic files prepared with LaTeX's AMS-TeX style file.

So my recommendation to mathematicians who do not want to pay a lot of attention to typesetting nitty-gritty: start with LaTeX. It will let you do 99% of what you want to do, and you can always write your way around the other 1%. After you have been using it for a few months and start bumping up against its limitations, get the TeX book and add that extra 1%.

Grinnell College's MathLAN

Gene Herman
Grinnell College

The Setting

Grinnell College is a private, four–year, undergraduate, liberal arts institution of 1200 students. The department of mathematics has approximately 8 full–time equivalents, including the mathematics faculty

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who teach computer science and statistics. We graduate between 15 and 25 mathematics majors each year and also teach a large number of nonmajors. Our greatest enrollments are in Calculus I (175 students in 1987–88), Calculus II (170), Linear Algebra and Differential Equations (95), Series and Differential Equations (46), Computer Programming with Pascal (90), and Introduction to Statistics (175), although the enrollment figures for Statistics include sections taught by faculty in other departments. The scholarly activities of the faculty include mathematical research, reviewing and editing for journals, expository writing, textbook writing, and software development.

Our physical facilities are new. We occupy the top floor of a wing of the science building, where we have 10 offices, 4 classrooms, a computer lab, and a small unstaffed department office. On the floor below is our secretary whom we share with another department. On the floor below that is our machine room. We moved into the building in June, 1987, and the first phase of our computer network, which we call MathLAN, was installed in October, 1987.

The Impetus

We have used computers in our department for years, but our use accelerated rapidly in the early 1980s, when we first got computing equipment in our offices and classrooms. In 1982, we got computer terminals in our offices, which connected us to a central PDP minicomputer. Then, in the summer of 1984, our terminals were upgraded to Rainbow microcomputers which doubled as terminals. A year later we got dot-matrix printers for our offices, and some of us got graphics boards and color monitors for our micros.

Although we had one classroom with a terminal as early as 1975, few of us did any computing in the classroom until the fall of 1981, when we installed an Apple II in each of two classrooms. We added two terminals in the summer of 1983. However, we went several years with inadequate projection equipment, until December of 1985, when we installed high quality Electrohome monitors in our classrooms and a switch box that let us choose whether the monitors would display output from the microcomputer or the terminal.

Even in the early years of our computer use, we had quite a variety of software. By 1985, we had both a simple word processing package and one that could produce fairly good mathematical output (MASS-11), an electronic mail system for on-campus communication (DREAMS), programming languages, a graphics subroutine package (the Core System), several statistical packages (including MINITAB and SAS), a spreadsheet and graphing package (Research System 1), a matrix analysis package (MAC, later renamed MAX), a computer algebra system (MACSYMA), and a number of Apple II packages that we used primarily for displaying graphics in the classroom.

Then in the fall of 1985, we learned we would be moved to a new wing of the science building. For several reasons, this was the perfect opportunity for us to plan a new computer system for the department. Most obviously, we would be able to design our new quarters to house computers comfortably rather than continue to struggle with the inadequate wiring, lighting, temperature control, and physical space in our old building. Also, for the preceding year the College had been studying the possibility of installing a local area network (LAN) on campus. So the administration was ready to consider a department-size LAN, and we were ready because we had been involved in the study.

Another set of reasons for our interest in a new computer system were our existing system's inadequacies, which had become more obvious as our use increased. For example, the Apple IIs in our classrooms were incompatible with both the Rainbows in our offices and the central minicomputer. The number of microcomputers on campus was so small that most of our classes could not be asked to use them to do assignments, and file transfer between micros or between a micro and the mini was tedious. The screen resolution on both types of micros was low and their computational speed was slow, which made them unsatisfactory machines for much of our graphical use. Graphics on the central minicomputer was no better, as timesharing slowed its responses. Also, the response time of the mini sometimes slowed our classroom presentations. Most frustrating of all, interesting new software was coming out that would not run on our small, outdated micros and would either run slowly or not at all on the timesharing mini. In short, our existing computer system lacked local power, uniformity, accessibility, and interconnectedness.

The Plan

During the 1985–1986 academic year and part of the next, we planned a new computer system, wrote grant proposals to the National Science Foundation and several private foundations, and worked with an architect to design our new space so it would support the kind of computing we envisaged. Our plan called for workstations with central fileservers, so we could have both local power and the convenience of a single location for all software. These would be connected together by a local area network to which peripherals

would also be attached. Furthermore, the network would be bridged to the central minicomputer (now a VAX 8600), so we could continue to use its facilities. A principal criterion in the choice of a vendor was the availability of appropriate software, especially software for mathematics and computer science.

We settled on a network of 50 Sun 3/50 monochrome workstations and three file servers, plus two Apple LaserWriter printers, a high-speed Printronix line printer, and a Hewlett-Packard 8-pen spooled plotter. These are linked by an Ethernet, which is bridged to the VAX by a fiberoptic cable. The workstations are distributed as follows: one in each of the 10 mathematics faculty offices, one in each of our 4 classrooms, 18 in a public terminal room that doubles as a lab for math courses, 15 in a computer-equipped classroom, two that drive printers, and one for our secretary. The file servers are in the basement machine room, one LaserWriter is in our department office so faculty alone can use it, and the remaining peripherals are in the public terminal room. We also continue to use our old dot-matrix printers, which are now driven by our office workstations. Projection equipment for the classrooms was again hard to find, but eventually Moniterm came out with monitors that can keep up with the Sun's high scan rate. In a typical 40-student classroom, we have four 25″ monitors overhead.

The mathematical software on MathLAN consists of MATLAB (for graphics and numerical linear algebra), SMP (computer algebra), MAX (matrix analysis), and S (statistics). We also have TEX for mathematical word processing. For programming, we have C, Pascal, LISP, FORTRAN, and a few more exotic languages. Finally, we have SunLink DNI (Sun's implementation of DECNET) for communicating with the VAX, which we use for electronic mail and for its various specialized packages that would be wasteful or impossible to duplicate on our system.

The computer center pays the maintenance contracts for our hardware, and their technicians provide routine maintenance. Their staff also hires and pays student User Consultants, who help others in our public terminal room. We, however, provide much of the system maintenance. That is, a member of the department creates accounts, installs software, does backups, writes supplementary documentation, runs workshops, and troubleshoots software problems.

The Current State

This past semester, the fall of 1988-1989, was the first one in which we completely moved over from our old computer system to MathLAN. During that semester, all of the mathematics faculty used the new system and about 40% of our students did. Average faculty use was about 6 hours a week, with about three-fourths of that related to teaching, and average student use was somewhat over 1 hour per week.

Our system's hardware is working very well, although a few problems remain. The principal one involves our computer-equipped classroom; the workstations are so bulky that they interfere with lines of sight. On the other hand, all the major benefits that we expected of our new hardware have indeed come about. Wherever we are—in our offices, a classroom, or the lab—we have enormous local power at our fingertips. Complex graphics and long computations are completed quickly; multiple processes are carried out simultaneously (or so it seems) and results easily transported between them; and heavy use of the system has no noticeable effect on response time. The uniformity, accessibility, and interconnectedness of the system have made instructional use particularly effective. We can prepare computer-based assignments in the privacy of our offices, demonstrate them in class without any need to move equipment or files, and have our students carry them out in the lab. Since the equipment is identical in all three locations, compatibility problems never arise.

Most of our software is working as well as expected to. We will probably switch to a different computer algebra system, and some of our other packages (S, SunLink DNI) await updates that promise to cure their most serious deficiencies. MATLAB, MAX, TEX, electronic mail, and the language compilers-the software we use most heavily-have been excellent. MATLAB is not easy for a computer novice to use, but, because it is programmable, Emily Moore of our department has been able to create a number of special-purpose front ends that are indeed easy to use. As a result, MATLAB is now our most heavily used graphical and numerical package. MAX, the MAtriX Algebra Calculator, is a package that I designed on our previous computer system and moved over to our new one. We use it extensively in teaching linear algebra. For mathematical word processing, many in our department are so comfortable with TEX that they use it themselves all the time, while others have our secretary do most of their TEXing. One use of electronic mail and SunLink DNI, then, has been to exchange files between ourselves and our secretary. SunLink's terminal emulator has also allowed us to continue using MINITAB in our Statistics course, even though we have this statistics package only on the central VAX. Thus, we can still demonstrate MINITAB in our classrooms and have

students practice it in a supervised lab. However, we expect to make increasing use of S in the future.

Underlying all of our software, of course, is Sun's Unix-based SunOS operating system and SunView windowing system, which have their good and not-so-good aspects. On the one hand, this is powerful software that supports multiple windows, multiple processes in each window, and easy communication between processes. On the other hand, not all of us are sufficiently interested in either the details or the sophisticated concepts of Unix to learn to use it well. Also, SunView does not hide enough of the Unix details from us, nor does it provide as uniform and easily understood an environment as, for example, the Macintosh windowing system does. We hope that Sun's new Open Look system will be a significant improvement.

Perhaps the most intimidating problem for us has been the amount of time we have had to invest in managing our computer system. Fortunately, the College has provided a few short-term reduced teaching loads for us and has tentatively agreed to a substantial long-term teaching reduction for one member of our department, John Stone, to be system manager. Also, we hope to turn over the more routine technical aspects of system management, such as doing backups, to the computer center.

The Impact

The completeness and uniformity of MathLAN has encouraged the mathematics faculty to use computing more heavily yet. We want even better software, of course, and we want the system to be even easier to use, but the workshops we run for ourselves and the tailoring we do on packages such as MATLAB have been helping us make good use of our system quickly. For example, our dependence on mathematical word processing software is complete. (All our classroom handouts, exams, and preprints look beautiful!) We are also more likely than ever to use the computer spontaneously in class for graphing and numerical computations. And, for the first time, we have been thinking seriously of getting large classes such as Calculus using the computer.

However, the greatest impact on our courses continues to be at the sophomore level. MAX has helped us improve our Linear Algebra and Differential Equations course, as we could never do without the computer. We now emphasize eigenvalues and eigenvectors, realistic applications, and the interplay of linear algebra with differential equations. The software lets students easily get the results of otherwise tedious computations, so they can spend their time more productively on planning their computations, interpreting the results, and trying to understand the concepts.

The succeeding semester, in Series and Differential Equations, we have students use the graphical and numerical capabilities of MATLAB to aid them in understanding convergence in many of its guises. The course covers both the pure mathematics, such as uniform convergence, Taylor series, and Fourier series, and numerical aspects, such as numerical solution of differential equations and numerical summation. Such a course is hardly conceivable without the computer. But with MATLAB, students are able to carry out projects and exercises that help them gain insight into analytic processes.

We also use MATLAB, at least for its graphics, in Calculus. However, in most sections last semester, this simply meant that the instructor used it for classroom demonstrations. In only 3 of our 8 sections did instructors have the students carry out graphical exercises using MATLAB. Still, it is clear that the computer is rapidly changing our attitude toward graphing in calculus, inclining us to treat graphing as a tool for analyzing functions and not as an end in itself.

On the other hand, we are less certain of the role of computer algebra systems in calculus. Existing software of this type requires one to learn many fussy details and a powerful but subtle command language. So before we impose such software on our students, we need a better understanding of its potential benefits. By contrast, students quickly pick up MAX and MATLAB just by watching the instructor use them in class.

The computer lab has been a great convenience, but especially for the Statistics and Programming with Pascal classes, which had only marginal lab facilities previously. Also, the superior programming environment on the Suns have helped us raise the level of our programming classes. The interactive debugger and the powerful Unix utilities have been particularly valuable.

Our MathLAN computer system has also given students and faculty in the department a stronger sense that we are working together in a common environment toward common goals. We take pride in having put together such an extraordinary resource, but we are certainly not complacent; the job of improving and making better use of computing goes on and on.

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Reviews of Mathematical Software

NetWare by Novell

Mark Sand

Introduction

NetWare by Novell, Inc. is a software package designed to allow IBM or IBM-compatible microcomputers to share common resources. NetWare has been widely used in business applications for several years, and is now breaking into the educational market.

While a true network would allow information on screen or in storage to move directly from one computer to another, NetWare achieves an interconnection through a file server system. This means that one computer, containing a hard disk drive with a large storage capacity, is dedicated to serving as the storage medium for all connected machines. Then this stored information can be accessed from the file server by anyone with the proper security clearance.

In the October, 1988 issue of *Notices*, R. Palais detailed the advantages of networks, so I shall attempt to describe the usage of, advantages of, and problems with this particular networking system. I would like to thank Loren Koepsell, our Director of Academic Computing, for his assistance in using NetWare and in writing this article.

Hardware And Software Requirements

To use NetWare it is necessary to have an 80286 or 80386 computer with 2 Mbytes of memory and a large hard disk to function as the file server. The computers connected to this server, referred to as workstations or nodes, can be any IBM-compatible computers, must have enough memory to run whatever applications are desired, and must be fitted with an expansion card called a NIC card. NetWare comes in many versions, with widely varying capabilities. These start at the cheaper and less-complex end with ELS, for "Entry Level System," go through the standard versions, and end with the most-powerful versions, referred to as SFT NetWare for "System Fault Tolerance." In SFT NetWare v2.1, the version used at Augustana, there can be up to 256 workstations physically connected to the server, with up to 100 of them actually "on-line" at a time. More than this number of workstations can be served, but only by chaining together more file servers. In contrast, ELS v2.0a restricts the network to linking only eight workstations and allows only four of them to be "on-line."

System Configuration

Each of the classroom buildings at Augustana has a computer classroom with Compaq computers and a NetWare-controlled file server containing a 130 Mbyte hard disk. These are used for teaching in all disciplines, independent student work, departmental administration, and some faculty research. Each file server also drives two or three printers.

Accessing The System

In order to access the system, I insert a floppy disk into the disk drive of a workstation and turn on the power (the file server is always powered-up). This disk contains MS-DOS to boot the workstation and the programs which connect the workstation to the server. A batch file executes these in the proper order, clears the screen, and gives the prompt: **Enter your login name:**. After typing **marks** and pressing "Enter" the system checks to see if my account is secured by a password. Finding that it is, it gives the prompt: **Enter your password:**. Upon typing the password, which doesn't show on the screen, and pressing "Enter" again, I am connected to the file server and can access some of its files.

The system comes in a standard configuration in which retrieving files or programs from the file server and manipulating them is done through commands given on a command line, similar to using DOS. In fact, NetWare acts as a "shell" around DOS, so that it recognizes all DOS commands and some additional network ones.

With hundreds of users, each having a subdirectory in which to store information, and dozens of application programs stored on the disk, it is not surprising that the directory structure on the disk can be very complicated. To make it a little easier to move around this directory, a system of "drive pointers" is used. Suppose that I routinely need to use files in the \Package\Private\Lotus and \Package\ subdirectories. Instead of having to type **cd\Package\ \Pcfile** for example, to move from one to the other, these can be assigned to letters. If I type **map F: = \Package\ Private** and **map G: = \Package\ Public\Pcfile**, then merely typing **F:** or **G:** will move me from one place to another, similar to switching from drive A to drive B on a computer with two floppy disk drives.

Another feature which makes the complicated structure easier to use is the "search drive." This is similar to the PATH command in DOS, but is necessitated by the fact that PATH can only affect the drives that are local to the workstation, not a network drive. For example, suppose that there is a file in my personal directory, \Faculty\ Marks, called **novell.tex** that I want to edit with the word processor PC-Write, and PC-Write is located in the directory \Package\Public\ Pcwrite. If I type **ed novell.tex** then nothing happens because the program named **ed** (which invokes PC-Write) is not in the currently active directory. So I first type **map s1:=\Package\ Public\Pcwrite** to make the files in the \Package\ Public\Pcwrite accessible from any other directory. This makes **ed novell.tex** the proper thing to type from the directory containing **novell.tex**.

Menus

All of these details seem like a bother, and they certainly can be just that. But the above description is of the default setup, which can be substantially changed to exactly fit each individual user's needs. Menus can be used to avoid the command-line input altogether. When I log onto the system, NetWare looks for my "login script," which is a sequence of commands to be executed in order to automatically set up the drive pointers and search drives that will help me. This script then invokes a menu of choices, similar to the one shown in figure 1.

The top line of the menu is highlighted, and I use the cursor keys to move the highlight to the desired line. Pressing "Enter" causes execution of whatever commands are stored for that line. Possible results are: (1) If the line contains the name of an application program, that program is invoked. (2) If the line contains a network operation, such as changing my password, those network commands are executed. (3) If the line contains a general topic, a sub-menu is shown where a further selection can be made. This third outcome is shown in figure 2.

After an operation is completed or an application program is exited, I am returned to the menus and can either select another application or log off the system. Also, to access something not included in the menus, I use the "Escape" key to exit the menu structure and return to the command-line interface.

Any user can create his or her own menu structure to be invoked upon login. However, this task involves some familiarity with the details of the NetWare system, and is usually reserved for a very small subset of users that are referred-to as "supervisors."

But What Good Is It?

Our network has been used more for teaching than for any other purpose. Although features such as sharing of data and electronic mail make research and administration more efficient, I shall refer the reader to the article by R. Palais on these matters and describe how we are using the network for education.

Teaching

After using the networked classroom the first time, it was disappointing to not be able to use it every day. Of course, in some classes, there probably isn't a reason to use it every day. But having each computer used by only one or two students in class allows for much more investigation than a demonstration performed by the lecturer. What goes on is what I think of as "guided individual instruction." What I mean is that instead of leading the students through a fixed series of examples or problems, each student can ask a different question or have different questions asked of them, and then use the resources at their fingertips to find the answers. For example, when teaching the Trapezoidal rule or Simpson's rule for approximate integration, each student is able to take an existing program in BASIC (or other language) and customize it to find the areas of those regions that they find interesting.

If the application program currently being used isn't the right one to help, they can immediately switch to another one which is better. There is no conflict over a small number of machines that contain the necessary hardware and software. Even an exam can be customized so that each student receives a different set of problems, which are then graded right on the computer.

Reducing paperwork can be another result of using the network. A special subdirectory can be created for a specific course, where the instructor can store files containing notes and assignments. In return, the students can "hand in" their homework by storing it in this directory instead of submitting a paper copy. This is especially nice for computer programming assignments, since they can then be individually test run—a much better method than checking over a stack of program listings. A network of personal computers has an advantage over a mainframe in this area, since some of the students and faculty have similar computers at home and can all work simultaneously with no competition for terminals or phone lines to the mainframe.

Laboratory Use

When the classroom is not occupied with a class, it is available for use by any student or faculty member on a walk-in basis. As the sample menus show, the system is used for many purposes. They can be put into four categories, each of which serves an important role: (1) The standard applications of word processing, spreadsheet, and database software are available, of course. These are used both to prepare assignments for the courses that teach these applications, and to assist in projects in almost every discipline. (2) Programming, for Computer Science course assignments and for problem-solving in other science courses, is done in the available languages. (3) A few special-purpose packages, such as a CADD program or MathCAD are available for advanced students. (4) Tutorials in many disciplines are loaded onto the network. Some of these were commercially produced and some were written by a faculty member in that discipline.

Help for the Novice

For the true beginner, who has never used a computer, the command–line interface of NetWare would seem truly frightening. But because of the menus described above, a computer novice may be better off using a NetWare workstation than a stand-alone PC. Everything that a beginner would need to do can be accomplished by choosing the correct lines from the menu. I have found that when working with novices, it is only necessary to give them a five-minute introduction to logging onto the system and what the menus can do, and they are then able to get to work on some application program or tutorial. In general, it takes much longer to become familiar with a typical application, such as a word processor, than to become comfortable with accessing that application on the network. The only areas in which most users need occasional reminders are in storing and printing files.

Supervisors and Security

NetWare can be fairly accurately described by the one word "security." When a new account is created, say Johndoe, the user Johndoe has very few capabilities other than logging onto the system and changing his password. So a list of "trustee rights" is assigned to his account by someone who is designated as a "supervisor" and has been given access to all accounts and files on the network. This means calling up the account name Johndoe from a NetWare menu utility named SYSCON (for SYStem CONfiguration) and entering the path to the desired directories and application packages into a list under the heading "trustee assignments." It is also necessary to create a separate subdirectory under some proper category in which Johndoe will be able to store files, for example \ Student\ Johndoe.

For each directory in the trustee assignments list, there are eight different rights which can be granted or revoked for a user. These include such capabilities as Searching the directory, Opening a file, Creating a file, Reading a file, Writing to a file, Deleting files, and others. So there is great flexibility in making the assignments. For example, the rights Read-Open-Search are commonly given for a directory in which there is an application program which the user should be able to use but not alter in any way. In contrast to that, Johndoe needs to have all rights to the directory \ Student\ Johndoe.

Only a minute or so is needed to create a new account with the proper assignments. However, to create many accounts at one time by this method would take too long, so there are ways to make it much more efficient. A NetWare utility called MAKEUSER can be used, or the users can be assigned to an existing group of users, or both. The one-at-a-time method is best reserved for only a few special situations.

The NetWare security is present at several levels: First, there is an account name and preferably a password required for access to the system (although students being a friendly lot, these are often not kept secret). Secondly, a user is given access to only that information which the supervisor allows. A third method of security is also available, that coming on the file level. In any directory, the files can be "flagged" with certain attributes. They may be "sharable" or "non-sharable" (many simultaneous users or maximum of one user), and they may be "read-write" or "read-only" (files may or may not be altered). As necessary as all this security is, even in an educational setting, it can have the effect of discouraging some from using the network.

Documentation

As you may suspect, NetWare comes with an entire fleet of manuals to describe all the aspects of the system. In fact, one of the manuals is entitled "Guide To Manuals." This includes a glossary of the terms used in all the manuals, and some advice on where to look for various problems that might arise. It refers to eight installation manuals (not touched except by the single installer), four manuals for supervisors, and four manuals for users. All are supplemented by "Quick Reference Cards." I have found the manuals somewhat daunting just by their sheer volume, but those that I am familiar with (which is most of them)

are very easy to understand. The writers must have realized that a sloppy presentation can obscure the many details being described, and were extra careful to not let that happen. Each section begins with a summary of the purpose and use of the command or utility being described. The available options are then listed, followed by an example of the use of the command. The examples are truly detailed—in comparison, they are much more informative than the examples given in a standard DOS manual. Also, those statements that would be typed by the user are printed in red ink. Other products should have such a clear presentation of what the user sees on the screen and what is entered from the keyboard.

Actually, most users never need to refer to a manual, since all of the software that they use can be accessed through the menu system that is set up by the supervisor, and other capabilities of the network are needed infrequently. The more that the supervisor is familiar with the network and can customize it to the users, the less that the users need to know about the manuals and the details they contain.

Difficulties Encountered

Network Configuration

Other than the frequency with which students forget their account names or passwords, probably the most inconvenient aspect of our network is that a separate floppy disk is required to boot up the workstation and establish its connection to the file server. An "auto-boot" card can be installed in each machine, at additional cost, to establish this connection upon turning on the workstation.

Using Application Software

To use any software package, it is merely loaded onto the file server in the same way that it would be loaded onto the hard disk of a separate microcomputer. However, we have found that the directory tree on the file server, being more complex than the directory tree found on most hard disks, makes some packages more difficult or impossible to use. One package we tried wouldn't run when placed deeper into the tree than the root directory. Another package, a calculus tutorial program, will only run on the workstations from a floppy disk (which is about one-tenth as fast as using the file server). The problem is that the program always looks for its data files on disk drives A and B, and there is no way to re-route the data searches to the network drive. Thus we have found that some packages are not sophisticated enough to be able to use the network in the most efficient way.

Legalities

The capabilities of a LAN make it easy for unscrupulous users to ignore software copyrights. Some steps must be taken to insure that the copyrights are protected for all software that is not shareware. If users at all workstations need to simultaneously access a software package, then a registered copy of that package must be purchased for each workstation, even though only one gets loaded onto the file server. If only one copy is purchased and stored on the server, then those files must be flagged as "non-sharable" so that only one user at a time can access them. Also, the executable program files have extensions of either **.exe** or **.com**. These need to be given the "execute-only" attribute by the supervisor, which prevents them from being copied off of the disk. This helps to assure the software-writing companies that networks are not merely places for easy illegal copying.

Printing

In our experience, the aspect of the system that has caused the most headaches is printing. Since most of our software packages are the same ones used on stand-alone computers, they have no special provisions for printing from a network. A newer "network version" of any software package will almost certainly make printing less painful.

Printing is done by using one of two possible methods. Some packages won't print on the network (only to a locally-connected printer), so the output is stored on a newly-created file, and then the network directed to print the file. If the file is named **test.tex**, for example, the necessary command is **nprint test.tex p=0**. The **p=0** ending to the command sends the file to a printer queue numbered 0. There can be several printers connected to the file server, each served by one or more queues operating under the expected first-in first-out order. The second method is for packages that will print on the network, the problem being that the output must be routed to the desired printer. This requires that a command such as **capture p=0** be typed before the application program is invoked. Then any printer output is directed to printer queue 0. The menu system can take care of both of these methods automatically, of course.

Various printing problems can occur, most of them difficult to explain but relatively harmless. The most serious problem that we have frequently seen can occur when a user makes a mistake while programming in a language. For example, it is fairly common for a

student to unknowingly create an infinite loop in a BASIC program. If that loop contains an LPRINT statement, then the output enters the printing queue and the printer "gets stuck" into printing that user's output forever. Then the printer must be left off, which blocks anyone else from printing until this infinite loop can be removed from the print queue. The quickest solution is to ask the user owning the offending program to delete that file from the print queue, by using the NetWare utility PCONSOLE. However, the user may not realize the problem or may leave exactly because of the problem. In that case, any supervisor or other user designated as a "print queue operator" can delete the unwanted file from the queue.

Summary

I do not have personal experience with other networking software packages. However, I have contacted several people familiar with both NetWare and other packages, and all agreed that NetWare has more power and flexibility than the software they have used. It is a very good system, and also very complex, which makes the job of system supervisor extremely important. Working from the command line, NetWare is much less user-friendly than DOS. However, if a user's login script is properly written, and the menus are detailed enough to contain all of the needed options, then the user is fairly well insulated from the details of the system. Knowing the difference between the choices available on the menus is all that is needed to use the network, and this can even be discovered by experimentation. We have found that students and faculty members alike become quickly accustomed to using the system, and are now competing for the available access. The success of the network encourages us to look forward to the day when the entire campus will be linked with NetWare.

Product Availability

NetWare is available from Novell, Inc. at 122 East 1700 South, Provo, Utah 84601. Retail prices range from $595 for ELS NetWare v2.0a to $4695 for SFT NetWare v2.1. Novell currently has an educational discount program in order to get into the education market, and many colleges and universities have received the software free of charge. Other retail prices are: $395 for the workstation NIC card, $895 for the file server connection card, and $1600 for the repeater box to extend the network beyond 600 feet.

A newer version, v2.12, has been released which clears up a few bugs in the accounting capabilities and makes installation easier. Version 2.15, which the company expects to release during the winter or spring, will allow Macintosh computers to be connected to the file server while still using the standard Mac windows, and will store Macintosh files. However, it will not automatically convert them into DOS files. To accomplish that will still require additional software.

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FITLIB - PC Scientific

Herbert L. Holden

FITLIB provides the user with FORTRAN subroutine libraries in both source code and object code format for the purpose of fitting data with tension splines. Both periodic and nonperiodic data may be processed and the data may be interpolated or smoothed. While there are no explicit provisions for variable tension splines, there are instructions for modifying source code to accommodate them. There are subroutines for both curve and surface fitting and the fitting function may be specified in a variety of formats with as many dependent and independent variables as is mathematically reasonable.

In addition to the subroutine libraries, there are nine tutorial programs, fifteen example programs, and 72 "skeleton" programs which contain variable declarations, initialization, and error checks to facilitate the production of user programs. This is a most welcome feature. The source code is well written, well commented, and carefully documented.

FITLIB requires an IBM PC (or compatible) and a FORTRAN compiler. The following compilers are supported:

Microsoft FORTRAN Version 3.31 or Version 4.01
IBM FORTRAN Version 2.00
Ryan-McFarland FORTRAN Version 2.42
Lahey F77L FORTRAN Version 2.22
(requires coprocessor)

The operating system requirements and minimal memory requirements are determined by the particular compiler used.

A math coprocessor is optional since two versions of the subroutine libraries are provided: one for computers with a math coprocessor and one for computers without. Parameters to the subroutines are single precision whether or not you use a coprocessor. The coprocessor can process single precision variables in its extended format much faster than the 8088 or 8086 can and there is also some advantage in computing intermediate results in a higher precision.

The documentation indicates that a hard disk is recommended but not required. However, I would be most reluctant to compile and link without one since the multiple support libraries are quite large. There is graphics output to the screen in the tutorial programs and some monochrome or color graphics capability is desirable.

There are no plotter drivers provided. It is up to the user to write subroutines which can plot points and lines or save output on disk for later processing to produce graphics. I have a strong preference for the later technique since it accommodates minor plotting disasters (such as running out of ink) and makes the results readily available for repeated processing in various formats.

Most software vendors indicate that users should be "experienced". In the world of personal computers we have at one end of the skill scale the "novice" who has recently learned to operate a PC and chew gum at the same time without crashing either system. At the other extreme we have the "black belt power user," whatever that is. All intermediate skill levels are called "experienced".

Here is my opinion (Procrustean as it may be) of the necessary background for a user of this software. The user should have knowledge equivalent to a three credit semester course in FORTRAN, have written at least 5000 lines of FORTRAN code, and performed the compile and link process on a PC at least 10 times. To take full advantage of this program, the user should have been introduced to spline fitting via a numerical analysis course (or advanced engineering mathematics) and not feel severe emotional distress in reading source material such as:

Schweikert, D.G. - An interpolation curve using a spline in tension, J. Math. and Physics, 45 (1966) 312-317

Cline, A.,K. - Scalar- and Planar-Valued Curve Fitting Using Splines Under Tension, Comm. ACM, Apr 1974 218-223

However, the documentation for FITLIB contains extensive, meticulous, and well written discussions of the tutorial programs which provide an excellent vehicle for learning about spline fitting given a modest background in calculus. Users of glitzy, pop-up, pull-down, window-oriented packages designed in total ignorance of the basic principles of communication arts and requiring the use of protective eyeware may be disappointed but I found the tutorials effective and easy to use with information displayed in a clean, uncluttered, simple format.

FITLIB is a PC version of the mainframe software product FITPACK which was developed by A. K. Cline and distributed by NCAR (National Center for Atmospheric Research). The package appeared in embrionic form in 1972 and six program units from this package appear as Algorithm 476 in the issue of Comm. ACM cited above. A nice discussion of the techniques appears in

Cline, A.K. - Curve Fitting Using Splines Under Tension, Atmospheric Technology No 3 Sept 1973 60-65

By 1977 the package was rewritten and expanded to 25 subroutines and in 1985 it was converted to run on a IBM PC by PC Scientific with minor modifications (respecifying constants, etc.) to the source code (which now consists of some 20,000 lines) and the addition of object libraries, tutorials, skeleton files, etc. to support the PC environment.

Thus, the software has a long history of successful application. It is used in contour mapping programs at NCAR and is used in software packages marketed by other commercial vendors not all of whom extend the courtesy of acknowledging its use. (Courtesy: Old earth custom popular in the slower-paced societies which existed before the computer revolution.)

The product is available on 5 1/4 or 3 1/2 inch disks (the software occupies ten 5 1/4 inch disks) and is accompanied by a Reference Manual (427 pages) and a Users Guide and Tutorial (286 pages) published by McGraw-Hill. (A note on the McGraw-Hill announcement of mathematical software available from PC Scientific appears in Academic Computing Jan 1989 p6.) The manuals (5 1/2 by 8 1/2 page size) come in three ring binders with ample sized D rings for easy page turning and the plain text is in 10 pt type. (Since I often read manuals in poor light I would have preferred 12 pt type.) There is a good bibliography and relatively few typos.

I had occasion to call PC Scientific with questions regarding their product and the impression I received was one of a congenial and knowledgeable staff.

Current pricing for the FITLIB product (or the technical support by phone which is available for an additional fee) can be obtained from:

Alyce Grover, Sales Manager
PC Scientific, Inc.
6 Pine Tree Drive, Suite 250
St. Paul, MN 55112
Phone: (612) 490-0615

Other sources of information can found in advertisements which appear in the January issues of journals such as NASA Tech Briefs, Pers. Eng. and Inst. News, Sci. Comp. and Auto., SIAM News, and Tech Minnesota.

Herbert Holden authored a text on FORTRAN IV (Macmillan 1970). He has served as chief of applications programming at UC Davis, senior programmer at SRI International and is currently associate professor of mathematics at Gonzaga University.

Three Issues for Computational Environments in Academic Departments

The above article by Gene Herman, and the review by Mark Sand report the creation of computational environments in two college mathematics departments. In an effort to get a discussion going, I want to make explicit three of the many issues that are implicit in these articles.*

Shared *vs.* homogeneous environments

While there are a number of differences in the systems created at Grinnell and Augusta, there are a number of similarities. One of the most striking is the decision to opt for what I would call a homogeneous environment, one where *isomorphic* machines are hooked together by a LAN. There are a number of things to be said for such a system. Herman ends his article with an eloquent statement of the attitude such a system is creating in his own department. A major advantage is that people can work together building up a stock of shared programs and other resources. Another virtue is that it can reduce costs in various ways; maintenance agreements are usually cheaper in bulk, and it takes fewer people to become experts with such a system involving one kind of machine than it does with a system using several radically different machines. Also, dead machines can be cannibalized to repair other machines.

These are all sound reasons for seriously considering a homogeneous environment. At least I hope so, since they are the considerations that were behind our decision to opt for such a system in the early days of CSLI. However, I discovered the hard way that there are serious problems with such a system, problems that eventually doomed ours.

One problem is that in most academic settings there are widely divergent computational needs and abilities. A few users will use computers only for email. Many will use it only for mail and tex processing. But many others will use it in research. And some will even use it in teaching. So a fair number will be actually doing computations, either symbolic or numerical. The problem with a homogeneous environment in such a setting is that inevitably some users are going to be using machines that are inappropriate to their needs or abilities. What a waste of a workstation to give it to someone who does nothing but read mail. And what a waste of a mathematician to force him to carry out memory intensive computations on a small personal microcomputer.

A related problem stems from the fact that many mathematicians already have a stock of programs, either purchased or created, that they use regularly. It is unlikely that a newly created homogeneous environment is going to support them all. So either people will not switch to the new environment, or else there will be a tremendous waste of previous investment in hardware, software, and learn time.

Similarly, what is going to happen to the homogeneous environment in two or three years? The computers that make it up are no longer state of the art, or start failing. As you replace them, do you start over again, or give up homogeneity and evolve into a heterogeneous system?

These pressures have led to the heterogeneous system now in place at CSLI: a hodge-podge of terminals, Macintosh Pluses, SE's and II's, some IBM PC's, and various high-end workstations, all connected by ethernet to a large file server which doubles as a time-sharing host, as well as highpowered workstations of various sorts (SUN, HP, Xerox), all linked together over a LAN to a pair of central mainframes which double as file servers. While there are some economic

* I would like to thank Bill Croft of CSLI for helpful comments on a draft of this editorial.

disadvantages of such a system, still it is cheaper than if we were all using the most expensive sorts of workstations, on which many of us were unhappy anyway. And for the most part, people have gravitated to the kind of machine on which they are most comfortable. We have not lost the sense of a shared environment, due to the extensive use of electronic mail, common programs like LaTeX, and the file servers which allow us to work collaboratively.

So my experience makes me wonder whether or not a strictly homogeneous environment is the best use of resources, and whether or not it is stable over time, especially in departments with widely divergent computer use. Technology becomes obsolete so quickly and user demands vary so radically that that it is seldom wise to put all your eggs in one basket. I think it is more prudent to spread the risk around with a heterogeneous system, and not to spend too much money all at once. And if you want to hedge a bit on the technology, invest in known standards, such as ethernet, TCP/IP, common lisp, C, Prolog, X windows, UNIX, TeX, etc. Then as the hardware changes you will be able to port your work to new platforms.

Computers in classrooms

First, a distinction. There are currently four ways to get computer technology into the mathematics classroom. Type I: One method is to have individual classrooms equipped with a single, permanent computer (or maybe two, of different kinds) and projection equipment of some sort. Type II: Another method is to have a classroom set up with a bevy of computers, so that the instructor and students can all use them in class. Type III: the computer lab, which is not really intended for class use, but for individual use. Type IV: Finally, at the other extreme, we have rooms that have no permanent computer equipment, but where the equipment is wheeled in on carts on an *ad hoc* basis.

Notice that while a room of Type II can be used as one of Type III, and vice versa, the optimum arrangements for each type differ. For example, a lab might have a variety of computers, for use with different kinds of software. And it might have things set up without any regard to lines of sight, perhaps having machines around the wall, or back to back.

Grinnell and Augusta have each set up a Type II classroom. I used to think this the way to go. However, my experience here at Stanford (not particularly at CSLI, where there is little teaching) has led me to question it, on several grounds.

First, just try giving a lecture in a room with 20 or 25 computers running. The noise (and heat) are something to contend with, as are the various things the students can find to play with on the machines, and the line-of-sight problems mentioned in Herman's article.

Second, as far as I can tell, few teachers actually take advantage of the student machines, especially in college level math courses. What they want is the ability to illustrate their lectures on the computer. But for this, all they need is one computer with an overhead projector. At best, the students' computers sit silent.*

Third, when a Type II room doubles as a Type III room, there is competition for space. True computer labs are busy night and day around here. It is very frustrating for a student in the middle of an assignment to have to leave, making room for a class, when they know perfectly well that the machines are not going to be used by that class.

Fourth, any Type II classroom is going to be based on some particular type of computer. This means that at least half the available courseware will not run on the machines in your classroom. So instead of buying two computers that, between them, run 90% of all courseware, you have purchased 25, which run less than 50%. Something seems wrong there.

Fifth is loss of room space. At Stanford, we are very short of classrooms. Setting up a classroom with individual computers cuts the classroom capacity in half, at least.

Personally, I favor a combination of rooms of Type I and III. This is the route Stanford is (slowly!) following. I reserve a room for the term that has the kind of computer I need for my courseware. (In addition, I reserve one of the computer labs to hold a problem session once a week when needed.) However, there should be a back-up system, in case the computer or projection system fails. Last term, the projector in my classroom went out the week before school started, and was repaired just in time for the final. In between, zilch, since there was no back-up system. I had to completely rethink the course, getting by with computer lab work on the student's part.

For some schools, a Type IV system might prove workable, at least for starters. You can get going with fewer computers, and there are fewer installation costs. However, compared with a type I system, it

* Of course, it could be argued that this represents a lack of training or imagination on the part of the faculty, but I am not convinced.

does put one more obstacle between the instructor and using computers in the classroom, and every such obstacle looses people who might otherwise take the plunge.

Costs

Cheap as they are becoming, relatively speaking, computers still cost a lot of money in absolute terms, especially by mathematics department standards. And common wisdom is that they last three to five years, on the average. And they take good people to keep them running. This makes the creation and maintenance of an adequate computational environment an very expensive proposition. Especially given the kinds of money schools are used to spending on mathematics, compared with the other sciences.

Is it worth it? Or should we just let those mathematicians that really use computers buy them on their own, or perhaps with grants? I suppose the answer to this is still out. Herman's essay says that 40% of their students use the departments computers outside of class, and then for an average of one hour a week. That does not seem like very much time. And yet Herman's essay makes clear that his department feels the payoff is more than worth the investment. My own experiences with the use of computers in logic classes bears this out. Part of what happens is that computer use is very uneven during the term. Parts of the course are computation intensive, others are not, very much like a chemistry lab in a chemistry course.

If we are going to justify the expense of these systems, we must learn to use them effectively. But we must also stop thinking of mathematics as the cheap science, the one that can be done only with a pencil, paper, and waste basket. The computer is changing all that forever. We must learn how to make the case to the university or college administration, to government agency, and to the public, that mathematics has the same need for computational support as any other science, including computer science. Only when we believe this ourselves will we be able to convince others, and so get the resources that are necessary.

Questions, not answers

As I said earlier, these remarks are by way of raising questions. I am not pretending to know the answers. My own experiences have led me to have strong opinions, but I would be the first to admit that they are not thoroughly tested. I am also aware that conditions vary a great deal from institution to institution. I hope some of you with different or more informed views will express them here.

Mathematical Freeware and Shareware

MathReader

In January, Wolfram Research announced that they are distributing *MathReader*, a program for use in viewing Notebooks prepared with *Mathematica*, free of charge. Although actual calculations require the full *Mathematica* system, *MathReader* allows a user to view notebooks prepared *Mathematica*. It supports text outlining and graphics animation, but not editing or printing of documents. The Macintosh version is available with a *Mathematica* demonstration disk that runs on any Macintosh. To obtain, contact Christine Schankin at Wolfram Research, (217) 398-0700.

CC

The Calculus Calculator (CC) evaluates algebraic and transcendental functions, computes integrals and derivatives, solves equations, and displays graphs in both cartesian and polar coordinates. It will also graph parametric equations. CC can perform these operations on any single-variable function that you define, including functions with derivatives and indefinite integrals. It was designed to be used by calculus students, and the distribution disk includes a 50 page manual showing how many different calculus problems can be solved with CC.

CC runs on any IBM-compatible PC with at least 512K of memory and one of the standard video graphics systems (CGA, Hercules, EGA, or VGA). Printer output is supported.

Copies may be obtained from:

David Meredith
Mathematics Applications Group
Department of Mathematics
San Francisco State University
1600 Holloway Avenue
San Francisco, CA 94132

Requests should included a return envelope and a blank 5 1/4" disk.

Rubik Algebra

Rubik Algebra is primarily a tool for illustrating, motivating and exploring a variety of ideas and basic theorems from elementary group theory, using Rubik's cube. The program allows the user to see the results of applying arbitrary sequences of face rotations to Rubik's cube. More important, however, is the facility to decompose an arbitrary sequence of face rotations into disjoint cycles. One can use the visual image of Rubik's cube along with cycle decompositions to

illustrate ideas such as (a) the order of an element in a finite group, (b) how to calculate the order of an element from its cycle decomposition, (c) the effect of conjugation on cycle structure and (d) even and odd permutations.

Useful (for actually solving Rubik's cube) sequences of face rotations can be built using the notions of commutators and conjugates. The impossibility of certain operations on Rubik's cube, such as a single transposition, can be illustrated.

Other features of the program are the ability to store on disk sequences of face rotations for later use, the ability to "undo" rotations already performed, a random scrambler, an unscrambler, menus and help screens.

The program runs on IBM PCs and compatibles with CGA graphics. It is being distributed as shareware with a price of $10. A copy may be obtained for evaluation by sending either a disk and self-addressed stamped disk mailer or $1.00 for a 5 1/4 inch disk or $1.80 for a 3 1/2 inch disk to Charles G. Fleming or Judy D. Halchin, Department of Mathematics, Eastern Illinois University, Charleston, IL 61920.

Inside the AMS

Elections

Robert M. Fossum

The Committee on Election Scheduling reported to the Council at its Phoenix meeting on 10 January 1989. The Committee consists of Jane P. Gilman, Irwin Kra, William P. Thurston, William A. Veech, and James A. Voytuk. Below I present the recommendations of the Committee. Preceding each recommendation, the current practice regarding the item addressed is stated in capsule form. Immediately following this article is another article written by Allyn Jackson about the Council meeting. In Jackson's article, one can find comments on this report that were made during and after the Council meeting.

The Nominating Committee.

There is no mention of the Nominating Committee in the Bylaws of the Society. Currently the Nominating Committee consists of eight members, each with a two-year term. Four members are elected by preferential ballots in the annual election held by the membership each fall. The newly elected members of the committee take office on 1 January of the year following election. Six candidates for the election are named by the President. Nomination by petition is allowed, but if fewer than two candidates are nominated by petition, then the President names enough candidates so that a slate of eight is presented for election.

This method of electing the Nominating Committee was decided upon by the Council in August 1975 upon recommendation of the Committee of Committees, which had delivered an extensive report to that Council.

The report of the Committee on Election Scheduling concerning the Nominating Committee is as follows:

1. Nominating Committee.
(a) The term of members of nominating committee shall begin on 1 September of each year.
(b) The term of office for nominating committee shall be three years. Three members shall be elected each year, so that the total membership is 9.
(c) Phase-in. At the time this provision is enacted, the President shall designate one member of the first-year class of the nominating committee, and two members of the second-year class, to have their terms extended to the 31 August following the previous expiration date of their term. Afterward, the schedule will be in a steady state.

It should be noted that recommendations (b) and (c) were passed by the April 1988 Council. The January 1989 Council approved (a). It is expected that this change will go into effect for the next election.

Vice-President.

The office of Vice-President is named in the Bylaws. Currently there are three Vice-Presidents at any one time, each with a term of two years. In the years that the Society elects a President-Elect, two Vice-Presidents are elected. In the other years, one Vice-President is elected. Elections are contested, and candidates can be nominated by petition. The report of the Committee on Election Scheduling concerning the Vice-Presidents is as follows:

2. Vice President.
(a) The term of office for Vice President shall be increased to three years.
(b) Alternative I. One Vice President shall be elected each year. In the year that this provision takes effect, the President shall designate one or two of the current Vice Presidents, as necessary, to have their terms extended to three years so that the term of office of one Vice President expires in each of the current years, the following year, and the year after the following year.
(b) Alternative II. In each year that a President is elected, one Vice President shall be elected, while

in every other year, two Vice Presidents shall be elected. Vice Presidents holding office before the provision lengthening their term takes effect shall serve for two years, while Vice Presidents elected after this provision takes effect shall serve for three years.

Treasurer and Associate Treasurer.

Both the Treasurer and Associate Treasurer are named as officers in the Bylaws. Each has a term of two years. Candidates have run in uncontested elections in the past. The report of the Committee on Election Scheduling concerning the Treasurer and Associate Treasurer is as follows:

3. Treasurer and Associate Treasurer.
(a) The term of office for Treasurer and Associate Treasurer shall be five years. A Treasurer or Associate Treasurer may be re-elected for at most one additional term.
(b) Phase-in. At the time this provision takes effect, the current term of the Associate Treasurer will be extended by two years. A Treasurer or Associate Treasurer, at the end of a term of less than five years, who has served a total of three or more years may be elected for at most one additional five-year term, and any Treasurer or Associate Treasurer who has served two years or less may be elected for two additional five-year terms.
(c) Treasurer-designate and Associate Treasurer-designate. One year before the end of the last term of a Treasurer or Associate Treasurer, as determined either by a letter of intent to resign or by the provisions above, a Treasurer-designate or Associate Treasurer-designate shall be elected. The Treasurer-designate and Associate Treasurer-designate will be a nonvoting member of all bodies on which the corresponding officer is an ex officio member.
(d) Ex Officio membership. The Treasurer and Associate Treasurer shall be ex officio members of the Board of Trustees, but not the Council. This provision shall take effect at the beginning of the term following the first election after it is enacted.
(e) Number of Candidates. Two qualified candidates shall be sought for each election for a Treasurer-designate, a Treasurer when there is no Treasurer-designate, an Associate Treasurer-designate, or an Associate Treasurer when there is no Associate Treasurer-designate.

Fine Adjustments to terms of office.

Currently, all terms of office (with very few exceptions) in the Society end on 31 December and new terms begin on 1 January. This includes most of the terms for committee membership. The Committee on Election Scheduling makes the following recommendation for terms of office:

4. Fine adjustments to terms of office. Terms of office for Council, Vice Presidents, and Presidents shall begin on 1 February following the election. In the year that this provision takes effect, all terms which were to expire on 1 January are extended by one month, to expire on 1 February.

Presentation of candidates to the membership.

At present, candidates for election to the offices of the Society are named in some appropriate issue of *Notices*. Biographical material and statements by the candidates are included in the material that is mailed, along with the ballots, to the membership. The Committee on Election Scheduling recommends the following procedures for presenting the candidates to the membership:

5. Presentation of candidates to the membership.
(a) The statements and biographical material on candidates shall be published in *Notices* at least two weeks before ballots are mailed, and the material shall also be included with the ballots.
(b) The candidate material should be gathered and organized in accordance with the discussion below, and discussion in Council. A committee of the Council shall be established to help with the gathering and reorganization of candidate material, in cooperation with the Secretary and the AMS staff.
[The "discussion below" to which the recommendation alludes is not included here. Briefly it asks that more complete biographical material be gathered and that an "interview" with the candidates for President-Elect be published.]

President.

The office of President is named in the Bylaws. The term of office is two years. In each odd calendar year a single candidate is presented for election by the membership to the position of President-Elect. In the year following election the person elected serves as President-Elect. The President-Elect takes over the office of President at the beginning of the next calendar

year. After serving two years as President, this person then serves for one year as Ex-President. Thus, at any time, the Society has a President and either a President-Elect or an Ex-President. That a single candidate is presented for election is based upon tradition. The Bylaws do not call for an uncontested election. The report of the Committee on Election Scheduling concerning the President is as follows:

> 6. President. The nominating committee and the Council shall put forward two candidates for President.

Executive Committee.

The Executive Committee of the Council is named in the Bylaws. It consists of four elected members and the President, the Secretary, the President-Elect (during even-numbered years), and the Ex-President (during odd-numbered years) as ex officio members. The Executive Committee of the Council is empowered to act for the Council on matters which have been delegated by the Council. Any member of the Council who is not an ex officio member of the Executive Committee is eligible for election to the Executive Committee. One person is elected each year for a term of four years. The Committee on Election Scheduling makes the following recommendation concerning the Executive Committee. If passed, it would require a change in the bylaws:

> 7. Executive Committee.
> (a) The term of office for Council representatives on the executive committee shall be increased to five years, beginning with the first member chosen from Council after this provision is enacted.
> (b) At the time that the fifth 5-year member is chosen, the Secretary shall become a nonvoting member of the EC.

Election results.

The current practice regarding the results of the election is to announce the numerical tallies to the Council, but to announce only the winners in *Notices*.

The report of the Committee on Election Scheduling concerning the Election results is as follows:

> 8. Election results. The numerical tallies of elections for officers shall be available to any Society member on request, and shall be distributed as an attachment to the regular Council agenda.

It should be noted that this has already been adopted by the April 1988 Council. It is mentioned here only for reference, since it is the last formal recommendation of the Committee.

The Council would be happy to receive comments from the membership on these recommendations. Comments may be directed to any member of the Council, a list of which is found elsewhere in this issue of *Notices*, or they may be sent directly to the Secretary, who will forward them to the Council. Discussion on these items will take place at the April 1989 Council, which will be held in Worcester, Massachusetts on 15 April 1989, at 7:00 p.m. at the Howard Johnson's Motor Lodge adjacent to the Holy Cross campus.

Any final action that may require changes in Bylaws will take place during the August 1989 Council meeting, which will be held on 6 August 1989, in Boulder, Colorado.

Phoenix Council Meeting

Allyn Jackson

A typical agenda for the AMS Council runs about half an inch thick, replete with proposals, ideas, and reports to be dicussed and considered. With about 35 of the 42 members present at the Council meeting in Phoenix in January, the discussion ranged from animated to unfocused to acerbic to humorous. The meeting lasted 7 1/2 hours, so a portion of it was bound to be soporific, but for the most part the interest and commitment of the members brought the meeting to life.

At the meeting, a host of issues were discussed, from ways to make the research announcements in the *Bulletin* more accessible, to adoption of an endorsement of school mathematics standards prepared by the National Council of Teachers of Mathematics, to selling TEX software to South Africa. Among those presenting reports were Kenneth M. Hoffman of the Joint Policy Board for Mathematics, who updated the Council on the Washington scene; Marcia P. Sward of the Mathematical Sciences Education Board at the National Research Council, who described a plethora of projects of that Board; and Ronald G. Douglas of the State University of New York, Stony Brook, who reported on the deliberations of the AMS Committee on Science Policy.

Focus on Election Procedures

Despite the various questions competing for the Council's attention, there was one set of issues that formed the focus of the meeting: election procedures for AMS

officers, and, specifically, the merits and disadvantages of contested elections. Though these topics have surfaced repeatedly in recent years, the current discussion began last April, when the Council considered a number of proposals put forth by Council member Irwin Kra of the State University of New York, Stony Brook, and AMS Vice President William P. Thurston of Princeton University. As a result, the Council appointed the Committee on Election Scheduling, the charge of which went considerably beyond the question of scheduling to explore other election matters. Besides Kra and Thurston, the Committee members were Jane P. Gilman of Rutgers University, William A. Veech of Rice University, and James A. Voytuk, then associate executive director of the AMS.

Given that only about 3700 out of 22,500 AMS members voted in the last election, perhaps some background on election procedures is in order. Currently, the President, Treasurer, Associate Treasurer, Secretary, and Associate Secretaries (there are four) are chosen in uncontested elections.

These offices are filled by *de facto* appointments by the AMS Nominating Committee, for, although the candidates appear on AMS ballots, there is no minimum number or percentage of membership votes required to approve the Committee's choices. Write-in candidates are permitted for all positions, but fewer than 20 write-in votes are cast for uncontested offices in a typical election. The Vice Presidents (there are three at any given time) and the Members-at-Large of the Council are chosen in contested elections from a pool of candidates twice as large as the number of positions to be filled. The names come either from the Nominating Committee or from petitions submitted by members.

The Committee on Election Scheduling presented to the Council a report which made several recommendations on such matters as the length of terms of office, the number of vice presidents, and the number of members on the Nominating Committee. In addition, the report presented views on election procedures solicited from a number of prominent members of the mathematical sciences community. But perhaps the most controversial provision of their report was the proposal to hold contested elections for AMS president. Also controversial but drawing less debate was the proposal that contested elections be held for treasurer and associate treasurer. The report also recommended exploring in future years the idea of contested elections for the Board of Trustees and Secretary.

In preparing the report, the Committee on Election Scheduling investigated the practices of 11 other scientific societies—among them the American Chemical Society, the American Physical Society, the Association for Computing Machinery, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics—and found that all had contested elections for president. In addition, most had contested elections for vice president, but there was variability for the offices of secretary and treasurer. During the meeting, Council member Lawrence Corwin of Rutgers University pointed out that most learned societies in nonscientific areas such as history and philosophy also choose their presidents in contested elections.

However, AMS Vice President Barry Simon of the California Institute of Technology noted that the practices of other organizations may provide little insight into what is appropriate for the AMS. He said that because the top researchers in other scientific areas are likely to run laboratories or other research facilities, they are usually more accustomed to administrative work than are mathematicians. In addition, their research can continue at the laboratory or facility even if they are not personally overseeing it. "It's a different culture in other sciences," said Simon. "Mathematicians' research is much more exclusive. If a mathematician doesn't do the research, it doesn't get done, so it's more difficult to make the time commitment necessary to be President." In comments presented in the report, Past-President G. D. Mostow of Yale University noted that "the principal responsibility and time commitment [of the AMS President] remains to his (or her) mathematical research." Both Mostow and the current President, William Browder of Princeton University, have indicated that they would not have run in contested elections. Several former presidents have indicated that they would have run had their elections been contested, but others said they might have declined.

An Honorary Office

One of the main arguments for keeping the presidential elections uncontested is that the office has historically been an honorary, rather than a policy-making, one, so asking candidates to compete for the position is inappropriate. Many have said that, given the time commitment involved, few individuals of the appropriate stature and distinction would run for the office unless it were seen as a singular honor.

Those favoring contested elections believe that someone who really wants to be president should run for the office. In comments presented in the report, Council member Richard S. Palais of Brandeis University says that while being named as president

is an honor, "there is certainly much more honor in the vote of confidence one receives by being truly elected, rather than virtually appointed. And if one is going to transact the business and spend the money of the Society, one will do it with more confidence and a better spirit if really chosen for that task by the members."

At the Council meeting, Thurston said that while the AMS has been fortunate to have had good, hard-working officers, institutional constraints are hampering the Society's effectiveness. "There are many issues facing the community—the declining number of people entering the profession, the lack of women and minorities, tight funding for research, the poor school curriculum," he said. "If we had contested elections, we would get officers with a more active involvement in solving the problems of the mathematical community." Thurston is also a strong supporter of one of the report's provisions recommending a more in-depth presentation of presidential candidates, including statements and biographical material presented in *Notices*. In addition, he favors the idea of publishing informal interviews with the candidates.

Some are fearful that contested elections would inject an unhealthy element of politics into the AMS. In comments presented in the Committee's report, David Sanchez of Lehigh University said that contested elections were unnecessary and possibly detrimental. "I imagine that the vast number of loyal, hardworking AMS members out there in the hinterlands would be hard pressed to decide between two eminent academicians, both of whom they have likely never heard, never met, and never understood," he wrote. "To create the possiblity of deals, campaigns, and propaganda needed to enlist these loyal members is moving the AMS in a direction fraught with danger and may cross the line from greater participation to greater politicization."

Some also say that there are very few mathematicians of appropriate stature and distinction to represent the Society, so that if two names were put forth in each election, the AMS would run out of suitable candidates in a few years. Some call this argument specious, saying that, with a membership of 22,500, the Society should have no problem finding suitable candidates. Two "unwritten rules"—that the president should be a member of the National Academy of Sciences and a former AMS vice president—reduce the pool of names to draw from. Though many feel that the Academy rule provides added insurance that the president would be a respected member of the larger scientific community, others believe that the rule is "elitist" and provides no insurance that a candidate has the necessary qualifications to be president.

Issues External to the AMS

Is the entire debate about election procedures deflecting attention from more important issues? Council member Michael C. Reed of Duke University said at the meeting that he fears contested elections may increase infighting. "We mathematicians love to argue and feel righteous," he said. "Will there be a pro-SDI and an anti-SDI candidate? A pro-South Africa and an anti-South Africa candidate?" In addition, he believes that placing so much emphasis on internal AMS procedures may be counterproductive. "This debate can detract from the outward issues such as education, government funding, and relations with the public and other areas of science. We may be setting ourselves up for more bickering that will impair our ability to act in concert on these important issues." Echoing this view, Associate Secretary Lance W. Small of the University of California at San Diego said after the meeting, "There are so many problems in the mathematical community, and the Council is arguing about whether to have 3 vice presidents or 4."

Nonetheless, the debate has generated some excitement and interest that demonstrates the commitment of the Council members to their role in the Society. At the Phoenix meeting, the Council adopted one proposal of the report, which called for increasing the size of the Nominating Committee from 8 to 9 members and moving the start of their terms to September 1 to allow the Committee more time to consider candidates for elections. The remaining proposals concerning contested elections will be settled at the Council meeting in August in Boulder, Colorado. If the report's provisions are adopted, the first president to be chosen in a contested election would take office in 1991.

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Washington Outlook

Kenneth M. Hoffman

This month's column is written by Hans J. Oser, who is a consultant to the Office of Governmental and Public Affairs of the Joint Policy Board for Mathematics in Washington, D.C.

Everybody Counts: Three-year Study of U.S. Math Education Released

At a Washington press conference, held jointly by the National Academy of Sciences and the National Academy of Engineering, the long-awaited report, *Everybody Counts, A Report to the Nation on the Future of Mathematics Education*, was released to the public on January 26. Prepared jointly (under the auspices of the National Research Council) by the Mathematical Sciences Education Board (MSEB), the Board on Mathematical Sciences (BMS), and the Committee on the Mathematical Sciences in the Year 2000, the report outlines a strategy for reforming math instruction in our schools and colleges over the next two decades.

In the foreword to the report, the President of the National Academy of Sciences, Frank Press, signals the commitment of the two Academies and the Institute of Medicine to participate in the long-term work of rebuilding mathematics education in the United States.

The press conference was opened by Robert M. White, President of the National Academy of Engineering. He praised the panels' work and echoed the message put forth by Frank Press. White had encouraged the mathematics education community, during an earlier gathering at the Academy, to be a pump, not a filter, in the process of educating our young people in the sciences and engineering.

In a departure from the usual format, the press conference began with a live class, consisting of eight sixth-graders and their teacher, Paula Duckett, from River Terrace Community School in Northeast Washington. During a 25-minute period, the students took measurements of each others' shoulder widths and arm lengths. After entering the measurements for each person (using a pocket calculator), they discussed the numbers with their teacher. They speculated on the proximity of the ratio to the golden mean which they had discussed previously in the context of art and architecture. Shirley Hill, Chair of the MSEB, stated that the purpose of this classroom demonstration was to show that group learning and interaction can lead to better involvement by the students. The demonstration also signals a departure from the traditional doctrine of teaching "the way it was taught": in this exercise, the students developed an appreciation for the magnitude of numbers and a critical attitude toward accepting measured results, and demonstrated that learning mathematics is not necessarily restricted to the individual, but that it can be a collective effort by a group learning together.

In separate statements, the Chair of the BMS, Phillip Griffiths, and Fred Bucy, Chair of the Committee on the Mathematical Sciences in the Year 2000 (usually referred to as MS 2000), offered their assessments for the need of substantial reform. They conveyed a sense of urgency and a commitment among the teachers of mathematics, to begin the long process of changing the curriculum for the year 2000 and beyond.

While admitting that the situation in the U.S. is unique among nations with its highly decentralized educational system, all speakers were confident that the proposed reforms would be adopted in due time without massive infusion of new federal money. To the contrary, Bucy said, there is now $330 billion being spent for education in the U.S. and spending it more wisely will allow carrying out part of the reforms within the current system. (Of that amount, more than $25 billion is spent for math education nationwide.)

Other members of the panel were Marcia Sward, Executive Director of the MSEB, and Ronald Douglas, State University of New York at Stony Brook. Reporters from national and local news media raised

the (rather anticipated) question whether calculators in the classroom prevent students from learning the "basics." Behind this question looms the suspicion that our children must be trained exactly the same way we learned mathematics in school. What needs to be understood is that mathematics did not stand still and that exciting developments have taken place in the past few decades that need to be taught. Getting the students to participate in discovery, rather than drilling them mindlessly, will be the challenge for teachers in the 1990s and beyond. No longer can we accept the excuse "My child does not have any aptitude for math," or we shall find a majority of high school graduates entering the work force as "innumerates." Industry now has to retrain high school graduates in order for them to develop the skills necessary to operate complex machinery, to diagnose malfunctioning components in measuring instruments, and to be able to decide when intervention is necessary in automated manufacturing systems.

Asked by reporters what kind of math is not now being taught, the panel suggested that students have to get better at problem solving and to appreciate mathematics for its significance for the understanding of real world problems in biology, the environment, economics, manufacturing, science, and engineering. Current attitudes must be changed, said Shirley Hill, and the pressure has to be kept on the system at all levels and in all components, including the textbook publishers, testing services, parents, teachers, and students. The momentum for reform is there; it is important not to lose it. The future of our children and the country depends on a successful reform in the way we teach and in what we teach.

As math instruction in the secondary schools improves, less time will be needed for remedial teaching in the colleges, thus allowing teachers to spend more time with individual students. We cannot envision future math teachers without at least a bachelor's degree in mathematics teaching our high school students. A lack of appreciation of new developments in mathematics, science, and engineering on the part of teachers is often cited as a reason why high school science and math are being perceived as dull and irrelevant. We must change that attitude.

It is appropriate to mention that there is still another player in the league of science education who is equally committed to reform: the National Science Foundation. NSF Director Erich Bloch, in a dinner speech the night before the release of the report, endorsed its main objectives, the new standards of instruction, upgrading of the teaching profession, and development of more effective procedures for assessing student proficiency. He called the report a milestone and praised the mathematics research community for its readiness to be influential in effecting the changes in math education that are imminent both at the precollege and undergraduate levels. He warned the audience, however, that this report was just the beginning, and that continuous involvement by all participants will be necessary. NSF, he said, expects to be a part of this effort.

Academies Offer White Papers to the New President

Late last year, the National Academy of Sciences (NAS), the National Academy of Engineering (NAE), and the Institute of Medicine (IOM) issued four white papers to the then President-Elect George Bush. The white papers deal with policy issues the three bodies urge the new president to consider because of the urgency with regard to the health of science and the nation in general.

The IOM and NAS, in a joint white paper, recommend action with regard to HIV infection with AIDS, issues that these two bodies have studied since 1985. Specific steps are suggested to the new administration ranging from the effective use of the National Commission on AIDS to patient care, education, research, and international health efforts.

The NAS, NAE, and IOM, in another white paper, recommend that the new President's science adviser be given high-level status in the White House. Without the status of Assistant-to-the-President, the paper states, the science adviser could not effectively deal with issues such as industrial competitiveness, weapons programs, setting of budget priorities in the $62 billion federal R&D program, AIDS, changes in the global environment, or establishing national goals for space exploration, to name the most pressing ones.

The NAS, NAE, and IOM, in a white paper on Global Environment Change, warn that global climate warming, ozone depletion, tropical deforestation, and acid depletion are issues that need attention early in the new administration. The issue of global environment change and the development of responsive policies must figure more prominently in the scientific, political, and foreign policy agendas of the United States. The three bodies recommend the establishment of a central point for oversight of national efforts toward the global environment in order to improve coordination and allocation of resources among related activities in government and to foster linkages between scientific understanding and policy options.

The academies also recommend that specific steps be taken in the near term (which is Academy-speak for saying action is urgent):

- Policies to foster energy efficiency and conservation
- Deeper reductions in emissions of ozone-destroying chemicals, and the eventual phaseout of chlorofluorocarbons in accord with the Montreal Protocol
- A plan for agriculture, water resources, forestry, coastal protection, and other climate-sensitive activities
- National policies to reduce acid deposition
- Increase of investment in research and monitoring of the global environment

The NAS and NAE, in a fourth white paper, offer recommendations for the Civil Space program. The two academies call for a commitment of $30 billion over the next decade to move ahead with a manned space station, without waiting for the final configuration to be determined now. Two structural components must be assured for the future space programs: the first, a base program that ensures the U.S. competence in all space activities. The recommended level of funding: about $10 billion annually. The second component consists of long-term special initiatives that serve U.S. scientific, political, cultural, and foreign policy objectives. These, the two Academies say, should be funded separately from the base program to ensure that operational expediency does not again erode the nation's basic capabilities in space. Each special initiative would require an additional $3 billion to $4 billion in peak years. Examples are the space station and human exploration of Mars or the Moon.

International partnership with other space-faring nations such as the Soviet Union, Western Europe, Japan, and China, should yield cost savings and political, scientific, and technical benefits not otherwise achievable.

Recommended Actions: In consultation with Congress, the Administration should establish long-term goals for space. Such goals might include automated scientific exploration; human exploration of the Moon or Mars in the next century, for which a space station is a prerequisite; expanded monitoring of the Earth for environmental and scientific purposes. Configuration and deployment of the Space Station should follow from these goals.

The four white papers are available from the National Academy Press. Telephone: (202) 334-3313 (or 3113).

JPBM's Washington office now has email addresses.

The Office of Governmental and Public Affairs is now connected to the ARPA and BITNET electronic mail systems. Ken Hoffman, Hans Oser, Kirsten Sampson, and Katherine Molloy can be reached at JPBM@UMD2.UMD.EDU on the ARPANET or at JPBM@UMD2 on BITNET. Try it some time. We'd enjoy hearing from you!

News and Announcements

J. Frank Adams
1930–1989

Frank Adams, one the world's most brilliant and influential algebraic topologists, died in an automobile accident on January 7, 1989. His work was the dominant force in the creation of the modern subject of stable homotopy theory, and his ideas and contributions pervade virtually every area of algebraic topology.

Adams was educated at Bedford School and Trinity College, Cambridge. His first teaching position was at Trinity Hall, Cambridge. He spent the years 1962–1970 at the University of Manchester, first as Reader and later as the Fielden Professor of Pure Mathematics. He returned to Trinity College and Cambridge University as the Lowndean Professor of Astronomy and Geometry in 1970. He was elected to the Royal Society in 1964 and was awarded its Sylvester Medal in 1982. He was elected a foreign associate of the National Academy of Sciences in 1985.

Adams regarded himself primarily as a problem solver, and he first became famous for his solutions to the Hopf invariant one problem and to the vector fields problem. One version of the former problem asks which dimensions are possible for a division algebra over the real numbers (answer: 1, 2, 4, or 8). The latter problem asks how many linearly independent vector fields there are on the n-sphere for each n.

In the course of solving the first of these problems, Adams developed the theory of higher order cohomology operations and invented what is now called the Adams spectral sequence, which has become the most fundamental tool in stable homotopy theory. In the course of solving the second of these problems, he introduced what are now called the Adams operations in topological K-theory.

In a fundamental series of papers, Adams posed what is now called the Adams conjecture, a basic assertion about the relationship between vector bundles and spherical fibrations, and developed its consequences. The later proofs of this remarkable insight led to such major mathematical developments as Sullivan's construction of localizations and completions of topological spaces and Quillen's invention of higher algebraic K-theory.

Adams was intensely interested in all developments in algebraic topology, and his expository lecture notes and monographs on a variety of topics in the subject are a vital part of the current literature. He took great pains to ensure that his own work met the highest standards of rigor, elegance, and clarity of exposition, and he expected others to at least attempt to measure up to the same high standards. His influence was exerted not only through his publications, but also through the refereeing of papers, which he took very seriously, and an enormous volume of mathematical correspondence.

Adams was a long time member of the American Mathematical Society and a frequent visitor to the United States. He spent the year 1957-1958 at the Institute for Advanced Study, and he was for many years a regular spring visitor to the University of Chicago.

J. Peter May
University of Chicago

Ronald J. DiPerna
1947–1989

Ronald J. DiPerna, who at a young age was already a major figure in analysis and nonlinear partial differential equations, died on January 8, 1989 at the age of 41. Ronald DiPerna was a professor of mathematics at the University of California at Berkeley and was a member of the Institute for Advanced Study in Princeton, N.J. at the time of his death. His wife, Maria Schonbek, is a professor of mathematics at the University of California at Santa Cruz.

DiPerna was born in Sommerville, Massachusetts in 1947 and received his Ph.D. in 1972 from the Courant Institute of Mathematical Sciences of New York University. He held faculty positions at Brown University, the University of Michigan, the University of Wisconsin and Duke University.

DiPerna was best known for his development of the method of compensated compactness. This is a very powerful method for controlling oscillation and thereby proving existence theorems. DiPerna proved existence of weak solutions in the large for equations of compressible gas dynamics and he obtained important results concerning uniqueness

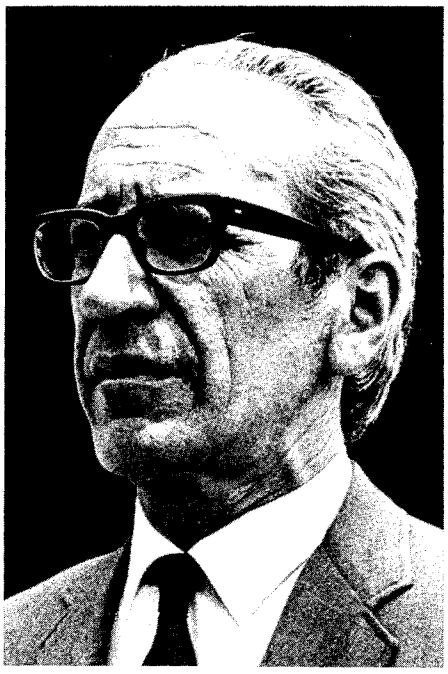
of solutions, their large time behavior and their local regularity as elements of BV spaces. His recent work concerned the Boltzmann equation (jointly with P. L. Lions) and the two dimensional Euler equation (jointly with A. Majda).

DiPerna liked hard problems and he perservered to conquer them. His courage and mathematical vision will stand as an inspiration to all who were privileged to know him and to those who will learn from his works.

James Glimm
SUNY, Stony Brook

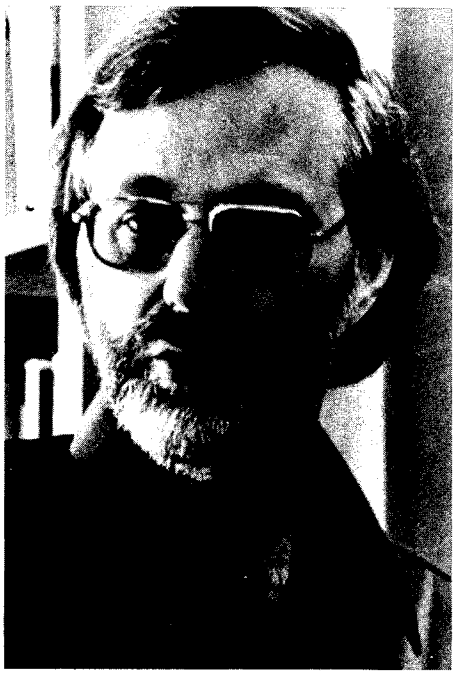
1989 Wolf Prizes

The Wolf Foundation has announced the 1989 prize winners in mathematics. The $100,000 prize in mathematics will be shared by Alberto P. Calderón of the University of Chicago and John W. Milnor of the Institute for Advanced Study, Princeton.



Alberto P. Calderón

Born in Mendoza, Argentina in 1920, ALBERTO P. CALDERÓN has been selected for his "groundbreaking work on singular integral operators and their application to important problems in partial differential equations." His work has had a lasting impact on the shape of contemporary Fourier analysis and on its connections with real variables, complex analysis, and partial differential equations. In particular, his contributions to the theory of singular integral operators have been decisive, both by bringing to the theory the sharpest technical tools and by applying the theory in imaginative ways to important problems in partial differential equations. He received the Bôcher of the AMS in 1978 for a paper on the Cauchy integral on Lipschitz curves. A student of Antoni Zygmund, Professor Calderón received his Ph.D. from the University of Chicago in 1950.



John W. Milnor

JOHN W. MILNOR, born in Orange, New Jersey in 1931, was recognized for "his ingenious and highly original discoveries in geometry which have opened important new vistas in topology from the algebraic, combinatorial, and differentiable viewpoint[s]." His work has exerted a major influence on the development of contemporary mathematics. The current state of the classification of topological, piecewise linear, and differentiable manifolds rests in large measure on his research in topology and algebra. Professor Milnor's work on "exotic" differentiable structures (i.e., those different from the standard structures) launched the subject of differential topology. His research in algebraic geometry on singular points of complex hypersurfaces relates exotic spheres to links around singularities. In combinatorics, he disproved the longstanding conjecture of algebraic topology known as the Hauptvermutung. Professor Milnor received his Ph.D. from Princeton University in 1954.

The awards will be presented by the President of Israel, Chaim Herzog, in May during ceremonies at the Parliament in Jerusalem. The Wolf Foundation, an Israel-based, international organization, presents annual prizes for achievements in chemistry, agriculture, medicine, physics, mathematics, and the Arts.

Established in 1975 by the late Dr. Ricardo Wolf to "promote science and art for the benefit of mankind," the Wolf Foundation also grants stipends each year to hundreds of students and researchers in Israel. Dr. Wolf, a German-born chemist, philanthropist, and diplomat, emigrated to Cuba before World War I and became Cuban Ambassador to Israel in 1961. He died in Israel in 1981.

1989 MAA Awards

The Mathematical Association of America (MAA) presented its Award for Distinguished Service to Mathematics and the Chauvenet Prize at its 72nd annual meeting in Phoenix on January 13.

IVAN NIVEN, Professor of Mathematics at the University of Oregon, Eugene, Oregon, received the Distinguished Service Award in recognition of service that has had significant nationwide influence on mathematics

and mathematics education. In addition to serving as President of the MAA (1983-1984), Professor Niven has been a member of the Association's Board of Governors since 1982 and has served on at least 30 MAA committees. As President, Professor Niven was influential in the creation of the American Mathematics Project, which seeks new ways to improve the teaching of mathematics at the secondary and primary levels. He has also served as chair and governor of the Pacific Northwest Section of the MAA and on numerous sectional committees. The author of seven books and some 70 papers, Professor Niven received his B.A. from the University of British Columbia in 1934 and his Ph.D. from the University of Chicago in 1938.

JACOB KOREVAAR, Professor of Mathematics at the University of Amsterdam, received the Chauvenet Prize for his paper, "Ludwig Bieberbach's conjecture and its proof by Louis de Branges," which appeared in *The American Mathematical Monthly* in 1986. The prize is given yearly to the author of a noteworthy expository survey paper. Upon making its selection, the Committee on the Chauvenet Prize said of Korevaar's paper, ". . .we are reminded that the beauty and power of a few simple ideas can sometimes lead to very deep results that can even be understood by students just starting to seriously study mathematics. Elegant arguments like those included in this paper are one of the best ways of attracting students to mathematics." Professor Korevaar's research areas are complex analysis and approximation theory, with a focus on Tauberian theorems and Muntz-type approximation. Born and educated in the Netherlands, he spent 25 years in the U.S., mostly at the University of Wisconsin at Madison and the University of California, San Diego. Since 1974 he has been at the University of Amsterdam. He is a member of the Netherlands Academy of Sciences.

ACM Awards

Three mathematical scientists received awards from the Association for
Computing Machinery at the ACM Computer Science Conference in Louisville, Kentucky on February 22, 1989.

IVAN SUTHERLAND has received the 1988 ACM Turing Award for his pioneering and visionary contributions to computer graphics. This award, the highest honor in computer science research and applications given by the ACM, has been presented annually since 1966 for contributions of lasting and major technical importance to the computing field. The prize is named for the British mathematician A. M. Turing, whose pioneering work was instrumental in the development of computer science and applications. Sutherland, Vice President and Technical Director of Sutherland, Sproull, and Associates, Incorporated, is the inventor and developer of the interactive graphics program called Sketchpad. The ACM Awards Committee cited Dr. Sutherland for the many innovations in Sketchpad, including "a display file for screen refresh, a recursively traversed hierarchical structure for modeling graphical objects, recursive methods for geometric transformations and an object-oriented programming style. Later innovations include a 'Lorgnette' for viewing stereo or colored images and elegant algorithms for registering digitized views, clipping polygons, and representing surfaces with hidden lines."

GUY L. STEELE, Senior Scientist at the Thinking Machines Corporation, received the 1988 ACM Grace Murray Hopper Award for "his general contributions to the development of Higher Order Symbolic Programming, principally for his advancement of lexical scoping in LISP." The Hopper Award, established in 1971, recognizes young individuals who have made outstanding technical contributions to the computer industry by age 30. Steele has published more than two dozen technical papers on the subject of LISP, in addition to three books on LISP and other computer science topics. At Thinking Machines, he works with parallel programming languages and other systems software for the Connection Machine. He received his A.B. in applied mathematics from Harvard University (1975) and his S.M. (1977) and Ph.D. (1980) degrees in computer science and artificial intelligence from the Massachusetts Institute of Technology.

CHARLES L. BRADSHAW, Chairman of the Computer Science Department at Mississippi State University, received the 1988 ACM Distinguished Service Award for "over thirty-five years of valuable and lasting contributions and service to the government, academic, and professional computing community as a computer scientist, educator, administrator, and ACM leader." With service to ACM spanning more than 25 years, Bradshaw's career in scientific computing has centered primarily on various space flight projects. From 1971 until 1988 he was Director of Computing at Vanderbilt University. Bradshaw received his B.S. degree in mathematics from Tennessee Technological University in 1947 and his M.A., also in mathematics, from the University of Tennessee in 1950.

Fulkerson Prizes Awarded

The Fulkerson Prize for outstanding papers in the area of discrete mathematics is sponsored jointly by the Mathematical Programming Society and the American Mathematical Society. The prize was established to encourage mathematical excellence in the fields of research exemplified by the works of Delbert Ray Fulkerson and is awarded for papers that have been published in a recognized journal during the preceding

six years. Beginning in 1979, up to three awards are presented at each (triennial) International Symposium of the Mathematical Programming Society.

The 1988 Fulkerson Prizes were awarded to ÉVA TARDOS of Eötvös Lorand University, Budapest, Hungary, and to NARENDRA KARMARKAR of AT&T Bell Laboratories, Murray Hill, New Jersey. Professor Tardos received the award for her paper "A strongly polynomial minimum cost circulation algorithm", *Combinatorica*, Volume 5 (1985) pages 247–256; and Dr. Karmarkar received the award for his paper "A new polynomial-time algorithm for linear programming", *Combinatorica*, Volume 4 (1984) pages 373–395. The prizes were awarded on the recommendation of a committee consisting of M. Padberg (chairman), M. Grotschel, and G.-C. Rota.

U.S.S.R. Academy of Sciences Elects 16 Americans

The U.S.S.R. Academy of Sciences recently announced the election of 44 foreign members. Sixteen of the newly elected foreign members are from the U.S. Prior to this election, there were only 13 U.S. members (out of a total of 93 foreign members). The Soviet academy said the honor had been bestowed upon them for outstanding achievements in the natural sciences and humanities and also for the promotion of international cooperation. The election is generally regarded as another sign of the continuing improvement in relations between the U.S. and the U.S.S.R.

The Americans elected to the U.S.S.R. Academy of Sciences who are of particular interest to readers of *Notices* are: LARS V. ALFORS, Harvard University; PETER D. LAX, Courant Institute of Mathematical Sciences; EDWARD N. LORENZ, Massachusetts Institute of Technology; FRANK PRESS, National Academy of Sciences; and J. ROBERT SCHRIEFFER University of California, Santa Barbara.

Honors for Soviet Women Mathematicians

Olga Oleinik, Head of the Department of Differential Equations at Moscow State University, was awarded the U.S.S.R. State Prize for her achievements in mathematical research.

In addition, Oleinik and Olga Ladyzhenskaia of the Leningrad Branch of the Mathematics Institute were elected to the Academy of the Lincei, a scientific academy in Rome, Italy. Both participated in the ceremonies in Rome on November 26, when the President of the Republic of Italy presented them with the insignia and documents of membership in the Academy.

NSF-CBMS Regional Conferences in the Mathematical Sciences

To stimulate interest in mathematical research, the National Science Foundation (NSF) is sponsoring 10 regional conferences between May 1989 and January 1990. A panel chosen by the Conference Board of the Mathematical Sciences, under a contract with the NSF, made the selections from among submitted proposals.

Each five-day conference typically has about 25 participants, and features 10 lectures presented by a single guest lecturer. The lecturer subsequently prepares and submits to the Conference Board a paper based on these lectures, which normally is published as a monograph as part of a regional conference series. Depending on the Conference topic, publication is sponsored by the American Mathematical Society or the Society for Industrial and Applied Mathematics, or jointly by the American Statistical Association and the Institute of Mathematical Statistics.

See the Funding Information for the Mathematical Sciences section of this issue of *Notices* for the announcement inviting proposals from prospective institutions for next year's Regional Conference.

The regional conferences for this coming year are:

Discrete Groups, Expanding Graphs and Invariant Measures, at the University of Oklahoma, with Alexander Lubotsky as lecturer. Andy Magid is the Principal Investigator (405-325-2052). May 1989.

Function Estimation in the Context of Independent and Dependent Observations, at the University of California, Davis, with Murray Rosenblatt as lecturer. George Roussas is the Principal Investigator (916-752-8142). June 1989.

Harmonic Analysis, Real Function Spaces and Related Areas, at Auburn University, with Guido Weiss as lecturer. Geraldo DeSouza is the Principal Investigator (205-826-4290). June 12–16, 1989.

Projection Pursuit and Related Computationally Intensive Techniques for Analyzing Multivariate Data, at George Washington University, with Jerome Friedman as lecturer. Robert Smythe is the Principal Investigator (202-994-6356). June 12–16, 1989.

Circuit Complexity, at the University of Chicago, with Michael Sipser as lecturer. Janos Simon is the Principal Investigator (312-702-3488). June 25–30, 1989.

Scientific Computation, at Butler University, with Richard S. Varga as lecturer. Amos Carpenter is the Principal Investigator (317-283-9436). June 26–30, 1989.

Algebraic Ideas in Ergodic Theory, at the University of Washington, with Klaus Schmidt as lecturer. Douglas Lind is the Principal Investigator (206-543-1723). July 17–21, 1989.

Heat Equations in Geometry, at the University of Hawaii, Honolulu, with Richard S. Hamilton as lecturer. Joel Weiner is the Principal Investigator (808-948-8595). July 24–29, 1989.

Singular Integral Operators, at the University of Montana, with

F. Michael Christ as lecturer. William Derrick is the Principal Investigator (406-243-5569). August 24–September 1, 1989.

The tenth Conference was approved for January 1990 at the University of Miami. The lecturer was to be Ronald DiPerna, who died on January 8, 1989. Further information regarding this conference will be announced at a future date.

News from the Institute for Mathematics and Its Applications

University of Minnesota

The Board of Governors of IMA in its last meeting in October 1988, has approved a proposal for Applied Linear Algebra as the annual program for 1991-1992. The organizers are: Richard A. Brualdi, George Cybenko, Alan George, Gene Golub, Paul van Dooren, and Mitchell Luskin.

The board also approved Time Series and Radar and Sonar as topics for the summer of 1990. The Radar and Sonar program is being organized by: Alberto Grunbaum, Marvin Bernfeld, Richard Blahut, and Richard Tolimieri (June 18–29). The Time Series program is being organized by: Emanuel Parzen, David Brillinger, R. Gnanadesikan, Murray Rosenblatt, Murad Taqqu, and John Geweke (July 2–31).

The annual program for 1989-1990 is Dynamical Systems and Their Applications and for 1990-1991 is Phase Transitions and Free Boundary Problems. The Institute is open to suggestions of new proposals, for both annual and short term programs. People interested in writing up a proposal should contact the Director, Avner Friedman.

It was recently decided to have two additional workshops in the spring of 1989: "Microlocal Analysis and Nonlinear Waves" (May 15–19) organized by: M. Beals, R. Melrose and J. Rauch, and "Symbolic Computation Methods and Differential Equations" (June 26–30) organized by: R. Caviness and M. Singer.

U.S.–U.S.S.R. Algebraic Geometry Symposium

The Mathematical Disciplines Center and the Department of Mathematics of the University of Chicago will hold a joint Soviet and American symposium on algebraic geometry from June 19 through July 14, 1989. The National Academy of Sciences and the Academy of Sciences of the U.S.S.R. gave their joint endorsement of the symposium at their annual interacademy meeting in December 1989. Partial funding has been requested from the NSF.

The main purpose of the Symposium is to assemble as strong a group of algebraic geometers as possible from each of the two countries and to do all that is possible to allow them to work together for a substantial amount of time. Although some of the invited participants will give talks, most of the time will be devoted to discussions, informal and formal, especially about open problems and directions for future work. There will be plenty of time for small groups to work on joint projects. Thus the emphasis will be more on participation in research than on transmittal of information.

Different broad areas of algebraic geometry will be emphasized during different phases of the Symposium. The main emphasis of the first week will be arithmetic algebraic geometry. Tentatively, the second week will emphasize applications to physics, K-theory, and representation theory. Other topics of discussion will include motivic cohomology, Hodge theory, intersection homology, perverse sheaves, D-modules, three-folds and higher dimensional varieties, and recent progress in such classical geometric topics as curves, surfaces, rationality and birationality questions, Abelian varieties, projective geometry, moduli questions, vector bundles, fundamental groups, etc.

About 25 Soviet algebraic geometers and 35 American algebraic geometers have been invited to participate (not including the expected Chicago area participants).

The organizers are S. Bloch, W. Fulton, R. Swan, and J. P. May. Mathematicians wishing to participate should write the organizers at the Department of Mathematics, the University of Chicago, Chicago, Illinois 60637 or call 312-702-7100.

Society for Mathematical Biology

The Society for Mathematical Biology, in conjunction with the Institute for Mathematics and its Applications, is sponsoring a meeting entitled "Classics of Theoretical Biology," in Oxford, England during July 3–8, 1989. The speakers and topics include John Rinzel and Jack Cowan, Neurophysiology; James Murray, Development; William Reed, Bioeconomics; Robert May, Ecology; Roy Anderson, Epidemiology; and William Provine, Population Genetics. The proceedings will be published as a special issue of the *Bulletin of Mathematical Biology* and as a separate volume by Pergamon.

Funding for partial travel support for graduate students is available from the Society for Mathematical Biology (see the Funding Information for the Mathematical Sciences section of this issue of *Notices* for further information).

For more information, contact Marc Mangel, Department of Zoology, University of California at Davis, Davis, CA 95616, 916-752-8830 (email msmangel@ucdavis).

Joint Meeting with LMS in 1992

For the first time, the AMS and the London Mathematical Society (LMS) will collaborate on a joint conference to be held in the summer of 1992 in Cambridge, England. The meeting

will feature five, one-hour invited addresses by mathematicians from the United States and Great Britain, in addition to Contributed Papers and Special Sessions. There will also be a festive banquet.

This auspicious event indicates the spirit of cooperation between the AMS and the LMS and the importance of strengthening ties in the international community of mathematical scientists. The friendly relationship between the the two societies has a long history, for it was the LMS that inspired the founder of the AMS to establish in 1888 a mathematical society in the United States.

The meeting will be held June 29–July 2, 1992. Mark your calendars now, and watch for more information on this historic meeting.

Pi Mu Epsilon Diamond Jubilee Celebration

In celebration of its 75th anniversary, Pi Mu Epsilon (PME), Incorporated, the international honorary mathematical society, will hold a Diamond Jubilee celebration, which will take place at the Joint Mathematics Meetings in Boulder, Colorado, August 7–10, 1989. As part of the celebration, PME is planning a number of special scientific and social events.

To mark this special event, the AMS has provided funds for a new Diamond Jubilee commemorative prize. The $1000 prize will be administered and awarded annually by PME, beginning this year.

In Boulder, the celebration will include an expanded scientific program, featuring the J. Sutherland Frame Lecture by Jane Cronin Scanlon of Rutgers University. In addition, Joseph A. Gallian of the University of Minnesota-Duluth will present a special AMS-MAA-PME address. A series of contributed paper sessions will give undergraduate students an opportunity to present papers.

Several social events are planned for Boulder. The celebration kicks off with a reception on August 7, and there will also be the PME banquet and other activities. "We hope it will be a mathematically enriching and festive time," says Eileen Poiani, President of PME.

In addition to the events at the Boulder meeting, PME plans to issue a special commemorative issue of the *πμε Journal* as part of the Diamond Jubilee. PME has published the semiannual journal since 1952.

PME was founded in 1914 at Syracuse University with the goal of promoting scholarship in mathematics. Through its more than 260 chapters nationwide, PME seeks to encourage more students to persist in mathematics and to pursue careers in mathematics research and related areas. Members are generally inducted into PME as undergraduate students and remain members for life. However, individuals need not be students to join, and they need not be affiliated with academic institutions.

PME encourages colleges and universities to send undergraduate student speakers and delegates to the Diamond Jubilee. There will be travel grants available for delegates and for students selected to present papers at the meeting. Information about the travel grants will be sent this month to colleges and universities across the nation.

For more information, contact Eileen Poiani, President of PME, Saint Peter's College, 2641 Kennedy Boulevard, Jersey City, NJ 07306; or Robert Woodside, Secretary-Treasurer of PME, Department of Mathematics, East Carolina University, Greenville, NC 27858, telephone 919-757-6414.

Science Literacy Conference

"Strategies for Change," a conference on improving science literacy, will be held March 13–15, 1989, in Washington, DC. The American Medical Association and several other groups concerned with science literacy are sponsoring the conference as part of the National Initiative for Science and Technology Education. The conference will serve as the initiative's genesis for formulating a national agenda and specific strategies for raising the science literacy of the general public. Covering the mathematical sciences on the program will be Lynn Arthur Steen of St. Olaf College.

The registration fee for the conference is $225. For more information, call 800-621-8335. In Illinois, call collect, 312-645-4987.

Database Connects Jobseekers and Employers

The AMS recently signed an agreement with an organization that manages a resume data bank used primarily by non-academic employers interested in hiring professional personnel with training in mathematics, science, and engineering. AMS members may now use this service free of charge.

The service, called Scientists and Professional Engineering Employment Registry (SPEER), includes a computerized database of resumes from a cross section of professionals interested in career opportunities. Employers specify their requirements for a particular job, and SPEER selects the individuals having the skills, experience, education, salary requirements, geographic preferences, and other characteristics matching the job requirements.

To indicate their interest in a particular individual meeting their job requirements, employers send to SPEER a "contact request." SPEER mails the request to the jobseeker, who is then free to respond directly to the company to arrange an interview. If the individual is not interested in the position, SPEER notifies the employer of the decision, and the individual remains anonymous. In addition, the resumes are specially coded so that a jobseeker's current

employer will not view the individual's resume.

Employers pay a flat-rate subscription fee to use SPEER, but there is no cost or obligation to the jobseeker. Individuals may update their resumes on file at SPEER and may have their names removed at any time.

For more information about SPEER, AMS members should write to AMS-SPEER, c/o Career Technologies Corporation, 138 Old River Road, Andover, Massachusetts 01810 or call (508)683-0098.

Mathematics Makes a Showing at AAAS Meeting

Ten thousand people turned out for the largest meeting in two decades of the American Association for the Advancement of Science (AAAS). Holding the meeting in San Francisco probably boosted attendance, but even those who came only for some mild California weather in the middle of January found much of interest on the extensive scientific program. Unlike most scientific conferences, AAAS meetings cover a broad range of disciplines and therefore provide a way for researchers to learn of developments in areas other than their own.

The several sessions in the mathematical sciences were well-attended and attracted many nonmathematicians. One program, entitled "Logic Today" and organized by Harvey Friedman of Ohio State University, focused on a number of current topics in mathematical logic and the implications for computer programming. "Mathematics and Molecular Biology" was organized by Michael S. Waterman of the University of Southern California, featured topics ranging from how knot theory has elucidated DNA recombination to the use of statistical methods in analyzing heredity. In addition, there was a 3-day session on chaos and dynamical systems, a host of talks on neural networks, and programs focusing on statistical methods.

Michael H. Freedman of the University of California, San Diego presented one of the "Frontiers of the Physical Sciences" lectures. His talk on an application of topology to incompressible fluids balanced geometric intuition and technical details to make the content accessible to mathematicians and nonmathematicians alike. Wang Yuan, professor at the Institute of Mathematics at the Chinese Academy of Sciences and President of the Chinese Mathematical Society, was one of the members of the Chinese delegation attending the meeting. He spoke on advances in number theory in China and their applications to numerical analysis.

AAAS meetings also provide a forum for discussion and analysis of broad issues of science policy. One session entitled "Federal Funding of the Academic Physical Sciences" featured six panelists, among them William P. Thurston of Princeton University and Richard M. Karp of the University of California at Berkeley; Barbara L. Simons of the IBM Almaden Research Center in San Jose, California was the moderator. The lively discussion ranged over such topics as setting priorities among federally funded science projects, the increasing proportion of academic research funded through military agencies, and the changing role of universities in the science research endeavor of the nation.

Several interesting sessions on education and pipeline issues indicated the broad attention such matters are receiving in the general scientific community. One session on minorities in science and engineering featured Los Angeles mathematics teacher Jaime Escalante, whose story was told in the movie *Stand and Deliver*. Arnold Ross of Ohio State University assembled a panel of prominent mathematicians and scientists who described the early experiences that had stimulated their interest in their disciplines. A session entitled "Women in Physics—Why So Few?" included a presentation by Mary Beth Ruskai of the Courant Insitute of Mathematical Sciences. Though focusing on physics, the session provided insight into the particular challenges faced by women in all areas of science and mathematics.

Overall, the meeting offered much of interest to the mathematical sciences community. In addition, with over 600 reporters in attendance, the meeting provided an excellent opportunity to develop public awareness of science and mathematics.

Section A, the mathematics section of AAAS, is interested in promoting and increasing the participation of the mathematical sciences community in future AAAS meetings. Warren Page, Secretary of Section A, says that he has found the AAAS program committee to be genuinely interested in having more symposia on mathematical topics of current interest. He noted that the success of the mathematics programs at the San Francisco meeting showed that top mathematical researchers can communicate effectively to a broad audience of scientists. "I need and welcome suggestions from the mathematics community on possible topics and individuals to serve as organizers," he said.

Plans are now being formulated for mathematics sessions to be held at the next meeting in New Orleans on February 15–20, 1990. Those who have ideas for possible topics are urged to contact Warren Page, Secretary (Section A), New York City Technical College, CUNY, Department of Mathematics, 300 Jay Street, Brooklyn, NY 11201; telephone 914-476-6446.

Math Awareness Week 1989

This year Mathematics Awareness Week will be held April 23–29, 1989. An effort to improve public understanding of mathematics, this national event gives the mathematical

sciences community an opportunity to celebrate mathematics and to communicate to the public the importance, relevance, and beauty of the discipline. The theme for 1989 is "Mathematics: Discovering Patterns."

Last year's Mathematics Awareness Week proved very successful and brought high-level exposure to mathematics. For example, the National Academy of Sciences exhibited a number of mathematical works of art, including the AMS Centennial poster and colorful fractal images. Fifty-seven radio stations in Pennsylvania carried a spot prepared and distributed by the public information office at Pennsylvania State University. The spot featured George Andrews commenting on the impact of mathematics in everyday life. A news story on Mathematics Awareness Week was fed to outlets of United Press International nationwide. Many colleges and universities across the nation sponsored special events for high school students and teachers.

The Joint Policy Board for Mathematics is promoting the participation of the mathematical sciences community in Mathematics Awareness Week by supplying ideas for various activities that mathematics faculty can undertake during this week. Some of these ideas are:

- Sponsoring a mathematics contest for a local high school or school district.
- Distributing a radio spot about mathematics education to the local media via public information offices.
- Hosting a film and reception for mathematics majors in your department.
- Arranging an exhibit of art, tools, photos, etc., which describe mathematics generally or specific mathematical events at your institution.
- Sponsoring a special symposium on a mathematically-related topic of community interest and inviting community leaders.
- Inviting the general public to a computer demonstration.
- Hanging a banner proclaiming "Mathematics Awareness Week" outside mathematics department offices.
- Initiating an effort to secure a local, city, or state proclamation declaring April 23-29 Mathematics Awareness Week.
- Asking local public television stations to run (or rerun) the series, "For All Practical Purposes: Introduction to Contemporary Mathematics." This series of 26, half-hour programs are free to PBS stations. For information, contact the Consortium for Mathematics and Its Applications at 617-641-2600.

These are just a few possibilites for ways of celebrating during Mathematics Awareness Week. For more information, contact Kirsten Sampson, Mathematics Awareness Week Coordinator, Office of Governmental and Public Affairs, Joint Policy Board for Mathematics, 818 Connecticut Avenue, N.W., Suite 515, Washington, DC 20006; telephone 202-659-6444. For those who do sponsor activities for Mathematics Awareness Week, the Board would appreciate receiving written descriptions of the activities and their success.

Voytuk New Head of MS2000

James A. Voytuk, former Associate Executive Director of the AMS, has been named as Project Director of Mathematical Sciences in the Year 2000: Assessment for Renewal in U.S. Colleges and Universities. Known as MS2000, this project is jointly sponsored by the Board on Mathematical Sciences and the Mathematical Sciences Education Board of the National Research Council (NRC).

Voytuk, who joined the AMS staff in 1985, also served as Managing Editor of *Notices*. Before taking his position at the Society, Voytuk was Executive Officer and Associate Professor in the Mathematical Sciences Department at Rensselaer Polytechnic Institute.

Voytuk succeeds Bernard L. Madison, who served as the first director of MS2000 and who has now returned to the University of Arkansas. Over the next few years, the project will develop a national plan for enhancing the flow of mathematical talent, renewing faculty, reinvigorating teaching and scholarship, and making fundamental changes in the curriculum at the college and university level.

One of the major events in which MS2000 was involved was the national colloquium, "Calculus for a New Century," held in October 1987. In addition, MS2000 cosponsored, along with the two NRC boards, the recently-released "Everybody Counts: A Report to the Nation on the Future of Mathematics Education." MS2000 is currently working on a report, due out this spring, on talent flow in the mathematical sciences.

Richard Nicholson Named Director of AAAS

Richard S. Nicholson has been selected as Executive Officer of the American Association for the Advancement of Science(AAAS).Nicholson succeeds Alvin W. Trivelpiece, who left the AAAS position late last year to become director of the Oak Ridge National Laboratory.

Nicholson will assume the AAAS office on or before April 15. He is currently Assistant Director for Mathematical and Physical Sciences at the National Science Foundation (NSF), a position that oversees the larger organizational structure housing the NSF's Division of Mathematical Sciences.

Nicholson began at the NSF in 1970 as director of the chemical analysis program in the chemistry division. He became deputy director of the chemistry division in 1975 and director of the division two years later. He held a number of other positions at the Foundation before he was named assistant director.

Prior to joining the NSF, Nicholson was in the chemistry department of Michigan State University. He received his B.S. in chemistry in 1960 form Iowa State University and his Ph.D., also in chemistry, in 1964 from the University of Wisconsin at Madison.

New Head of NSA Math Program

Marvin C. Wunderlich, former Deputy Director of the Mathematical Sciences Program at the National Security Agency, is now the director of that program. He succeeds S. Brent Morris, now the executive secretary of the agency's scientific advisory board.

U.S.-U.S.S.R. Symposium Held

A joint U.S.-U.S.S.R. Symposium on Mathematics and its Applications to Physics was held at the University of Pennsylvania December 9-10, 1988. The speakers were Raoul H. Bott, Ljudvig D. Faddeev, Charles L. Fefferman, Izrail' M. Gel'fand, Elliott H. Lieb, Yurii I. Manin and Sergei P. Novikov, Over 180 mathematicians and physicists participated. The Symposium was sponsored by the Department of Mathematics and the Natural Science Association of the University of Pennsylvania with partial support from several National Science Foundation grants.

NSF Graduate Fellow Commemorative Lectures

At the Joint Mathematics Meetings in January, two of the AMS Invited Addresses were designated as National Science Foundation (NSF) Graduate Fellowship Commemorative Lectures. The distinction was granted to mark the 25,000th award in the Foundation's Graduate Research Fellowship Program, which began in 1952. The two designated lecturers are former NSF Graduate Fellows who have gone on to distinguished careers in mathematical research. They are David S. Fried of Boston University (Fellow, 1971–1973) and Peter S. Landweber of Rutgers University (Fellow, 1960–1962).

Errata

In the February 1989 issue of *Notices*, page 165, the Colloquium Lecturer at the August 1989 meeting in Boulder was incorrectly identified. The Colloquium Lecturer will be William P. Thurston.

Funding Information for the Mathematical Sciences

Travel Support for Foreign Graduate Students

The Society is pleased to announce that travel support for foreign graduate students attending 1989 conferences is expected to be available again this year through a grant from the STEP program of the Institute of International Education. An application has been filed by the Society for foreign students attending the AMS Summer Research Institute, the AMS-SIAM Summer Seminar, and the AMS-IMS-SIAM Joint Summer Research Conferences. Full information on these conferences may be found in the November issue of *Notices*, pages 1374–1380, and subsequent issues.

To be eligible for these grants, the foreign student must be enrolled in full-time graduate studies at a U.S. institution of higher education. Students are ineligible if they are receiving any U.S. government funds for academic support or if they are on refugee, immigrant, or tourist visa status. Previous recipients of STEP awards are ineligible for a second grant.

To apply for a STEP grant: First, follow the application procedure for the conference you wish to attend outlined in the announcements in this issue. Second, enclose with your application to the conference coordinator a letter stating your name, home country, student status, the name of the institution at which you are enrolled, the name of an official at the institution who can verify your status and financial situation, and the name of the AMS conference you plan to attend.

Proposals for the NSF's Division of Mathematical Sciences

Proposals submitted to the National Science Foundation (NSF) for support of research in the mathematical sciences should be submitted six to nine months prior to the expected start date to ensure timely notification of outcome. The Division of Mathematical Sciences (DMS) will accept such proposals at any time of the year. The program officers in the DMS are listed below:

Algebra and Number Theory	
Jonathan Lubin	202-357-3695
Ann Boyle	
Applied Mathematics	
Peter Bates	202-357-3686
Bart Ng	
Classical Analysis	
John Ryff	202-357-3455
Computational Mathematics	
Raymond Chin	202-357-3691
Geometric Analysis	
Russell Walker	202-357-3451
Modern Analysis	
William Paschke	202-357-3697
Special Projects	
Deborah Lockhart	202-357-3453
Elbert Walker	
Statistics and Probability	
Mary Ellen Bock	202-357-3693
Peter Arzberger	
Topology and Foundations	
Ralph Krause	202-357-3457

Program officers may be contacted via electronic mail. To form an individual's address, take the first initial and last name, and append @note.nsf.gov for Internet, @nsf.arpa for CSNET, or @nsf for BITNET. For example, to contact Jonathan Lubin by Internet, use the address jlubin@note.nsf.gov.

Mittag-Leffler Institute 1989–1990 Grants

The Mittag-Leffler Institute announces a number of grants for the year 1989–1990. The program of the institute starts on September 1 and ends on May 31. The grants are intended for recent Ph.D.'s or advanced graduate students and amount to 8.500 Swedish crowns per month, or 85.000 for those who attend for the duration of the program. Housing on the premises of the institute can be offered to some of the participants.

The subject for 1989–1990 is *Hyperbolic geometry and quasiconformal mappings.*

Several aspects of the field will be treated, such as

- Riemann surfaces
- Kleinian groups
- Teichmüller spaces
- Hyperbolic manifolds
- Quasiconformal groups
- Quasiregular mappings

The following experts in the field have already agreed to take part in the program for an extended period:

Lars V. Ahlfors, Boris Apanasov, Lipman Bers, Adrien Douady, Clifford J. Earle, David B. A. Epstein,

Jose Fernandez, Michael H. Freedman, Frederick W. Gehring, Jane P. Gilman, Mikhael Gromov, John Harer, Tadeusz Iwaniec, Troels Jörgensen, Linda Keen, Steven Kerckhoff, Irwin Kra, Ravi Kulkarni, Albert Marden, Gaven Martin, Bernard Maskit, Curt McMullen, Bruce Palka, Pierre Pansu, Ulrick Pinkall, Martin Reimann, Uri Srebro, Kurt Strebel, Dennis P. Sullivan, Nicholas Varopoulos, Scott Wolpert, Michel Zinsmeister.

The following Scandinavians also plan to stay at the institute during some period:

Kari Astala, Kari Hag, Juha Heinonen, Tero Kilpeläinen, Tapani Kusalo, Peter Lindqvist, Jouni Luukainen, Olli Martio, Raimo Näkki, Marjatta Näätänen, Mika Seppälä, Tuomas Sorvali, Matti Vuorinen.

Application forms can be obtained from the institute and should be returned to: The Board of the Mittag-Leffler Institute, Auravägen 17, S-182 62 Djursholm, Sweden, before **March 31, 1989**. Telephone (46) 80-755 1809.

DOD Announces New URI Competition

The Department of Defense (DOD) has announced a new competition for 1989 in its University Research Initiative (URI) program. The URI is intended to strengthen the capability of universities and colleges to perform basic multidisciplinary research in areas important to national defense. Since its inception in 1986, the URI has made almost $300 million available to U.S. universities. For fiscal year 1989, the program is budgeted for $5 million.

The awards will range from $50,000 to $250,000 per year. The new program will place special emphasis on education and human resources and will provide substantial funds for equipment. In addition, the new URI is directed at institutions that have the capability to perform defense research, but may lack resources to assemble multidisciplinary teams. The competition is open to historically black colleges and universities, other minority institutions, and any academic institution that received less than $4 million from the DOD for research and developmetn in either 1986 or 1987.

The deadline for proposals is **March 30, 1989**. The four main DOD agencies that fund basic research will handle the URI program. Each agency has specified certain research areas in which mathematical scientists might have an interest. These are listed below with the appropriate contact person in each agency.

- Air Force Office of Scientific Research, nonlinear mathematical modeling. Contact Arje Nachman, Mathematical and Information Sciences Directorate, AFOSR, Bolling Air Force Base, DC 20332-6448.
- Army Research Office, smart materials and structures. Contact Andrew Crowson, Materials Science Division, ARO, P.O. Box 12211, Research Triangle Park, NC 27709-2211.
- Office of Naval Research, physical and structural acoustics. Logan Hargrove, Physics Division, ONR, 800 North Quincy St., Arlington, VA 22217-5000.
- Defense Advanced Research Projects Agency, transport processes related to the synthesis of advanced materials. Ben Wilcox, Defense Sciences Office, DARPA, 1400 Wilson Blvd., Arlington, VA 22209-2308.

Society for Mathematical Biology Travel Awards

The Society for Mathematical Biology has funds to partially support the travel of graduate students to meetings co-sponsored by the Society including the Institute for Mathematics and its Applications meeting in Oxford, England (July 3–8, 1989), the Fortieth Annual Meeting of the American Institute of Biological Sciences in Toronto, Canada (August 6–10, 1989), and the Second Annual Meeting of the International Neural Network Society (September 5–9, 1989). Graduate students who wish support may apply to: Michael C. Reed, Department of Mathematics, Duke University, Durham, NC 27706.

The application, which should be received by **May 1, 1989**, should include a one page research summary and one letter from a faculty sponsor.

1989 AMS Elections

Nominations by Petition

Vice-President or Member-at-Large

Two positions of vice-president and member of the Council ex officio for a term of two years are to be filled in the election of 1989. The Council intends to nominate four candidates, whose names may be expected to appear in the June issue of *Notices*, which is scheduled to be mailed by the printer on 25 May. Nominations by petition as described in the rules and procedures are acceptable.

Five positions of member-at-large of the Council for a term of three years are to be filled in the same election. The Council intends to nominate seven candidates, whose names may be expected to appear in the June *Notices*. Nominations by petition in the manner described in the rules and procedures are acceptable. The Council has stated its intent to have at least ten candidates and will bring the number up to ten if the nominations by petition do not do so.

Petitions are presented to the Council, which, according to Section 2 of Article VII of the bylaws, makes the nominations. The Council of 23 January 1979 stated the intent of the Council of nominating all persons on whose behalf there were valid petitions. The Council of 20 January 1987 established a policy that, beginning with the interval 1987–1996, the Council intends to approve no more than two nominations by petition of the same individual in any ten year period.

Prior to presentation to the Council, petitions in aid of a candidate for the position of vice-president or of member-at-large of the Council must have at least 50 valid signatures and must conform to several rules and operational considerations, which are described below.

Editorial Boards Committee

Two places on the Editorial Boards Committee will be filled by election. The new members will be elected in a preferential ballot. The President will name three candidates for these two places. The names may be expected to appear in the June issue of *Notices*. Nominations by petition, in the manner described in the rules and procedures, will be accepted. Should the final number of candidates be less than four, the President will bring it up to four.

The name of a candidate for member of the Editorial Boards Committee may be placed on the ballot by petition. The candidate's assent and petitions bearing at least 100 valid signatures are required for a name to be placed on the ballot. In addition, several other rules and operational considerations, described below, should be followed.

The Nominating Committee for 1990

Three places on the Nominating Committee will be filled by election. There will be six continuing members of the Nominating Committee, namely:

Joan S. Birman	Victor Klee
James E. Humphreys	Alan O. Weinstein

Two members to be named by the President.

The new members will be elected in a preferential ballot. The President will name five candidates for these three places. The names may be expected to appear in the June issue of *Notices*. Nominations by petition, in the manner described in the rules and procedures, will be accepted. Should the final number of candidates be less than six, the President will bring it up to six.

The name of a candidate for member of the Nominating Committee may be placed on the ballot by petition. The candidate's assent and petitions bearing at least 100 valid signatures are required for a name to be placed on the ballot. In addition, several other rules and operational considerations, described below, should be followed.

Rules and Procedures

Use separate copies of the form for each candidate for vice-president, member-at-large, or member of the Nominating and Editorial Boards Committees.

1. To be considered, petitions must be addressed to Robert M. Fossum, Secretary, P.O. Box 6248, Providence, Rhode Island 02940, and must arrive by 6 July 1989.

2. The name of the candidate must be given as it appears in the *Combined Membership List*. If the name does not appear in the list, as in the case of a new member or by error, it must be as it appears in the mailing lists, for example on the mailing label of the *Notices*. If the name does not identify the candidate uniquely, append the member code, which may be obtained from the candidate's mailing label or the Providence office.

3. The petition for a single candidate may consist of several sheets each bearing the statement of the petition, including the name of the position, and signatures. The name of the candidate must be exactly the same on all sheets.

4. On the next page is a sample form for petitions. Copies may be obtained from the Secretary; however, petitioners may make and use photocopies or reasonable facsimiles.

5. A signature is valid when it is clearly that of the member whose name and address is given in the left-hand column.

6. The signature may be in the style chosen by the signer. However, the printed name and address will be checked against the *Combined Membership List* and the mailing lists. No attempt will be made to match variants of names with the form of name in the CML. A name neither in the CML nor on the mailing lists is not that of a member. (Example: The name Robert M. Fossum is that of a member. The name R. Fossum appears not to be. Note that the mailing label of the *Notices* can be peeled off and affixed to the petition as a convenient way of presenting the printed name correctly.)

7. When a petition meeting these various requirements appears, the Secretary will ask the candidate whether he is willing to have his name on the ballot. Petitioners can facilitate the procedure by accompanying the petitions with a signed statement from the candidate giving his consent.

NOMINATION PETITION FOR 1989 ELECTION

The undersigned members of the American Mathematical Society propose the name of

_____

as a candidate for the position of (check one):

- ☐ **Vice-President**
- ☐ **Member-at-Large of the Council**
- ☐ **Member of the Nominating Committee**
- ☐ **Member of the Editorial Boards Committee**

of the American Mathematical Society for a term beginning 1 January, 1990; or 1 September, 1990, in the case of member of the Nominating Committee.

Name and Address (printed or typed, or *Notices* mailing label)	Signature
	Signature
	Signature
	Signature
	Signature
	Signature
	Signature

Meetings and Conferences of the AMS

FUTURE MEETINGS

FUTURE CONFERENCES

Coming Events

With a scientific program of superior quality and a setting of breathtaking natural beauty, the August meetings in Boulder promise to be among the best. Especially exciting will be the debut of the new AMS lecture series *Progress in Mathematics*, featuring DUSA MCDUFF of the Institute for Advanced Study, who will speak on recent developments in symplectic geometry, and HAIM BREZIS of the University of Paris, who will speak on liquid crystals. (More information on this lecture series appears on page 149 of the February issue of *Notices*.)

The popular series of AMS-MAA Invited Addresses on the history and development of mathematics will continue with four excellent speakers covering a broad range of topics. Speakers include JOHN CONWAY, SERGE LANG, and JEAN TAYLOR. PERSI DIACONIS will present the MAA's Hedrick Lectures, and WILLIAM P. THURSTON will be the AMS Colloquium Lecturer.

Such an outstanding program makes the Boulder meetings a must! Mark your calendars now and be sure not to miss the June 1 deadline for preregistration and housing. A full announcement of the Boulder meetings, including the Preregistration/Housing Form, will appear in the next issue of *Notices*.

Worcester, Massachusetts
College of the Holy Cross
April 15 - 16

Program

The eight-hundred-and-forty-eighth meeting of the American Mathematical Society will be held at the College of the Holy Cross in Worcester, Massachusetts, on Saturday, April 15, and Sunday, April 16, 1989.

Invited Addresses

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

IGOR FRENKEL, Yale University, *Vertex operator algebras and quantum groups*, 11:00 a.m. Sunday.

ADRIAN OCNEANU, Pennsylvania State University, *The structure of symmetries of quantum space*, 11:00 a.m. Saturday.

THOMAS H. PARKER, Michigan State University, *The geometry of the Yang-Mills moduli space*, 1:30 p.m. Saturday.

KARL RUBIN, Columbia University, *The arithmetic of elliptic curves*, 1:30 p.m. Sunday.

Special Sessions

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

Operator algebras, Galois theory and representations, RICHARD HERMAN and ADRIAN OCNEANU, Pennsylvania State University.

Infinite-dimensional symmetries in mathematics and physics, JAMES LEPOWSKY, Rutgers University.

Gauge theory and differential geometry, THOMAS H. PARKER.

L-functions and arithmetic, KARL RUBIN, and GLENN STEVENS, Boston University.

Knot theory and algebraic geometry in the large, LEE RUDOLPH, Clark University.

Contributed Papers

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

Council

The Council of the Society will meet at 7:00 p.m. on Saturday, April 15, 1989, in Sturbridge Rooms A and B at the Howard Johnson's Motor Lodge, located at 800 Southbridge Street, Worcester, MA 01610, which is adjacent to the College of the Holy Cross campus.

Other Events of Interest

From 9:00 a.m. to 3:00 p.m. on Saturday, April 15 and 9:00 a.m. to noon of Sunday, April 16, there will be several tables set up in the atrium in Swords Hall with a selection of AMS publications and information about member services. Several electronic and optical retrieval systems for accessing MathSci will also be demonstrated, including the online and the new CD-ROM systems for browsing and searching Mathematical Reviews and Current Mathematical Publications. Information on TeX software will also be available. All participants are invited to visit the display.

Registration

The registration desk will be located in Swords Hall and signs will be posted directing participants to the meeting registration area. The meeting registration desk will be open from 8:00 a.m. to 3:00 p.m. on Saturday, April 15, and on Sunday, April 16, from 8:00 a.m. to 11:00 a.m. The registration fees are $30 for members of the AMS, $45 for nonmembers, and $10 for students or unemployed mathematicians.

Social Event

The Department of Mathematics will be hosting a Beer, Soft Drink and Pizza party which will take place on

Saturday evening, April 15, in the Atrium which is located in Haberlin and Swords Halls. The department will be providing the pizza for the guests of the meeting but it should be noted that beer and soft drinks will be available for purchase on a cash basis during the party. To insure that an ample amount of pizza is ordered, it is requested that members intending to attend the social please so indicate when registering on Saturday.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Phoenix meeting announcement on page 1502 of the December 1988 issue of *Notices*.

Accommodations

There are no accommodations available for housing on campus during the meeting.

Rooms have been blocked at the Howard Johnson's Motor Lodge adjacent to the campus. Participants should make their own reservations directly with the motel of their choice and identify themselves as attending the meeting of the American Mathematical Society at the College of the Holy Cross. **The deadline for reservations at these locations was February 28**. The rates below are subject to change and do not include applicable taxes.

Howard Johnson's Motor Lodge
800 Southbridge Street
Worcester, MA 01610
Telephone: (508) 791-5501

Single $49 Double $53

The following motels are located between two and five miles from campus. Although rooms have not been blocked at any of these locations, they are included here for information purposes.

Best Western Centrum Inn
110 Summer Street
Worcester, MA 01610
Telephone: (508) 757-0400

Single $52 Double $58

Days Lodge of Worcester
50 Oriol Drive
Worcester, MA 01610
Telephone: (508) 852-2800

Single $56.88 Double $61.88

Howard Johnson's Motor Lodge
West Boylston Street
West Boylston, MA 01583
Telephone: (508) 835-4456

Single $59.50 Double $71.50

Sheraton-Lincoln Inn
500 Lincoln Street
Worcester, MA 01610
Telephone: (508) 852-4000

Single $85 or $95 poolside
Double $95 or $105 poolside

Worcester Marriott
10 Lincoln Square
Worcester, MA 01610
Telephone: (508) 791-1600

Single $115 Double $127

Yankee Budget Motor Lodge
531 Lincoln Street
Worcester, MA 01610
Telephone: (508) 852-5800

Single $33.73 Double $38.29

Yankee Drummer Inn
624 Southbridge Street
Auburn, MA 01501
Telephone: (508) 832-3221

Single $74.90 Double $79.90

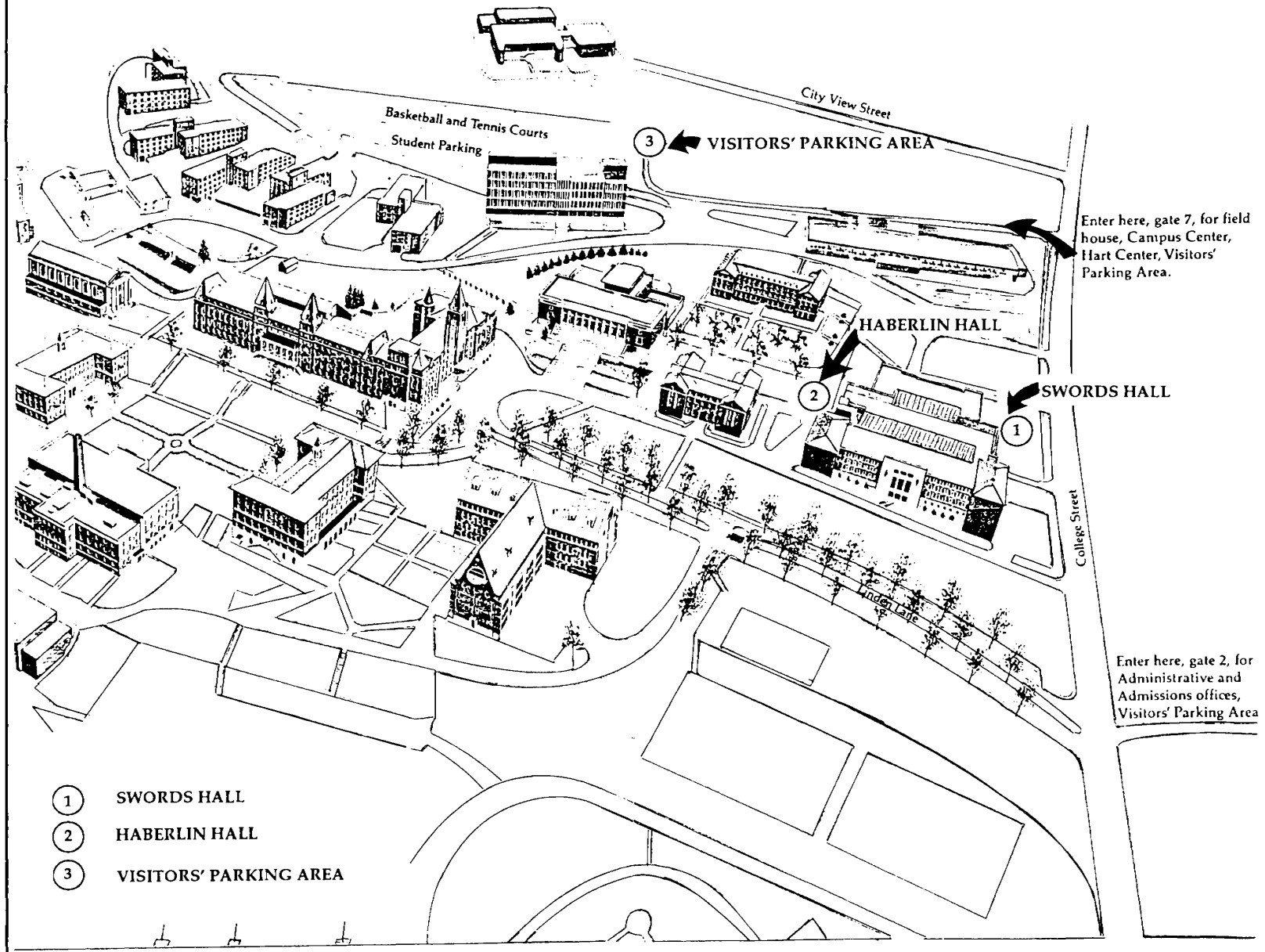
Food Service

A variety of options are available for luncheon in Hogan Center on Saturday and Sunday. A special section will be designated as the dining area for meeting participants, where meal service is cafeteria-style. The most efficient avenue for getting a suitable lunch is a large Burger King adjacent to the Howard Johnson's across from the campus. Information on other campus food service options and restaurants in the Worcester area will be available at the meeting registration desk.

Travel

The Worcester airport is located about five miles from the campus. Airline service to Worcester is provided by Northwest Airlines, Piedmont, Continental Express, and United Express, with direct flights from Baltimore, Washington, Pittsburgh, Newark and New York City. There is an extensive array of connecting airlines directly into the Worcester Airport. Since travel time from Logan International Airport in Boston can involve more than two hours, flying directly into Worcester is recommended if possible.

CAMPUS OF HOLY CROSS COLLEGE



Those participants electing Logan International should make use of the Worcester Limousine Service, which will transport passengers directly to the campus or elsewhere in Worcester. **Reservations are necessary** and may be obtained by calling (508) 756-4834; at the same time information will be provided concerning passenger pickup at Logan.

Worcester is also served by Peter Pan Bus Lines and AMTRAK rail service. The bus station is about one mile from the campus. Taxi service is available from the bus station to the campus for approximately $5.00

Participants driving to the meeting should use Auburn Exit No. 10 from the Massachusetts Turnpike, then take Route 290 East to Worcester. The College Square Exit from Route 290 is a block from the campus.

Special Needs

Participants attending the meeting who may have special needs with regard to their talks in terms of audio-visual aids, etc., should contact Leonard Sulski in the Department of Mathematics at College of the Holy Cross either by mail or telephone and be quite specific. Every attempt will be made to meet such requests.

Parking

Free parking is available at several lots located on the College of the Holy Cross Campus. Hogan Lot is the best option.

JOINT MATHEMATICS MEETINGS

August 7-10, 1989 • University of Colorado • Boulder, Colorado

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 March 1989 issue of *Abstracts of papers presented to the American Mathematical Society*, ordered according to the numbers in parentheses following the listings below.

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

Saturday, April 15

AMS Session on Graphs, Trees and Groups

8:55 a.m.–10:50 a.m. Room 19, Haberlin Hall

8:55 a.m. (1) *On the structure of the strong orientations of a graph.*
John Donald and **John Elwin***, San Diego State University (848-05-31) (Sponsored by Edgar J. Howard)

9:10 a.m. (2) *Construction of self-dual graphs.*
Peter R. Christopher* and **Brigitte Servatius**, Worcester Polytechnic Institute (848-05-73)

9:25 a.m. (3) *Three and four-dimensional Catalan numbers.*
Stephen Snover* and **Stephanie Troyer**, University of Hartford (848-05-95)

9:40 a.m. (4) *m-Dimensional Catalan numbers.*
Stephen Snover and **Stephanie Troyer***, University of Hartford (848-05-94)

9:55 a.m. (5) *Rigidity trees.*
Brigitte Servatius, Worcester Polytechnic Institute (848-05-46)

10:10 a.m. (6) *Completely normal lattices.* Preliminary report.
Constantine Tsinakis, Vanderbilt University (848-06-75)

10:25 a.m. (7) *The Tits conjecture and the five-string braid group.*
Carl Droms*, James Madison University, **Jacques Lewin**, Syracuse University, and **Hermann Servatius**, College of the Holy Cross (848-20-32)

10:40 a.m. (8) *Surface subgroups of infinite Coxeter groups.* Preliminary report.
Carl Droms, James Madison University, **Brigitte Servatius**, Worcester Polytechnic Institute, and **Hermann Servatius***, College of the Holy Cross (848-20-52)

AMS Special Session on Infinite-dimensional Symmetries in Mathematics and Physics, I

9:00 a.m.–10:50 a.m. Room 236, Haberlin Hall

9:00 a.m. (9) *Multiplicities in the discrete series of the Virasoro algebra.*
Alvany Rocha, Bernard M. Baruch College, City University of New York (848-17-63)

9:30 a.m. (10) *The KP deformations of vector bundles over an elliptic curve.* Preliminary report.
Emma Previato*, Boston University, and **George Wilson**, Imperial College, London (848-14-38)

10:00 a.m. (11) *A correspondence between an infinite Grassmannian and arbitrary vector bundles on algebraic curves.*
Motohico Mulase, Temple University and Institute for Advanced Study (848-58-10)

10:30 a.m. (12) *Catastrophes, conformal theories and Calabi-Yau manifolds.*
Cumrun Vafa, Harvard University (848-81-84) (Sponsored by James I. Lepowsky)

AMS Special Session on Gauge Theory and Differential Geometry, I

9:00 a.m.–10:50 a.m. Room 328, Swords Hall

9:00 a.m. (13) *Constructing the Floer cycles.*
Cliff Taubes, Harvard University (848-53-67) (Sponsored by Thomas H. Parker)

9:30 a.m. (14) *Vortices on Kähler manifolds.*
Steven Bradlow, Stanford University (848-53-17)

10:00 a.m. (15) *Instantons and the geometry of the nilpotent variety.*
Peter Kronheimer, Institute for Advanced Study (848-53-20)

10:30 a.m. (16) *Converging Ricci flow for metrics with indefinite curvature in arbitrary dimensions.*
James Isenberg, University of California at San Diego, La Jolla, and University of Oregon (848-53-15)

Saturday, April 15 (cont'd)

AMS Special Session on L-functions and Arithmetic, I

9:00 a.m.–10:50 a.m. Room 414, Haberlin Hall

9:00 a.m. (17) *A formal Mellin transformation in the arithmetic of function fields.*
David Goss, University of Maryland, Baltimore County (848-14-23)

9:30 a.m. (18) *Representations of the Weil group.*
George Zettler*, Columbia University, and **Don M. Blasius**, University of California, Los Angeles (848-11-96) (Sponsored by Karl Rubin)

10:00 a.m. (19) *Arithmetic ampleness.*
Christophe Soulé, Centre National de la Recherche Scientifique and Harvard University (848-11-65) (Sponsored by Glenn Howard Stevens)

10:30 a.m. (20) *Modular caps, totally real fields, and periods of Eisenstein series on $GL(n)$.* Preliminary report.
Glenn Stevens, Boston University (848-11-66)

AMS Special Session on Operator Algebras, Galois Theory and Representations, I

9:30 a.m.–10:50 a.m. Room 238, Haberlin Hall

9:30 a.m. (21) *Noncommutative toroidal orbifolds.*
Ola Bratteli, University of Trondheim, Norway, **George A. Elliott***, University of Toronto, **David E. Evans**, University College of Swansea, Wales, and **Akitaka Kishimoto**, Tôhoku University, Japan (848-46-49)

10:00 a.m. (22) *Representations of projections.* Preliminary report.
Man-Duen Choi, University of Toronto (848-47-50)

10:30 a.m. (23) *Symmetries of the CAR algebra.*
Bruce Blackadar, University of Nevada, Reno (848-46-87)

AMS Special Session on Knot Theory and Algebraic Geometry in the Large, I

10:00 a.m.–10:50 a.m. Room 359, Swords Hall

10:00 a.m. (24) *The equisymmetric stratification of the moduli space.* Preliminary report.
S. Allen Broughton, Cleveland State University (848-14-54)

10:30 a.m. (25) *Homology of Abelian covers.* Preliminary report.
A. Libgober, University of Illinois, Chicago (848-99-98)

AMS Invited Address

11:00 a.m.–12:00 noon Room 103, Haberlin Hall

(26) *The structures of symmetries of quantum space.*
Adrian Ocneanu, Pennsylvania State University, University Park (848-99-92)

AMS Invited Address

1:30 p.m.–2:30 p.m. Room 103, Haberlin Hall

(27) *The Yang-Mills moduli space.*
Thomas H. Parker, Michigan State University (848-53-91)

AMS Special Session on Infinite-dimensional Symmetries in Mathematics and Physics, II

2:45 p.m.–5:05 p.m. Room 236, Haberlin Hall

2:45 p.m. (28) *Representation theory and the Schubert calculus.*
Dale H. Peterson, University of British Columbia (848-22-88) (Sponsored by James I. Lepowsky)

3:15 p.m. (29) *Vertex operators and integral bases of affine Lie algebras.*
Shari Prevost, Rutgers University, New Brunswick (848-17-62)

3:45 p.m. (30) *Constructions of vertex operator superalgebras and para-algebras.*
Alex J. Feingold*, **John F. X. Ries**, State University of New York, Binghamton, and **Igor B. Frenkel**, Yale University (848-17-39)

4:15 p.m. (31) *Level two standard representations of affine special linear Lie algebras.*
Kailash C. Misra, North Carolina State University (848-17-82)

4:45 p.m. (32) *Vertex operator relations for affine Lie algebras.* Preliminary report.
Stefano Capparelli, Yale University (848-17-57)

AMS Special Session on Gauge Theory and Differential Geometry, II

2:45 p.m.–5:05 p.m. Room 328, Swords Hall

2:45 p.m. (33) *On the existence of hyperbolic monopoles.*
L. **M. Sibner***, Polytechnic Institute of New York, **R. J. Sibner**, Brooklyn College, City University of New York, and **Karen Uhlenbeck**, University of Texas, Austin (848-53-79)

3:15 p.m. (34) *The geometry of magnetic monopoles.*
Peter J. Braam, University of Utah and Merton College, England (848-53-22)

3:45 p.m. (35) *Torsion constraints in supergeometry.*
John Lott, University of Michigan, Ann Arbor (848-53-19)

4:15 p.m. *Classifying connections by holonomy.*
(36) **R. J. Sibner***, Brooklyn College, City University of New York, and **L. M. Sibner**, Polytechnic Institute of New York (848-53-80)

4:45 p.m. *Fixed points of finite group actions on 3-manifolds.*
(37) Preliminary report.
Nicholas Buchdahl*, **Slawomir Kwasik**, Tulane University, and **Reinhard Schultz**, Purdue University, West Lafayette (848-53-21)

AMS Special Session on L-functions and Arithmetic, II

2:45 p.m.–5:05 p.m. Room 414, Haberlin Hall

2:45 p.m. *L-functions of universal elliptic curves over Igusa curves.*
(38) **Douglas L. Ulmer**, Massachusetts Institute of Technology (848-11-24)

3:15 p.m. *Trilinear forms and local ϵ-factors for GL_2.*
(39) **Dipendra Prasad**, Harvard University (848-11-42)

3:45 p.m. *Averages of L-functions and their derivatives.*
(40) **V. Kumar Murty***, University of Toronto, and **Ram Murty**, McGill University (848-11-72) (Sponsored by Glenn Howard Stevens)

4:15 p.m. *The formal group of the Jacobian of an algebraic curve.*
(41) **Margaret N. Freije**, College of the Holy Cross (848-11-70)

4:45 p.m. *Modular quaternionic L-value congruences.*
(42) Preliminary report.
Ted Chinburg, Columbia University (848-11-08)

AMS Special Session on Knot Theory and Algebraic Geometry in the Large, II

2:45 p.m.–5:05 p.m. Room 359, Swords Hall

2:45 p.m. *Higher codimensional algebraic knots.* Preliminary
(43) report.
Alan H. Durfee, Mount Holyoke College (848-57-26)

3:15 p.m. *Complex algebraic plane curves via their links at*
(44) *infinity.*
Walter D. Neumann, Ohio State University, Columbus (848-57-34)

3:45 p.m. *A congruence between link polynomials.*
(45) **Lee Rudolph**, Clark University (848-57-30)

4:15 p.m. *The fundamental group of the complement of an*
(46) *algebraic curve.*
Stepan Yu Orevkov, Moscow, USSR (848-14-51) (Sponsored by Lee N. Rudolph)

4:45 p.m. Discussion

AMS Session on Geometry, Topology and Applied Mathematics

2:45 p.m.–5:10 p.m. Room 19, Haberlin Hall

2:45 p.m. *A note on κ-uniform rotundity.*
(47) **Srinivasa Swaminathan**, Dalhousie University (848-46-43)

3:00 p.m. *Interior hull inequalities for lattice polygons.*
(48) **Stanley Rabinowitz**, Westford, Massachusetts (848-52-74)

3:15 p.m. *Invariant affine connections on symmetric spaces.*
(49) **H. Turner Laquer**, Case Western Reserve University (848-53-53)

3:30 p.m. *Complete stable minimal surfaces in R^3.*
(50) **Marty Ross**, Stanford University (848-53-09)

3:45 p.m. *Comparison of the handle and tunnel numbers of*
(51) *classical knots.* Preliminary report.
John Erbland, University of Hartford (848-57-45)

4:00 p.m. *The interbubble medium: Inflationary IBM.* Preliminary
(52) report.
Stephen L. Weinberg, Berkeley Academy of Artscience, Berkeley, California (848-85-06)

4:15 p.m. *The force field holor.*
(53) **Shama Y. Uma**, Bridgewater State College, and **Domina Eberle Spencer***, University of Connecticut, Storrs (848-78-13)

4:30 p.m. *Electromagnetic field holors.*
(54) **Shama Y. Uma***, Bridgewater State College, and **Domina Eberle Spencer**, University of Connecticut, Storrs (848-78-12)

4:45 p.m. *A theory of duality in mathematical programming.*
(55) **Andrzej Wieczorek**, Polish Academy of Sciences, Warsaw (848-90-07)

5:00 p.m. *Computing characteristic classes of continuous lattice*
(56) *gauge fields.*
A. V. Phillips, State University of New York, Stony Brook, and **David A. Stone***, City College, City University of New York (848-81-44)

AMS Special Session on Operator Algebras, Galois Theory and Representations, II

3:15 p.m.–4:35 p.m. Room 238, Haberlin Hall

3:15 p.m. *Continuous semigroups of *-endomorphisms of $B(H)$.*
(57) **Robert Powers**, University of Pennsylvania (848-46-28)

3:45 p.m. *The C^*-algebras generated by pairs of semigroups of*
(58) *isometries satisfying certain commutation relations.*
Geoffrey Price, United States Naval Academy (848-46-81)

4:15 p.m. *Index theory for pairs of factors of infinite index.*
(59) **Richard Herman*** and **Adrian Ocneanu**, Pennsylvania State University, University Park (848-46-85)

Saturday, April 15 (cont'd)

AMS Council

7:00 p.m.–10:00 p.m. Sturbridge A & B, Howard Johnson's Motor Lodge

Sunday, April 16

AMS Special Session on Operator Algebras, Galois Theory and Representations, III

8:30 a.m.–10:50 a.m. Room 238, Haberlin Hall

8:30 a.m. (60) *Applications of equivariant Kasparov theory.* Preliminary report. **Peter Haskell**, Virginia Polytechnic Institute and State University (848-46-41)

9:00 a.m. (61) *de Rham cohomology for discrete groups.* **Paul Baum***, Pennsylvania State University, University Park, and **Alain Connes**, College of France, Paris (848-46-89)

9:30 a.m. (62) *Comparison of (negative) algebraic and topological K-theory for C^*-algebras.* **Jonathan Rosenberg**, University of Maryland, College Park (848-55-29)

10:00 a.m. (63) *Transverse cyclic cocycles via elliptic renormalization.* Preliminary report. **Ronald G. Douglas**, State University of New York, Stony Brook (848-58-56)

10:30 a.m. (64) *Operator algebraic invariants for elliptic operators.* **Jerry Kaminker**, Indiana University-Purdue University, Indianapolis (848-46-86)

AMS Special Session on Infinite-dimensional Symmetries in Mathematics and Physics, III

8:30 a.m.–10:50 a.m. Room 236, Haberlin Hall

8:30 a.m. (65) *Higher-order Sugawara operators for affine Lie algebras.* **Roe Goodman*** and **Nolan R. Wallach**, Rutgers University, New Brunswick (848-22-48)

9:00 a.m. (66) *Bernstein-Gelfand-Gelfand resolution for arbitrary Kac-Moody algebras.* **Shrawan Kumar**, Institute for Advanced Study (848-22-61) (Sponsored by James I. Lepowsky)

9:30 a.m. (67) *Vertex operators, symmetric polynomials and symmetric groups.* **Naihuan Jing**, Yale University (848-17-37)

10:00 a.m. (68) *Z_2-orbifold theory.* **Yi-Zhi Huang**, Rutgers University, New Brunswick (848-17-59)

10:30 a.m. (69) *Duality, crossing and Mac Lane's coherence.* **Ram Brustein**, **Yuval Neeman**, Tel Aviv University, Israel, and **Shlomo Sternberg***, Tel Aviv University, Israel and Harvard University (848-18-64) (Sponsored by James I. Lepowsky)

AMS Special Session on L-functions and Arithmetic, III

8:30 a.m.–10:50 a.m. Room 414, Haberlin Hall

8:30 a.m. (70) *Cohomology of $GL(n, \mathbf{Z})$.* Preliminary report. **Avner Ash**, Ohio State University, Columbus (848-11-05)

9:00 a.m. (71) *Relations among L-functions attached to algebraic varieties.* Preliminary report. **Michael Rosen**, Brown University (848-11-71)

9:30 a.m. (72) *The Markov equation $X^2 + Y^2 + Z^2 = 3XYZ$ over quadratic imaginary fields.* Preliminary report. **Joseph H. Silverman**, Brown University (848-11-04)

10:00 a.m. (73) *Vanishing and nonvanishing of certain L-functions.* Preliminary report. **David Rohrlich**, Rutgers University, New Brunswick (848-11-55)

10:30 a.m. (74) *Mock Heegner points and congruent numbers.* **Paul Monsky**, Brandeis University (848-11-25)

AMS Session on Analysis

8:40 a.m.–10:50 a.m. Room 19, Haberlin Hall

8:40 a.m. (75) *On B_4-sequences.* **John C. M. Nash**, Marshall University (848-11-68)

8:55 a.m. (76) *L-functions and differential equations.* Preliminary report. **Peter F. Stiller**, Institute for Advanced Study (848-14-33)

9:10 a.m. (77) *Compact subgroups and compactly generated subgroups of topological groups.* **R. W. Bagley***, **T. S. Wu** and **J. S. Yang**, University of Miami (848-22-02)

9:25 a.m. (78) *Properties of power-series coefficients of $H^2(\Pi_+)$ functions.* **Charles Slavin**, University of Maine, Orono (848-30-11)

9:40 a.m. (79) *Positive almost periodic solutions of some delay integral equations.* **A. M. Fink*** and **J. A. Gatica**, University of Iowa (848-34-03)

9:55 a.m. (80) *On some inequalities for polynomials.* **Narendra K. Govil**, Auburn University, Auburn (848-41-36)

10:10 a.m. (81) *On equations in Banach spaces involving composition products of set-valued mappings.* **Frank U. Williamson, Jr.**, Vitry sur Seine, France (848-93-01)

10:25 a.m. (82) *Unique base-normed predual Banach spaces and quantum logics.* Preliminary report.
Yewande Olubummo, University of Massachusetts, Amherst (848-46-16)

10:40 a.m. (83) *On merging of probabilities.* Preliminary report.
Anthony D'Aristotle*, State University of New York, College at Plattsburgh, **Persi Diaconis**, Stanford University, and **David Freedman**, University of California, Berkeley (848-54-14)

AMS Special Session on Gauge Theory and Differential Geometry, III

9:00 a.m.–10:50 a.m. Room 328, Swords Hall

9:00 a.m. (84) *Non-unitary anomalies in semiclassical Yang-Mills theory.*
Steven Rosenberg, Boston University (848-58-76)

9:30 a.m. (85) *Applications of Donaldson theory to the topology of algebraic surfaces.*
John Morgan, Columbia University (848-53-69)

10:00 a.m. (86) *The L^2 superior metric on Yang-Mills moduli spaces.*
David Groisser, University of Florida (848-53-77)

10:30 a.m. (87) *Higher-order singularities in gauge fields.*
Thomas Otway, University of Texas, Austin (848-35-18)

AMS Special Session on Knot Theory and Algebraic Geometry in the Large, III

9:30 a.m.–10:50 a.m. Room 359, Swords Hall

9:30 a.m. (88) *Cohopficity of 3-manifold groups.*
F. González-Acuña, University Nac Autonoma de Mexico, and **Wilbur Whitten***, University of Southwestern Louisiana (848-57-40)

10:00 a.m. (89) *Spherical 3-orbifolds which do not fiber over 2-orbifolds.*
William Dunbar, Pennsylvania State University, Erie (848-57-27)

10:30 a.m. (90) *Skein modules of an interval bundle over a surface.*
Jim Hoste, Pomona College, and **Józef H. Przytycki***, University of British Columbia and Warsaw University, Poland (848-57-47)

AMS Invited Address

11:00 a.m.–12:00 noon Room 103, Haberlin Hall

(91) *Vertex operator algebras and quantum groups.*
Igor B. Frenkel, Yale University (848-99-93)

AMS Invited Address

1:30 p.m.–2:30 p.m. Room 103, Haberlin Hall

(92) *The arithmetic of elliptic curves.*
Karl Rubin, Columbia University (848-11-90)

AMS Special Session on Infinite-dimensional Symmetries in Mathematics and Physics, IV

2:45 p.m.–4:35 p.m. Room 236, Haberlin Hall

2:45 p.m. (93) *Einstein's equations and representation theory.*
Bertram Kostant, Massachusetts Institute of Technology (848-22-83)

3:15 p.m. (94) *A Jacobi identity for relative twisted vertex operators.*
Chongying Dong* and **James Lepowsky**, Rutgers University, New Brunswick (848-17-58)

3:45 p.m. (95) *Relative $\mathbf{Z}_2$-twisted vertex operators and standard $sl(2)^{\sim}$-modules.*
Cristiano Husu, Rutgers University, New Brunswick (848-17-60)

4:15 p.m. (96) *String path integral realization of vertex operator algebras.*
Haruo Tsukada, University of California at San Diego, La Jolla (848-22-97)

AMS Special Session on Gauge Theory and Differential Geometry, IV

2:45 p.m.–4:05 p.m. Room 328, Swords Hall

2:45 p.m. (97) *Smooth 2-spheres in indefinite 4-manifolds.*
Daniel Ruberman, Brandeis University (848-57-78)

3:10 p.m. (98) *Applications of fixed point varieties of unipotent transformations to the space of $SU(n)$-instantons on the four-sphere.* Preliminary report.
Martin A. Guest, University of Rochester (848-81-35)

3:45 p.m. Discussion

AMS Special Session on L-functions and Arithmetic, IV

2:45 p.m.–4:05 p.m. Room 414, Haberlin Hall

2:45 p.m. Discussion

W. Wistar Comfort
Associate Secretary
Middletown, Connecticut

Presenters of Papers

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* Ulmer, D. L., 38
Uma, S. Y., 54
* Vafa, C., 12
Weinberg, S. L., 52
* Whitten, W., 88
Wieczorek, A., 55
Williamson, F. U., Jr., 81
* Zettler, G., 18

Chicago, Illinois
Loyola University of Chicago
May 19 – 20

Second Announcement

The eight-hundred-and-forty-ninth meeting of the American Mathematical Society will be held on the Lake Shore Campus of Loyola University of Chicago on Friday, May 19, and Saturday, May 20, 1989. All special sessions and sessions for contributed papers will be held in Damen Hall and all invited addresses in the auditorium of Flanner Hall.

Invited Addresses

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

HENRI GILLET, University of Illinois at Chicago, *Analogies between number fields and function fields*

NICHOLAS LERNER, Purdue University, *Microlocal analysis and applications*

RICHARD ROCHBERG, Washington University, *Estimates for singular numbers of integral operators*

SHMUEL WEINBERGER, University of Chicago, *Flexibility and rigidity of stratified spaces*

Special Sessions

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

Noncommutative ring theory, JEFFREY BERGEN, DePaul University

Sequence spaces and summability, MARTIN BUNTINAS, Loyola University and BILLY RHOADES, Indiana University

Geometric topology, TIM D. COCHRAN, Northwestern University

Numerical methods in harmonic analysis, JONATHAN COHEN, DePaul University

Kazhadan-Lusztig theory and related topics, VINAY DEODHAR, Indiana University.

Algebraic groups and related topics, STEPHEN DOTY, Loyola University of Chicago

Arithmetic geometry and intersection theory, HENRI GILLET

Recursion theory, CHRISTINE HAUGHT, University of Chicago

Codes and designs, NEAL BRAND, North Texas State University, and CARY HUFFMAN, Loyola University of Chicago

Algebraic topology and varieties, RONNIE LEE, Yale University, and STEVEN WEINTRAUB, Louisiana State University

Partial differential equations, NICHOLAS LERNER

Quadratic forms and real algebraic geometry, COLM MULCAHY, Spelman College, VICTORIA POWERS, Emory University

Nonlinear analysis and its applications, S. P. SINGH, Memorial University of Newfoundland

Contributed Papers

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

Registration

The meeting registration desk will be located in room 147 of Damen Hall and will be open from 8:00 a.m. to 5:00 p.m. on Friday, May 19, and 8:00 a.m. to noon on Saturday, May, 20. The registration fees are $30 for members of the AMS, $45 for nonmembers, and $10 for students or unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Phoenix meeting announcement on page 1502 of the December 1988 issue of *Notices*.

Accommodations

Blocks of rooms are being held in Mertz Hall on the Lake Shore Campus. **This air conditioned facility** is adjacent

to a campus parking lot, cafeteria, and athletic facilities. It is a three-minute walk to Damen and Flanders Halls. Participants should make reservations by calling 312-508-3300, and should indicate that they are attending the AMS meeting. After May 1, 1989, reservations will be accepted on a space available basis. Families are welcome in Mertz Hall, and arrangements can be made to stay longer than the time of the conference. The rates are $32 for single occupancy and $22 per person double occupancy.

For participants staying on campus, housing registration and check-in will be in the Front Desk Lobby on the second floor of Mertz Hall. The Front Desk is open daily from 7:00 a.m. until midnight. If the Front Desk is not open, please refer to the Conference Staff Duty Roster that is posted at the Front Desk for the extension of the staff member on duty. Dial the four digit extension on the beige house phone located around the corner from the Front Desk and the person on duty will come to the Front Desk.

Although rooms have not been blocked at either of the following locations, they are included for information. Rates are subject to change. Both are approximately 20 minutes by car and 30 minutes by public transportation from Loyola.

Holiday Inn, Evanston
1501 Sherman Ave.
Evanston, IL 60201
Telephone: (312) 491-6400

Single $70 Double $78

Orrington Hotel
1710 Orrington Ave.
Evanston, IL 60202
Telephone: (312) 866-8700

Single $90 Double $100

Food Service

The campus food service is located on the second floor of Centennial Forum, across the patio from Mertz Hall. A daily meal pass costing $10 can be purchased at the housing registration desk (second floor, Mertz Hall). Present this pass or pay the appropriate price to gain entry into any meal. Among the features offered by the food service are a variety of cereals, a salad bar with a multitude of fresh fixings, a daily soup bar, menu variety for both meat eaters and vegetarians, a selection of ice cream, a large array of beverages, and unlimited seconds.

There are several restaurants and fast food establishments within walking distance or a short drive. A list of these will be available at the meeting registration desk in Damen Hall 147.

Travel

To reach Loyola University's Lake Shore Campus at 6525 North Sheridan Road, corner of Sheridan Road on Loyola Avenue:

FROM MIDWAY AIRPORT: Take the Continental Airport bus to the Park Hyatt Hotel on Chicago Avenue. Walk two blocks west on Chicago Avenue to the State Street subway and take the Howard line north to Loyola Avenue. Or, take the Outer Drive Express bus (CTA #147), or the Sheridan Howard Terminal bus (CTA #151), north to Sheridan and Devon (catch this bus on the north-east corner of Water Tower Place). By taxi it is fifty-six blocks north.

FROM O'HARE FIELD: Take the Continental Airport bus to the Park Hyatt Hotel on Chicago Avenue. Walk two blocks west on Chicago Avenue to the State Street subway and take the Howard line north to Loyola Avenue. Or, take the Outer Drive Express bus (CTA #147), or the Sheridan Howard Terminal bus (CTA #151), north to Sheridan and Devon (catch this bus on the north-east corner of Water Tower Place). By taxi it is fifty-six blocks north.

Alternately, take the airport bus to the Holiday Inn in Evanston and a taxi to Loyola. This would be a shorter ride. Or, take the O'Hare/Congress or O'Hare/Douglas subway (located under the O'Hare Hilton) downtown to Washington Street. Get off at Washington and take the stairs down to the tunnel and walk across to the State Street subway and take the Howard Line north (A or B train) to Loyola Avenue.

FROM THE GREYHOUND OR TRAILWAYS BUS STATION: From the Greyhound Station walk east on Randolph to State Street (two blocks) and take the Howard Line subway north to Loyola Avenue Station.

From the Trailways Station walk west on Randolph to State Street and take the Howard Line subway north to Loyola Avenue Station.

FROM UNION STATION (AMTRAK): Take the Sheridan/Devon (CTA #151) to State Street, then take the Howard Line subway north to Loyola Avenue Station.

FROM THE ILLINOIS CENTRAL STATION (SOUTH SHORE): Take the Outer Drive Express bus (CTA #147) at Michigan Avenue north to Loyola Avenue, or walk west to State Street and take the Howard Line subway north to Loyola Avenue Station.

BY AUTOMOBILE: If arriving from the south, east, or west by Interstates 55, 57, 90, or 94, take an exit to Lake Shore Drive north to its limit. Turn north on Sheridan Road and take it to Loyola.

If arriving on Interstate 94 from the north, take Touhy Avenue eastbound to its limit at Sheridan Road South. Take a right on to Sheridan Road. Loyola is on the left approximately 8 or 9 blocks south.

If arriving on Interstate 194 or 294 from the north or northwest, take Foster Avenue east to Broadway or Sheridan, then north to Loyola.

Parking

Parking is available in the parking lot south of Mertz Hall. The fee is 50 cents. To park in the lot overnight, please obtain a parking sticker at the housing desk.

Athletic Facilities

All meeeting participants will be given complimentary access to the new George Halas Jr., Sports Center on Loyola's campus. This facility has an olympic-size swimming pool, six racketball/handball courts, weight rooms with free-weight and Nautilus equipment, two aerobic dance rooms, three full length basketball courts, and an indoor track (an outdoor track is also available).

Weather

The average high temperature in Chicago in May is 70° F and the average low is 48° F. Because the university is located on the shore of Lake Michigan, it may be slightly cooler during the daytime. The average rainfall for the month is 3.15 inches.

Andy Roy Magid
Associate Secretary
Norman, Oklahoma

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.

Chicago, May 1989

Henri Gillet
Nicholas Lerner
Richard Rochberg
Shmuel Weinberger

Boulder, August 1989

Maury D. Bramson
Haim Brezis (Progress in Mathematics Lecture)
John Conway (AMS-MAA)
Persi Diaconis (Hedrick Lecture)
Joseph A. Gallian (AMS-MAA-PME)
Shizuo Kakutani (AMS-MAA)
Serge Lang (AMS-MAA)
Howard A. Masur
Dusa McDuff (Progress in Mathematics Lecture)
Jean Taylor (AMS-MAA)
William Thurston (Colloquium Lecture)

Hoboken, October 1989

Russel Caflisch
Fang Hua Lin
Bruce Kitchens
Sheldon E. Newhouse

Muncie, October 1989

Laszlo Lempert
Kenneth Meyer
Paul S. Muhly
Steven Sperber

Louisville, January 1990

Sun-Yung Alice Chang
George B. Dantzig (Gibbs Lecture)
Shlomo Sternberg (Colloquium Lecture)

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.

May 1989 Meeting in Chicago
Central Section
Associate Secretary: Andy Roy Magid
Deadline for organizers: Expired
Deadline for consideration: Expired

Jeffrey Bergen, *Noncommutative ring theory*
Martin Buntinas and Billy Rhoades, *Sequence spaces and summability*
Tim D. Cochran, *Geometric topology*
Jonathan Cohen, *Numerical methods in harmonic analysis*
Vinay Deodhar, *Kazhdan-Lusztig theory and related topics*
Stephen Doty, *Algebraic groups and related topics*
Henri Gillett, *Arithmetic geometry and intersection theory*
Christine Haught, *Recursion theory*
Cary Huffman and Neal Brand, *Codes and designs*
Ronnie Lee and Steven Weintraub, *Algebraic topology of varieties*
Nicholas Lerner, *Partial differential equations*
Colm Mulcahy and Victoria Powers, *Quadratic forms and real algebraic geometry*
S. P. Singh, *Nonlinear analysis and its applications*

August 1989 Meeting in Boulder
Associate Secretary: Andy Roy Magid
Deadline for organizers: Expired
Deadline for consideration: April 25, 1989

Richard A. Askey, *History of orthogonal polynomials*
Maury D. Bramson and David S. Griffeath, *Complex random phenomena*
George J. Fix and Rangabhary Kannan, *Mathematical questions in computational geometry*
Kirk E. Lancaster and Edward W. Stredulinsky, *Free boundary problems and partial differential equations*

Howard A. Masur and John Smillie, *Dynamics and moduli space*
Kevin S. McCurley, *Computational number theory and applications*

October 1989 Meeting in Hoboken
Eastern Section
Associate Secretary: W. Wistar Comfort
Deadline for organizers: Expired
Deadline for consideration: July 26, 1989

Prabir Bhattacharya and Robert A. Melter, *Geometry related to computer vision*
Stephen Bloom, *Algebraic semantics*
Mark Feighn, Lee Mosher and Ulrich Oertel, *Low-dimensional topology*
Bruce P. Kitchens and Sheldon Newhouse, *TBA*
Richard Lyons and Richard O'Nan, *Finite groups*
Charles Sims, *Computational algebra*
Marvin D. Tretkoff, *Algebraic geometry, p-adic aspects*

October 1989 Meeting in Muncie
Central Section
Associate Secretary: Andy Roy Magid
Deadline for organizers: Expired
Deadline for consideration: July 26, 1989

Alan Adolphoson and Steven Sperber, *Number theory and algebraic geometry*
David Bennett and Laszlo Lempert, *Complex analysis*
Ananda Gubbi, *Extremally disconnected spaces and their applications*
David Larson, *Triangular operator algebras*
Kathryn Porter, *Functions spaces and topology*
T. K. Puttaswamy, *Differential equations*

November 1989 Meeting in Los Angeles
Far Western Section
Associate Secretary: Lance W. Small
Deadline for organizers: Expired
Deadline for consideration: July 26, 1989

January 1990 Meeting in Louisville
Associate Secretary: Joseph A. Cima
Deadline for organizers: March 22, 1989
Deadline for consideration: September 28, 1989

Information for Organizers

Special Sessions at Annual and Summer Meetings are held under the supervision of the Program Committee for National Meetings. They are administered by the Associate Secretary in charge of that meeting with staff assistance from the Meetings and Editorial Departments in the Society office in Providence.

According to the "Rules for Special Sessions" of the Society, Special Sessions are selected by the Program Committee from a list of proposed Special Sessions in essentially the same manner as Invited Speakers are selected. The number of Special Sessions at a Summer or Annual Meeting is limited. The algorithm that determines the number of Special Sessions allowed at a given meeting, while simple, is not repeated here, but may be found in "Rules for Special Sessions" which can be found on page 614 in the April 1988 issue of *Notices*.

Each Invited Speaker is invited to generate a Special Session, either by personally organizing one or by having a Special Session organized by others. Proposals to organize a Special Session are sometimes requested either by the Program Committee or by the Associate Secretary. Other proposals to organize a Special Session may be submitted to the Associate Secretary in charge of that meeting (who is an *ex-officio* member of the committee and whose address may be found below). These proposals must be in the hands of the Program Committee well in advance of the meeting and, in any case, at least nine (9) months prior to the meeting at which the Special Session is to be held in order that the committee may consider all the proposals for Special Sessions simultaneously. Proposals that are sent to the Providence office of the Society, to *Notices*, or directed to anyone other than the Associate Secretary will have to be forwarded and may not be received in time to be considered for acceptance.

It should be noticed that Special Sessions must be announced in *Notices* in such a timely fashion that any member of the Society who so wishes may submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration. This deadline is usually three (3) weeks before the Deadline for Abstracts for the meeting in question.

Special Sessions are very effective at Sectional Meetings and can usually be accommodated. They are selected by the Committee to Select Hour Speakers for the Section. The processing of proposals for Special Sessions for Sectional Meetings is handled by the Associate Secretary for the Section, who then forwards the proposals to the Committee to Select which makes the final selection of the proposals. Each Invited Speaker at a Sectional Meeting is invited to organize a Special Session. Just as for national meetings, no Special Session at a Sectional Meeting may be approved so late that its announcement appears past the deadline after which members can no longer

send abstracts for consideration for presentation in that Special Session.

The Society reserves the right of first refusal for the publication of proceedings of any Special Session. These proceedings appear in the book series Contemporary Mathematics.

More precise details concerning proposals for and organizing of Special Sessions may be found in the "Rules for Special Sessions" or may be obtained from any Associate Secretary.

Send Proposals for Special Sessions to the Associate Secretaries

The programs of sectional meetings are arranged by the Associate Secretary for the section in question:

Far Western Section (Pacific and Mountain)

Lance W. Small, Associate Secretary
Department of Mathematics
University of California, San Diego
La Jolla, CA 92093
(Telephone 619-534-3590)

Central Section

Andy Roy Magid, Associate Secretary
Department of Mathematics
University of Oklahoma
601 Elm PHSC 423
Norman, OK 73019
(Telephone 405-325-2052)

Eastern Section

W. Wistar Comfort, Associate Secretary
Department of Mathematics
Wesleyan University
Middletown, CT 06457
(Telephone 203-347-9411)

Southeastern Section

Joseph A. Cima, Associate Secretary
Department of Mathematics
University of North Carolina, Chapel Hill
Chapel Hill, NC 27599-3902
(Telephone 919-962-1050)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

Information for Speakers

A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special Session has been scheduled. Contributors should know that there is a limitation in size of a single special session, so that it is sometimes true that all places are filled by invitation. Papers not accepted for a Special Session are considered as ten-minute contributed papers.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Editorial Department, American Mathematical Society, P. O. Box 6248, Providence, RI 02940) by the special deadline for Special Sessions, which is usually three weeks earlier than the deadline for contributed papers for the same meeting. The Council has decreed that no paper, whether invited or contributed, may be listed in the program of a meeting of the Society unless an abstract of the paper has been received in Providence prior to the deadline.

Number of Papers Presented
Joint Authorship

Although an individual may present only one ten-minute contributed paper at a meeting, any combination of joint authorship may be accepted, provided no individual speaks more than once. An author can speak by invitation in more than one Special Session at the same meeting.

An individual may contribute only one abstract by title in any one issue of Abstracts, but joint authors are treated as a separate category. Thus, in addition to abstracts from two individual authors, one joint abstract by them may also be accepted for an issue.

Symposium on Complex Geometry and Lie Theory
Sundance, Utah
May 26–May 29, 1989

With the support from the National Science Foundation, Duke University, and the University of Utah, a symposium on *Complex Geometry and Lie Theory* will take place Friday through Monday, May 26-29, 1989 at the Sundance Center, Sundance, Utah.

The topic was selected by the AMS Committee on Summer Institutes and Special Symposia whose members at the time of selection were: Eric M. Friedlander, Steven L. Kleiman, Paul H. Rabinowitz, Thomas C. Spencer, Robert B. Warfield, Jr., and John Wermer.

Proceedings will be published by the American Mathematical Society.

The Organizing Committee for the symposium includes JAMES A. CARLSON, University of Utah (co-chair); C. HERBERT CLEMENS University of Utah (co-chair); and DAVID MORRISON, Duke University.

This symposium will review the interaction of the two fields of complex geometry and Lie theory, with concentration on the interaction related to Hodge theory. Speakers will also present current work and discuss possible future directions.

The list of invited speakers includes ENRICO ARBARELLO, University of Rome, Italy; ROBERT BRYANT, Duke University; JAMES CARLSON, University of Utah; EDUARDO CATTANI, University of Massachusetts, Amherst; C. HERBERT CLEMENS, University of Utah; MAURIZIO CORNALBA, University di Pavia, Italy; ROBERT FRIEDMAN, Columbia University; PHILLIP GRIFFITHS, Duke University; MARK GREEN, University of California, Los Angeles; RICHARD HAIN, University of Washington; JOSEPH HARRIS, Harvard University; AROLDO KAPLAN, University of Massachusetts, Amherst; JANOS KOLLAR, University of Utah; ROBERT MACPHERSON, Massachusetts Institute of Technology; JOHN MORGAN, Columbia University; DAVID MORRISON, Duke University; CHRIS PETERS, University of Leiden, The Netherlands; MORIHIKO SAITO, RIMS Kyoto; WILFRIED SCHMID, Harvard University; CARLOS SIMPSON, Princeton University; ANDREW SOMMESE, Notre Dame University; JOSEPH STEENBRINK, University of Nijmeigen, The Netherlands; STEPHEN ZUCKER, Johns Hopkins University.

Registration

The symposium registration desk will be located in the Cottage Reception Center. The desk will be staffed from 2:00 p.m. until 7:00 p.m. on Thursday, from 7:00 a.m. until 4:30 p.m. Friday through Sunday, and from 7:00 a.m until 11:00 a.m. on Monday. Participants opting for the meal plan should check in at the symposium desk in order to obtain a meal card. There is a restaurant to serve participants not on the meal plan.

Registration Fees

All participants including speakers and committee members are required to pay a $25 social fee and a $15 registration fee. The social fee will cover the cost of refreshments served at breaks and evening refreshments. These fees cannot be prorated for those participants choosing not to attend the full period of the symposium. Cash, travelers' checks, and personal checks will be accepted; credit cards cannot be accepted.

Accommodations

The accomodations are a collection of privately owned homes scattered among the aspen and pine. They range from the rustic charm of log homes to contemporary architecture. Individual needs can be met with single accomodations to large Inns holding up to twelve people. All units are equipped with kitchen and bathroom units. Many units also have fireplaces and jacuzzi spas.

Two types of accommodations are available. The first, referred to as cottages, are units consisting of two-bedroom and three-bedroom complexes, all with kitchenettes, living rooms, and private bathrooms. The bedding configuration varies greatly from one twin bed to two queen-sized beds per room.

The second type of accommodations are private homes, referred to as cabins, along the mountainside of Mt. Timpanagos. These cabins range in size from two-bedroom to seven-bedroom homes. All cabins

have at least two full baths, several parlors, full kitchens, and many have at least one jacuzzi spa. The bedding configuration in these cabins is more varied than the cottages, with one king or queen-sized bed to four assorted sized beds per room.

Participants with special dietary needs are encouraged to bring any special foods required and are free to make use of the kitchen facilities in any of the accommodations. Utensils are supplied in kitchen areas.

Participants desiring accomodations at the resort cannot be guaranteed the preferred type of housing due to the unique configurations of the bedroom areas offered. Final housing assignments are responsiblity of the Organizing Committee.

A housing form for participants to use to reserve accommodations can be found at the back of this issue. **Deadline for receipt of this form is April 7, 1989.**

Check-In Locations and Times

The residence check-in desk will be located at the Cottage Reception Center. The desk is open on a 24-hour basis. Participants opting for the meal plan should refer to the schedule listed in the **Registration** section of this announcement.

Room and Board Rates

Due to the limited nature of dining facilities and the isolated location of the Sundance Resort a complete meal plan is being offered to participants beginning with dinner on Thursday evening, May 25 from 7:00-9:00 p.m, and ending with a continental breakfast on Tuesday morning, May 30. The cost for the meal plan is $225.00.

Single occupancy	$60.00
Double occupancy	$30.00

Travel

The Salt Lake City International Airport has service from all parts of the country, and the major carrier is Delta Airlines. The distance to the Sundance Resort is 50 miles and approximately a one-hour drive by car.

Limousine service directly to the resort is provided by Key Limo Transportation at a cost of approximately $40 round trip. A shuttle service will also be available to participants for travel to and from the Salt Lake City area and the resort. A schedule for this service will appear in the April issue of *Notices*.

Social Event

A professionally organized two day river trip on the Colorado River is planned following the symposium. The trip does not require river skills, and the total cost including all food, and transportation to and from Sundance and the Salt Lake City airport is $235. Individuals who do not have the necessary camping gear such as sleeping bags and parkas will be charged an additional $30 rental fee.

The bus taking participants to the embarkation point on the Colorado River will leave Sundance at 6:00 a.m. on Tuesday morning, May 30, arriving at the starting point by 2:00 p.m that afternoon. Return service is on Wednesday afternoon at approximately 2:00 p.m., at which time participants will be bussed back to Salt Lake City by early evening. At present there are only 35 openings and reservations can be made by contacting Herb Clemens, Mathematics Department, University of Utah, Salt Lake City, UT 84112. The telephone number is 801-581-5275. Reservations can also be made by contacting Barbara Smoot at 801-581-7710. **The deadline for making reservations is April 7, 1989.**

1989 Summer Research Institute

Several Complex Variables and Complex Geometry
University of California, Santa Cruz, July 10 - 30

The thirty-seventh Summer Research Institute sponsored by the American Mathematical Society will be devoted to *Several complex variables and complex geometry* and will take place at the University of California, Santa Cruz. Members of the Organizing Committee are: ERIC BEDFORD, Indiana University at Bloomington; JOHN D'ANGELO, University of Illinois at Urbana-Champaign, ROBERT E. GREENE, University of California, Los Angeles; and STEVEN G. KRANTZ, Washington University (chair). It is anticipated that the institute will be partially supported by a grant from the National Science Foundation. Proceedings of the institute will be published in the AMS series *Proceedings of Symposia in Pure Mathematics.*

This topic was selected by the 1987 Committee on Summer Institutes and Special Symposia whose members were ERIC FRIEDLANDER, STEVEN L. KLEIMAN, PAUL H. RABINOWITZ, THOMAS C. SPENCER, ROBERT B. WARFIELD, JR., and JOHN WERMER (chair).

In 1975, a summer institute was held on several complex variables; prior to that an institute was held in 1953 (to celebrate the solution of the Levi problem). The institute for 1989 marks a substantial lapse of time and at least as great an increment of growth in the subject. There follows a discussion of some of the new developments which will be treated during this institute.

The partial differential equations that define holomorphic functions are called the Cauchy-Riemann equations (or the $\overline{\partial}$ equation). Theorems about these equations go hand in hand with the solution of function-theoretic problems, because one can perform real variable constructions with smooth functions and correct them with the $\overline{\partial}$ equation. In these constructions, regularity at the boundary is of crucial importance. However the $\overline{\partial}$-Neumann problem is not elliptic at the boundary and new techniques had to be developed by Kohn to obtain so-called subelliptic estimates on strongly pseudoconvex domains; local boundary regularity follows. More recently, Catlin has found necesesary and sufficient conditions for subellipticity. The conditions are in terms of order of contact of complex varieties with the boundary and reveal surprising connections between partial differential equations and algebraic geometry–especially the intersection of theory of complex varieties.

A second partial differential equation arising in several complex variables is the complex Monge-Ampère equation. This equation is a nonlinear generalization of the Laplacian. This equation is important in plurisubharmonic function theory, the construction of Kähler metrics, and in the potential theory of several complex variables. The existence and regularity theory for this equation does not fit any standard mold and has brought many surprises.

Biholomorphic and proper maps have been intensely studied in recent years. In 1974, C. Fefferman proved that biholomorphic mappings of strongly pseudoconvex domains continue smoothly to the boundary. More recently, new methods have been found which apply to broader classes of domains and to proper mappings and correspondences as well. At the same time, proper mappings of domains in different dimensions are revealing surprising pathologies. These pathologies, and the methods used to construct them, are related to the inner functions of Aleksandrov and Løw. Inner functions have aided in the resolution of a number of problems in constructive function theory.

Yet another method in holomorphic mapping theory is complex analytic dynamics. Fifty years ago H. Cartan used this method to study automorphisms of domains in $\mathbf{C}^n$. More recently, these methods have been used to obtain new constructions of Fatou-Bieberbach mappings (entire mappings with "small range") and to prove new characterizations of automorphisms.

The intersection theory of complex analytic varieties has been used by D'Angelo to describe the geometry of real hypersurfaces in $\mathbf{C}^n$. When the hypersurface bounds a domain, then the boundary geometry influences the function theory on the interior. The invariant metrics of Bergman, Carathèodory, Kobayashi/Royden are a useful device for mediating between boundary geometry and interior function theory. The theories of Hardy spaces, Bloch functions, the Lindelöff Principle, and so forth, are being increasingly treated with this metric language. In addition, the work of Lempert on extremal discs for

the Kobayashi/Royden metric has tied invariant metrics to the Monge-Ampère equation and to mapping problems.

The function theory of complex manifolds is also predominantly geometric. Even for topologically trivial complex manifolds, many different function theories can arise: the curvatures of complex geometries specify the possibilities. If one specializes to Hermitian symmetric spaces, Kähler manifolds, parabolic manifolds, inbedded CR manifolds, or other contexts with structure, then a subject rich in texture emerges. In the last decade powerful machines such as nonlinear partial differential equations, positive and negative vector bundles, Hodge theories and vanishing theorems have been exploited to further the subject.

Complex analysis in several variables has grown considerably since 1975. A significant component of this growth has stemmed from the interaction with other parts of mathematics. The 1989 institute will make explicit many of these connections and review several of the major achievements stemming from them. One principal purpose of the institute is to foster and encourage further interaction among complex analysts with diverse interests.

The list of principal speakers for week one includes DAVID BARRETT, University of Michigan; STEVEN BELL, Purdue University; BO BERNDTSSON, Chalmers Institute of Technology, Sweden; FRANC FORSTNERIC, University of Ljubljana; LASZLO LEMPERT, Purdue University; JEAN MARTINET, University de Strasbourg, France; SERGEI PINCHUK, Ufa State University, USSR; JEAN PIERRE ROSAY, University of Wisconsin, Madison; NESSIM SIBONY, University de Paris-Sud, France; BERIT STENSONES, Rutgers University; A. G. VITUSHKIN, Steklov Mathematical Institute, USSR.

The list of principal speakers for week two includes EDWARD BIERSTONE, University of Toronto, Canada; JAMES CARLSON, University of Utah; PIERRE DEMAILLY, Universite de Grenoble, France; AKITO FUTAKI, Chiba University, Japan; NGAIMING MOK, Columbia University; TAKEO OHSAWA, Kyoto University, Japan; YUM TONG SIU, Harvard University; GANG TIAN, Princeton University; SHING TUNG YAU, Harvard University.

The list of principal speakers for week three includes M. SALAH BAOUENDI, University of California, San Diego; DAVID CATLIN, Purdue University; MICHAEL CHRIST, University of California, Los Angeles; YAKOV ELIASHBERG, University of California, Berkeley; JOHN FORNAESS, Princeton University; GENNADI M. HENKIN, Mathematical Institute AN, USSR; JOSEPH T. KOHN, Princeton University; LINDA PREISS ROTHSCHILD, University of California, San Diego; ELIAS M. STEIN, Princeton University; FRANCOIS TREVES, Rutgers University; SIDNEY WEBSTER, University of Minnesota, Minneapolis.

A tentative list of the topics to be addressed follows. Please note, however, that the program is subject to change.

Week One: Complex Function Theory

Biholomorphic and proper maps, complex potential theory, plurisubharmonic functions, approximation theory, complex analytic dynamics, convolution equations, analytic multifunctions, inner functions.

Week Two: Complex Manifolds and Complex Geometry

Hermitian and Kähler geometry, curvature, holomorphic mappings, invariant metrics, deformations, parabolic manifolds, finite type conditions, positive and negative vector bundles, vanishing theorems, Hodge theory.

Week Three: Analysis and Partial Differential Equations

Cauchy-Riemann equations, CR geometry of hypersurfaces, CR functions, complex Monge-Ampère equation, integral kernels and asymptotics, pseudoconvexity, hyperfunctions.

Accommodations will be available in the campus residence halls for participants; cafeteria style meals will be available. All facilities will be accessible to the handicapped.

Information on housing, dining, travel and the local area will be sent to invited participants in the spring. Each participant will pay a registration fee and a social fee to cover the costs of social events scheduled during the institute.

Those interested in receiving an invitation to participate in the institute should send the following information to Wayne S. Drady, Summer Institute Conference Coordinator, American Mathematical Society, Post Office Box 6248, Providence, RI 02940, **prior to April 1, 1989**, or through electronic mail WSD@MATH.AMS.COM.

Please type or print the following:

1. Full name;
2. Mailing address;
3. Telephone number and area code for office and home;
4. Which week or weeks you wish to attend;
5. Your scientific background relevant to the institute topic;
6. Financial assistance requested;

7. Indicate if support is not required, and if interested in attending even if support is not offered.

Requests for invitations will be forwarded to the Organizing Committee for consideration. Requests will be considered after April 1, 1989, and applicants selected will receive formal invitations and notification of financial assistance beginning in mid-May.

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- ☐ *The European Mathematicians' Migration to America*, by Lipman Bers, Code VIDBERS/NA
- ☐ *Zoll Surfaces*, by Victor Guillemin, Code VIDGUILLEMIN/NA
- ☐ *Matrices I Have Met*, by Paul R. Halmos, Code VIDHALMOS/NA
- ☐ *Episodes in the Origins of the Representation Theory of Lie Algebras*, by Thomas Hawkins, Code VIDHAWKINS/NA
- ☐ *How Computers Have Changed the Way I Teach*, by John G. Kemeny, Code VIDKEMENY/NA
- ☐ *The Flowering of Applied Mathematics in America*, by Peter D. Lax, Code VIDLAX/NA
- ☐ *Oscar Zariski and His Work*, by David Mumford, Code VIDMUMFORD/NA

ICM-86 Plenary Addresses
VHS Format, approx. one hour,
Price $49 each

- ☐ *Geometry of four-manifolds*, by Simon K. Donaldson, Code VIDDONALDSON/NA
- ☐ *Underlying concepts in the proof of the Bieberbach conjecture*, by Louis de Branges, Code VIDDEBRANGES/NA
- ☐ *Recent progress in arithmetic algebraic geometry*, by Gerd Faltings, Code VIDFALTINGS/NA
- ☐ *Soft and hard symplectic geometry* by Mikhael Gromov, Code VIDGROMOV/NA
- ☐ *Efficient algorithms in number theory*, by Hendrik W. Lenstra, Code VIDLENSTRA/NA
- ☐ *New developments in the theory of geometric partial differential equations*, by Richard M. Schoen, Code VIDSCHOEN/NA
- ☐ *Classifying general classes*, by Saharon Shelah, Code VIDSHELAH/NA
- ☐ *Complexity aspects of numerical analysis*, by Stephen Smale, Code VIDSMALE/NA
- ☐ *Problems in harmonic analysis related to oscillatory integrals and curvature*, by Elias M. Stein, Code VIDSTEIN/NA
- ☐ *Representations of reductive Lie groups*, by David A. Vogan, Jr., Code VIDVOGAN/NA
- ☐ *String theory and geometry*, by Edward Witten, Code VIDWITTEN/NA
- ☐ Also available from ICM-86: Addresses on the Work of the 1986 Fields Medalists and Nevanlinna Prize Winner (These four talks are on one tape.) Code VIDMEDAL/NA

  On the work of Simon K. Donaldson, Fields Medalist, by Michael F. Atiyah; *On some of the mathematical contributions of Gerd Faltings*, Fields Medalist, by Barry Mazur; *On the work of Michael Freedman*, Fields Medalist, by John W. Milnor; *On the work of Leslie G. Valiant*, Nevanlinna Prize Winner, by Volker Strassen

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1988-1989. **Academic Year Devoted to Operator Algebras**, Mittag-Leffler Institute, Djursholm, Sweden. (February 1988, p. 307)

October 1988–August 1989. **Symposium on Singularity Theory and Its Applications**, University of Warwick, Coventry, United Kingdom. (May/June 1988, p. 724)

1989. **40th Anniversary of Kansas Gamma of Pi Mu Epsilon**, Wichita State University, Wichita, Kansas. (January 1989, p. 63)

1989. **Concentration Year on Fluid Dynamical Aspects of Combustion Theory**, Instituto Per Le Applicazioni Del Calcolo, Rome, Italy. (January 1989, p. 63)

1989–1990. **Academic Year Devoted to Hyperbolic Geometry and Quasiconformal Mappings**, Mittag-Leffler Institute, Djursholm, Sweden. (December 1988, p. 1584)

January 1–December 23, 1989. **Mathematisches Forschungsinstitut Oberwolfach** (Weekly Conferences), Federal Republic of Germany. (April 1988, p. 629 and November 1988, p. 1381)

March 1989

* 19–23. **Workshop on Novikov's Conjectures**, University of Chicago, Chicago, Illinois.

PROGRAM: Survey talks on Novikov's conjectures will be given on March 19, coinciding with one of the regular quarterly Midwest Topology Seminars. Technical talks and working sessions will be held on the following days.

INVITED SPEAKERS: M. Bokstedt; D. Burghelea; S. Cappell; G. Carlsson; R. Cohen; T. Goodwillie; T. Farrell; S. Ferry; W.-C. Hsiang; B. Hughes; J. Jones; L. Jones; I. Madsen; H. Moscovici; A. Nicas; F. Quinn; A. Ranicki; J. Rosenberg; J. Shaneson.

INFORMATION: M. Rothenberg (312-702-7100), S. Weinberger (312-702-7345), or B. Williams (312-702-7349), Department of Mathematics, the University of Chicago, Chicago, Illinois 60637.

27–30. **Twentieth Annual Iranian Mathematical Conference**, University of Tehran, Tehran, Iran. (October 1988, p. 1242)

Mathematical Sciences Meetings and Conferences

THIS SECTION contains announcements of meetings and conferences of interest to some segment of the mathematical public, including *ad hoc*, local, or regional meetings, and meetings or symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. (Information on meetings of the Society, and on meetings sponsored by the Society, will be found inside the front cover.)

AN ANNOUNCEMENT will be published in *Notices* if it contains a call for papers, and specifies the place, date, subject (when applicable), and the speakers; a second full announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in each issue until it has been held and a reference will be given in parentheses to the month, year, and page of the issue in which the complete information appeared. Asterisks (*) mark those announcements containing new or revised information.

IN GENERAL, announcements of meetings and conferences held in North America carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of *Notices*, care of the American Mathematical Society in Providence.

DEADLINES for entries in this section are listed on the inside front cover of each issue. In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence SIX MONTHS prior to the scheduled date of the meeting.

28–31. **Annual Scientific Conference of the Society of Applied Mathematics and Mechanics (GAMM)**, University of Karlsruhe, Federal Republic of Germany. (September 1988, p. 1058)

30–31. **Workshop on Applied Computing '89**, Stillwater, Oklahoma. (October 1988, p. 1242)

30–April 1. **Conference Honoring Richard S. Varga**, Kent, Ohio. (October 1988, p. 1242)

31–April 1. **Sixth Southeast Mathematical Ecology Conference**, Wakulla Springs, Florida. (December 1988, p. 1586)

31–April 1. **Fifth South-Eastern Analysis Meeting (SEAM 5)**, University of Georgia, Athens, Georgia. (November 1988, p. 1383)

31–April 1. **Spring Conference on the First Two Years: Teaching the Mathematical Core**, University of Hartford, West Hartford, Connecticut. (January 1989, p. 64)

April 1989

2–6. **Fifth Conference on the Scientific Use of Statistical Software (SoftStat '89)**, Heidelberg, Federal Republic of Germany. (October 1988, p. 1242)

2–8. **Spektraltheorie Singulärer Gewohnlicher Differentialoperatoren**, Oberwolfach, Federal Republic of Germany. (February 1989, p. 175)

3–5. **Third SIAM Conference on Optimization**, Boston, Massachusetts. (October 1988, p. 1242)

3–6. **IEEE International Conference on Control and Applications**, Jerusalem, Israel. (April 1988, p. 638)

3–7. **Seventh International Conference on Finite Element Methods in Flow Problems**, University of Alabama in Huntsville, Huntsville, Alabama. (January 1989, p. 65)

3–7. **Forty-first British Mathematical Colloquium**, University of Nottingham, Nottingham. (December 1988, p. 1586)

3–14. **Workshop on Multidimensional Hyperbolic Problems and Computations**, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (September 1988, p. 1058)

5–7. **The Worker in Transition: Technological Change**, Washington, District of Columbia. (January 1989, p. 65)

* 7–8. **Sixty-seventh Annual Meeting of the Southeastern Section of the MAA**, University of Tennessee, Knoxville, Tennessee.

PROGRAM: A short course entitled "Microcomputer Use in the Mathematics Curriculum" will be conducted by L. Husch of the University of Tennessee, Knoxville.
INVITED SPEAKERS: H. S. Wilf, University of Pennsylvania, The White-Screen Problem; C. Linder, Auburn University, Graph Decompositions and Quasigroup Identities; H. Reitner, the University of North Carolina at Charlotte, In Search of Mathematical Meaning – Some Successes and a Failure.
INFORMATION: J. G. Ware, Secretary/Treasurer, Department of Mathematics, University of Tennessee at Chattanooga, Chattanooga, Tennessee 37403.

* 7–8. **Spring Meeting of the Missouri Section of the MAA**, University of Missouri-Columbia, Columbia, Missouri.

INFORMATION: S. K. Katti, Department of Statistics, 314 Mathematical Sciences Building, University of Missouri-Columbia, Columbia, Missouri 65211.

7–8. **Sixth Annual Auburn Miniconference on Real Analysis**, Auburn University, Alabama. (December 1988, p. 1586)

7–9. **Fifth Annual Geometry Festival**, State University of New York at Stony Brook, Stony Brook, New York. (January 1989, p. 65)

* 8. **Algebra Day**, University of Ottawa, Ontario, Canada.

SPONSORS: Carleton University and the University of Ottawa.
INVITED SPEAKERS: V. Deodhar, Indiana University; M. P. Malliavin, Université de Paris; M. Schacher, University of California, Los Angeles.
INFORMATION: M. Racine, Department of Mathematics, University of Ottawa, Ottawa, Ontario, Canada K1N 6N5.

* 8–9. **Twelfth Annual Texas PDE Seminar**, University of Houston, Houston, Texas.

CALL FOR PAPERS: The deadline for contributed papers is March 20.
INFORMATION: G. Auchmuty or B. Fitzgibbon, Department of Mathematics, University of Houston, Houston, Texas 77204-3476.

8–9. **Midwest Partial Differential Equations Seminar**, University of Illinois at Chicago, Chicago, Illinois. (February 1989, p. 175)

9–13. **Fourth Copper Mountain Conference on Multigrid Methods**, Copper Mountain, Colorado. (October 1988, p. 1242)

10–12. **Conceptual and Numerical Analysis of Data**, Universität Augsburg, Federal Republic of Germany. (October 1988, p. 1242)

10–13. **IEEE Artificial Neural Networks Conference**, Sheraton International Conference Center, Reston, Virginia. (Note date change, March 1988, p. 465)

11–13. **EUROCRYPT '89: Workshop on the Theory and Applications of Cryptographic Techniques (IACR)**, Houthalen, Belgium. (October 1988, p. 1243)

13–15. **Operators and Function Theory: The Role of de Branges's Spaces**, University of Arkansas, Fayetteville, Arkansas. (September 1988, p. 1058)

15. **Conference on the Future of Calculus**, Ithaca College, Ithaca, New York. (January 1989, p. 65)

15–16. **Eastern Section Meeting of the AMS**, College of the Holy Cross, Worcester, Massachusetts. (May/June 1988, p. 731)

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

16–20. **NCGA '89**, Philadelphia Civic Center, Philadelphia, Pennsylvania. (September 1988, p. 1058)

17–21. **Minisymposium on Computational Issues for Nonlinear Hyperbolic Waves**, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (September 1988, p. 1058)

17–21. **Minisymposium on Front Tracking in a Supercomputer Environment**, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (October 1988, p. 1243)

17–28. **Topical Meeting on Hyperbolic Geometry and Ergodic Theory**, Trieste, Italy. (October 1988, p. 1243)

* 21–22. **Joint MAA-KS Meeting**, Hutchinson Community College, Hutchinson, Kansas.

INFORMATION: K. Dundas, Program Chair 1989 Conference, Hutchinson Community College, 1300 North Plum, Hutchinson, Kansas 67501.

21–22. **Conference Honoring the 60th Birthday of Sir Michael Atiyah**, Oxford, England. (December 1988, p. 1586)

23–29. **International Conference on Computing and Information, Session I**, McMaster University, Hamilton, Ontario, Canada. (February 1989, p. 176)

25–27. **International Conference on Analytic Number Theory**, University of Illinois Conference Center at Allerton Park. (October 1988, p. 1243)

27–29. **Third Annual Conference on Undergraduate Research**, Trinity University, San Antonio, Texas. (October 1988, p. 1243)

28–29. **1989 Spring Meeting of the Association for Symbolic Logic**, Chicago, Illinois. (November 1988, p. 1384)

* 29–30. **Southern California Analysis and Partial Differential Equations Conference**, University of California, San Diego, La Jolla, California.

INVITED SPEAKERS: A. Chang, University of California, Berkeley, and University of California, Los Angeles; M. Crandall, University of California, Santa Barbara; L. Lempert, Purdue University; L. Nirenberg, New York University, Courant Institute

of Mathematical Sciences; L. Simon, Stanford University.
INFORMATION: S. Baouendi or L. Rothschild, Department of Mathematics, University of California, San Diego, La Jolla, California 92037.

May 1989

* **NSF-CBMS Conference on Discrete Groups, Expanding Graphs, and Invariant Measures**, University of Oklahoma, Norman, Oklahoma.

LECTURER: A. Lubotsky.
INFORMATION: A. Magid, Department of Mathematics, University of Oklahoma, Norman, Oklahoma 73019, 405-325-2052.

1–31. **Geometry of Loop Spaces**, Max-Planck-Institut für Mathematik, Bonn, Federal Republic of Germany. (January 1989, p. 65)

4–5. **Twentieth Annual Pittsburgh Conference on Modeling and Simulation**, Pittsburgh, Pennsylvania. (September 1988, p. 1058)

4–7. **Mathematicians and Education Reform Network**, University of California, Berkeley, Berkeley, California. (January 1989, p. 66)

* 5. **Mathematical Modeling in Biology**, State University of New York, Stony Brook, New York.

INVITED SPEAKERS: C. Peskin, Courant Institute of Mathematical Sciences; C. DeLisi, Mount Sinai School of Medicine.
INFORMATION: E. Beltrami, Department of Applied Mathematics and Statistics, State University of New York at Stony Brook, Stony Brook, New York 11794, 516-632-8367.

8–10. **Forty-Third Annual Quality Congress**, Toronto, Canada. (March 1988, p. 465)

8–12. **Algorithmique Et Programmation Pascal**, Marseille, France. (February 1989, p. 176)

8–12. **Workshop on Arithmetic Groups and Buildings**, Mathematical Sciences Research Institute, Berkeley, California. (March 1988, p. 465)

* 14–16. **Workshop on Markov Processes in Functional Spaces**, Cornell University, Ithaca, New York.

CONFERENCE TOPICS: Infinite-Dimensional Diffusions; Measure-Valued and Distribution-Valued Processes; Stochastic Partial Differential Equations.
INVITED SPEAKERS: D. Dawson; E. B. Dynkin; I. Gyöngy; T. Kurtz; E. Perkins; T. Shiga; J. Walsh.
INFORMATION: Mathematical Sciences Institute, 201 Caldwell Hall, Cornell University, Ithaca, New York 14853, 607-255-7740, 8005 or 7763.

15–17. **1989 New Zealand Mathematics Colloquium**, Palmerston North, New Zealand. (May/June 1988, p. 731)

15–19. **Moments de Geometrie Symplectique**, Marseille, France. (February 1989, p. 176)

15–19. **Workshop on Microlocal Analysis and Nonlinear Waves**, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (February 1989, p. 176)

17–19. **Joint IMA/SMAI-GAMNI Conference on Computational Methods in Aeronautical Fluid Dynamics**, Sophia Antipolis, France. (October 1988, p. 1243)

17–19. **SIAM Conference on Control and Systems Theory**, San Francisco, California. (December 1988, p. 1586)

19–20. **Central Section Meeting of the AMS**, Loyola University, Chicago, Illinois.

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

22–24. **International Conference on Algebraic Methodology and Software Technology, AMAST**, Iowa City, Iowa. (December 1988, p. 1587)

22–24. **Sparse Matrix Meeting**, Salisham Resort, Oregon. (October 1988, p. 1243)

22–24. **Workshop on Vortex Methods**, Mathematical Sciences Research Institute, Berkeley, California. (September 1988, p. 1059)

22–24. **SIAM Conference on Sparse Matrices**, Portland, Oregon. (November 1988, p. 1384)

22–25. **Second Dublin Differential Equations Meeting**, Dublin, Republic of Ireland. (November 1988, p. 1384)

22–26. **Cohomolgie des Groupes Arithmetiques**, Marseille, France. (February 1989, p. 176)

22–26. **Capital City Conference on Combinatorics and Theoretical Computer Science**, George Washington University, Washington, District of Columbia. (February 1989, p. 176)

22–26. **Meeting on Rational Mechanics and Analysis in Honor of Clifford Truesdell on His 70th Birthday**, Pisa, Italy. (December 1988, p. 1587)

22–June 3. **NATO Advanced Study Institute on Orthogonal Polynomials and Their Applications**, The Ohio State University, Columbus, Ohio. (September 1988, p. 1059)

* 23–26. **Association for Computing Machinery Sigmetrics and Performance '89 Conference**, Berkeley, California.

INFORMATION: L. Cabrera, IBM Almaden Research Center, Mail Code K52/803, San Jose, California 95120-6099.

23–26. **Third International Conference on Numerical Combustion**, Antibes, France. (December 1988, p. 1587)

23–27. **International Conference on Computing and Information**, Toronto, Ontario, Canada. (April 1988, p. 638)

25–26. **Eleventh Symposium on Mathematical Programming with Data Perturbations**, The George Washington University, Washington, District of Columbia. (January 1989, p. 66)

25–27. **Fourth Annual Lehigh University Geometry and Topology Conference**, Bethlehem, Pennsylvania. (November 1988, p. 1384)

26–30. **AMS Pure Mathematics Symposium on Complex Geometry and Lie Theory**, Sundance, Utah.

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

28–June 1. **Sixteenth International Symposium on Computer Architecture**, Jerusalem, Israel. (September 1988, p. 1059)

29–June 1. **Third International Conference in Mathematics: Fractional Calculus and Its Applications**, Nihon University, Tokyo, Japan. (May/June 1988, p. 731)

29–June 2. **NSF-CBMS Regional Conference on Discrete Groups, Expanding Graphs, and Invariant Measures**, University of Oklahoma, Norman, Oklahoma. (February 1989, p. 177)

29–June 2. **AVIGNON '89: Ninth International Workshop on Expert Systems and their Applications**, Avignon, France. (February 1989, p. 177)

29–June 2. **Ondelettes**, Marseille, France. (February 1989, p. 177)

* 29–June 3. **Conference on Wavelets and Some of Their Applications**, Marseille-Luminy, France.

PURPOSE: This conference aims to give a status report on wavelets by describing specific examples where some important problems were solved using wavelet techniques.
INVITED SPEAKERS: A. Arneodo, Centre de Recherche Paul Pascal; M. Farge, ENS Paris; M. Holschneider, CPT Marseille; M. Basseville, IRISA, Rennes; P. Flandrin, ICPI, Lyon; R. Coifman, Yale; M. Duval-Destin; S. Mallat, Courant Institute of Mathematical Sciences; R. Kronland-Martinet, LMA, Marseille.
CONFERENCE TOPICS: Wavelets, Dynamical Systems and Richardson Cascades in Turbulence; Wavelets and Non-stationary Signal Processing; Wavelets and Numerical Analysis; Wavelets and Image Processing; Wavelets and Acoustics.
INFORMATION: Y. Meyer, Ceremade, Université Paris Dauphine, 75775-Paris Cedex 16, France. Telephone: (33)-1-47277503.

29–June 3. **Meeting on Computer and Commutative Algebra (COCOA II)**, Dipartimento di Matematica, Università, Genova, Italy. (February 1989, p. 177)

29–June 9. **Joint AMS-SIAM Summer Seminar on the Mathematics of Random Media**, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. (Please note date change from May/June 1988, p. 731)

INFORMATION: B. Verducci, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

30–June 2. **1989 Annual Meeting of the Statistical Society of Canada**, Ottawa, Ontario, Canada. (November 1988, p. 1385)

31–June 2. **Workshop on Blow-up and Extinction for Parabolic and Other Systems**, Heriot-Watt University, Edinburgh. (January 1989, p. 66)

31–June 3. **Seventh Biennial Conference of the Association of Christians in the Mathematical Sciences**, Messiah College, Grantham, Pennsylvania. (December 1988, p. 1587)

June 1989

* **IMACS International School on Lyapunov Functions**, Irkutsk, Union of Soviet Socialist Republics.

INFORMATION: V. M. Matrosov, Director of the Irkutsk Computing Center, Siberian Branch, Union of Soviet Socialist Republics Academy of Sciences, Lermontov Str. 134, 664033 Irkutsk, Union of Soviet Socialist Republics.

* **NSF-CBMS Conference on Function Estimation in the Context of Independent and Dependent Observations**, University of California, Davis, California.

LECTURER: M. Rosenblatt.
INFORMATION: G. Roussas, Department of Statistics, University of California, Davis, California 95616, 916-752-8142.

* 1–3. **Annual Summer Meeting of the Canadian Mathematical Society**, University of Windsor, Windsor, Ontario.

PROGRAM: The meeting will include four special sessions, each featuring a plenary speaker. There will be a session for 15-minute contributed papers.
INVITED SPEAKERS: F. Atkinson, Differential Equations; D. Passman, Group Algebras; B. Kostant, Lie and Nonassociative Algebras; D. Friedan, Mathematical Physics.
CALL FOR PAPERS: Two copies of each abstract should be submitted to the organizing committee by March 15.
INFORMATION: F. Lemire, Chairman, Organizing Committee, Department of Mathematics and Statistics, University of Windsor, Windsor, Ontario, Canada N9B 3P4.

1–10. **Third Annual Meeting of the International Workshop In Analysis and Its Applications**, Dubrovnik-Kupari, Yugoslavia. (October 1988, p. 1243)

2–5. **Seminar on Fractional Calculus**, Nihon University, Koriyama, Japan. (February 1989, p. 177)

3–August 5. **Joint AMS-IMS-SIAM Summer Research Conferences in the Mathematical Sciences**, Humbolt State University, Arcata, California.

INFORMATION: C. Kohanski, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

4–8. **1989 IEEE International Conference on Computer Vision and Pattern Recognition**, San Diego, California. (October 1988, p. 1243)

4–9. **Geometrical and Algebraical Aspects in Several Complex Variables**, Cetraro (CS), Italy. (November 1988, p. 1385)

4–30. **1989 Complex Systems Summer School**, Santa Fe, New Mexico. (January 1989, p. 67)

5–7. **An International Symposium on Asymptotic and Computational Analysis**, Winnipeg, Manitoba, Canada. (September 1988, p. 1059)

5–8. **International Colloquium on Complex Analysis and Sixth Romanian-Finnish Seminar**, University of Bucharest, Romania. (December 1988, p. 1588)

5–8. **Fourth Annual Symposium on Logic in Computer Science (LICS)**, Asilomar, California. (October 1988, p. 1244)

5–9. **International Symposium on Bayesian Decision Theory**, Sherbrooke, Canada. (January 1989, p. 67)

5–9. **Chaos and the Microcomputer**, Salisbury State University, Salisbury, Maryland. (January 1989, p. 67)

5–9. **Conference in Mathematical Analysis in Honor of the Memory of Jose Luis Rubio de Francia**, El Escorial, Spain. (February 1989, p. 178)

5–10. **Analytic Number Theory**, Centre de recherches mathématiques, Université de Montréal. (Please note date change from September 1988, p. 1059)

* 5–10. **William H. Roever Lectures in Geometry, and Algebraic Geometry Conference**, Washington University, Saint Louis, Missouri.

SPONSORS: Washington University and the National Science Foundation.
PURPOSE: The conference will bring together specialists in various branches of algebraic geometry to discuss recent developments, results, and problems in their fields.
MAIN SPEAKER: W. Fulton, University of Chicago, will deliver five 90-minute talks on Toric Varieties.
OTHER INVITED SPEAKERS: H. Clemens, University of Utah; S. Bloch, University of Chicago; R. Lazarsfeld,

University of California, Los Angeles; L. Ein, University of Illinois at Chicago; T.-t Moh, Purdue University; D. Morrsion, Duke University; Z. Ran, University of California at Riverside; D. Harbater, University of Pennsylvania; M. P. Murthy, University of Chicago; R. Donagi, University of Pennsylvania.
INFORMATION: D. Wright or D. Webb, Department of Mathematics, Washington University, Saint Louis, Missouri, 314-889-6781.

5–10. **Theorie du Point Fixe et Applications**, Marseille, France. (February 1989, p. 178)

5–16. **Workshop on the Geometry of Hamiltonian Systems**, Mathematical Sciences Research Institute, Berkeley, California. (April 1988, p. 638)

6–8. **Fourth International Conference on Boundary Element Technology**, Windsor, Ontario, Canada. (September 1988, p. 1059)

7–9. **Canadian Applied Mathematics Society Tenth Annual Meeting**, Winnipeg, Canada. (September 1988, p. 1059)

7–10. **International Conference on Differential Equations: Theory and Applications in Stability and Control**, University of Colorado at Colorado Springs and The Colorado College, Colorado Springs, Colorado. (November 1988, p. 1385)

8–16. **Singapore Probability Conference**, National University of Singapore, Republic of Singapore. (November 1988, p. 1385)

11–14. **SRCOS-ASA Summer Research Conference**, Unicoi State Park, Georgia. (January 1989, p. 67)

*12–16. **NSF-CBMS Conference on Harmonic Analysis, Real Function Spaces and Related Areas**, Auburn University-Auburn, Auburn University, Alabama.

LECTURER: G. Weiss.
INFORMATION: G. DeSouza, Department of Mathematics, Auburn University-Auburn, Auburn University, Alabama 36849, 205-826-4290.

*12–16. **NSF-CBMS Conference on Projection Pursuit and Related Computationally Intensive Techniques for Analyzing Mulitivariate Data**, George Washington University, Washington, District of Columbia.

LECTURER: J. Friedman.
INFORMATION: R. Smythe, Department of Statistics, George Washington University, Washington, District of Columbia 20052, 202-994-6356.

12–16. **Greco Calcul Formel**, Marseille, France. (February 1989, p. 178)

12–16. **Decision Making and the Microcomputer**, Salisbury State University, Salisbury, Maryland. (January 1989, p. 67)

12–16. **Computers and Mathematics**, Massachusetts Institute of Technology, Cambridge, Massachusetts. (July/August 1988, p. 894)

12–17. **Conference on the Geometry of Banach Spaces**, Strobl on Wolfgangsee, Austria. (October 1988, p. 1244)

12–July 8. **Summer Conference on Complex Analysis**, Bordeaux, France. (February 1989, p. 178)

13–15. **Third Chico State Western States Topology Conference**, California State University, Chico, Chico, California. (February 1989, p. 178)

*13–17. **Mathematical Modeling**, Northern Illinois University, DeKalb, Illinois.

SPONSOR: Illinois Section of the Mathematical Association of America.
PURPOSE: This conference is designed to give teachers insight and techniques useful for a course in modeling.
PRINCIPAL SPEAKERS: F. R. Giordano, United States Military Academy; M. D. Weir, Naval Postgraduate School.
INFORMATION: R. F. Wheeler, Department of Mathematical Sciences, Northern Illinois University, Dekalb, Illinois 60115, 815-753-6738.

14–17. **International Conference on Dynamical Systems, Control Theory, and Applications**, Wright State University, Dayton, Ohio. (October 1988, p. 1244)

15–17. **Northeast Conference on General Topology and Applications**, The College of Staten Island, City University of New York, Staten Island, New York. (January 1989, p. 67)

15–18. **Third Boston Workshop for Mathematics Faculty**, Wellesley College, Wellesley, Massachusetts. (February 1989, p. 178)

*15–19. **Workshop on the Packing and Mechanics of Aggregates of Spheres**, Cornell University, Ithaca, New York.

PURPOSE: This workshop will bring together researchers working in the geometry and rigidity of regular and random packing of spheres, the numerical simulation of arrays of hard or elastic spheres, and the modeling of the mechanical behavior of idealized granular materials.
INVITED SPEAKERS: A. Bezdek; K. Bezdek; C. S. Chang; R. Connelly; H. Frost; Z. Gaspar; J. T. Jenkins; J. Papadopoulos; E. Petrakis; T. Rosato; M. Satake; T. Tarnai; W. Whiteley.
INFORMATION: For further information on the scientific program, contact J. Jenkins, Department of Theoretical and Applied Mechanics, Cornell University, Ithaca, New York 14853, 607-255-7185 or 5062. To attend the workshop, contact the Mathematical Sciences Institute, 201 Caldwell Hall, Cornell University, Ithaca, New York 14853, 607-255-7740, 8005 or 7763. (Note: Limited funding is available for partial support of predoctoral and young postdoctoral attendees.)

15–23. **CIME Course on Methods of Nonconvex Analysis**, Villa Monastero, Varenna Lake (Lake of Como), Italy. (January 1989, p. 67)

18–24. **Reelle Analysis**, Oberwolfach, Federal Republic of Germany. (February 1989, p. 178)

18–24. **Conference on Nonlinear Analysis**, Academia Sinica, Taiwan, Republic of China. (February 1989, p. 179)

*19–20. **IFAC/IMACS Workshop on Computer-Aided Control Systems Design**, Alma-Ata, Union of Soviet Socialist Republics.

INFORMATION: V. I. Venets, Union of Soviet Socialist Republics Nat. Comm. on Automatic Control, 65 Profsoyuznaya Street, 117806 Moscow GSP-7, Union of Soviet Socialist Republics.

19–21. **Bar-Ilan Symposium on the Foundations of Artificial Intelligence**, Bar-Ilan University, Ramat Gan, Israel. (February 1989, p. 179)

19–22. **Fourth Annual Conference on Structure in Complexity Theory**, University of Oregon, Eugene, Oregon. (December 1988, p. 1588)

19–23. **1989 International Symposium on the Mathematical Theory of Networks and Systems (MTNS-89)**, Amsterdam, The Netherlands. (October 1988, p. 1244)

19–24. **Harmonizable Fields and Related Topics**, Marseille, France. (February 1989, p. 179)

*19–July 14. **US-USSR Algebraic Geometry Symposium**, The University of Chicago, Chicago, Illinois.

PURPOSE: The main purpose of the symposium is to assemble as strong a group of algebraic geometers as possible from each of the two countries and to do all that is possible to allow them to work together for a substantial amount of time.
CONFERENCE TOPICS: Different broad areas of algebraic geometry will be emphasized during different phases of the symposium. The main emphasis of the first week will be arithmetic algebraic geometry. The second week is tentatively scheduled to emphasize applications to physics, K-theory, and representation theory.
INFORMATION: J. P. May, The University of Chicago Mathematical Disciplines Center, 5734 University Avenue, Chicago, Illinois 60637.

20–22. **1989 National Educational Computing Conference (NECC '89)**, Boston, Massachusetts. (October 1988, p. 1244)

21–23. **Thirty-second Meeting of the Society for Natural Philosophy on Geometrical and Toplogical Methods in Mechanics**, Calgary, Canada. (December 1988, p. 1588)

25–28. **Western Regional Meeting of the Biometric Society (WNAR) and the Institute of Mathematical Statistics**, Davis, California. (January 1989, p. 68)

*25–30. **NSF-CBMS Conference on Circuit Complexity**, University of Chicago, Chicago, Illinois.

LECTURER: M. Sipser.
INFORMATION: J. Simon, Department of Computer Science, University of Chicago, Chicago, Illinois 60637, 312-702-3488.

25–July 1. **18th Conference on Stochastic Processes and Their Applications**, University of Wisconsin-Madison, Madison, Wisconsin. (January 1989, p. 68)

*26–28. **Workshop on Feasible Mathematics**, Cornell University, Ithaca, New York.

PURPOSE: This workshop will gather together researchers from various disciplines to discuss the state of the art in this area.
CONFERENCE TOPICS: Possible topics include polynomial-time logics, bounded versions of arithmetic and lambda calculus, proof theory of feasible systems, feasible polymorphic languages, and polynomial time versions of algebra and analysis.
INVITED SPEAKERS: M. Ajtai; L. Blum; S. Buss; P. Clote; J. Crossley; S. Cook; J-Y, Girard, Y. Gurevich; K-I. Ko; D. Leivant; A. Nerode; J. Remmel; A. Scedrov; P. Scott; G. Takeuti; A. Urquhart.
INFORMATION: For more information on the scientific program, contact S. Buss, Department of Mathematics, University of California at San Diego, La Jolla, California 92093, 619-534-6455 or P. Scott, Department of Mathematics, University of Ottawa, Ontario, Canada K1N 6N5, 613-564-5884. To attend the workshop, contact the Mathematical Sciences Research Institute, 201 Caldwell Hall, Cornell University, Ithaca, New York 14853, 607-255-7740, 8005, or 7763. (Note: Limited funding is available for partial support of predoctoral and young postdoctoral attendees.)

26–28. **Qualitative Theory of Vector Fields**, Centre de Recherches Mathématiques (CRM) Université de Montréal. (January 1989, p. 68)

*26–29. **IFAC/IMACS/IFIP Symposium on Control of Distributed Parameter Systems**, Perpignan, France.

INFORMATION: A. El Jai, Lab. d'Automatique IMP du CNRS, Université de Perpignan, 50 Avenue de Villeneuve, F-66000 Perpignan, France.

26–29. **ICOSAHOM '89: International Conference on Spectral and High Order Methods for Partial Differential Equations**, Como, Italy. (February 1989, p. 179)

*26–30. **NSF-CBMS Conference on Scientific Computation**, Butler University, Indianapolis, Indiana.

LECTURER: R. S. Varga.
INFORMATION: A. Carpenter, Department of Mathematics, Butler University, Indianapolis, Indiana 46208, 317-283-9436.

*26–30. **Short Course on the Mathematics of Computer Graphics**, Carleton College, Northfield, Minnesota.

SPONSOR: North Central Section of the Mathematical Association of America.
PRINCIPAL LECTURER: J. Goldfeather.
PROGRAM: There will be a short course on computer graphics together with several invited lectures and contributed papers.
INFORMATION: S. Galovich, Department of Mathematics and Computer Science, Carleton College, Northfield, Minnesota 55057.

*26–30. **AAECC-7 International Conference**, P. Sabatier University, Toulouse.

CONFERENCE TOPICS: Error Correcting Codes (theory and applications) and Computational Algebra and Geometry.
INFORMATION: A. Poli, Lab. AAECC/LSI, P. Sabatier University, 118 route de Narbonne, 31062 Toulouse cedex (F).

26–30. **Centenaire Halpen**, Marseille, France. (February 1989, p. 179)

26–30. **Workshop on Symbol Manipulation**, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (February 1989, p. 179)

27–30. **Second Conference of the International Federation of Classification Societies (IFCS)**, Charlottesville, Virginia. (October 1988, p. 1244)

July 1989

***Logic at Botik '89: A Seminar on Logical Foundations of Computer Science**, Pereslavl-Zalessky, Union of Soviet Socialist Republics.

INFORMATION: Logic at Botik '89, Post Office Box 11, Program Systems Institute of the Union of Soviet Socialist Republics Academy of Sciences, 152140 Pereslavl-Zalessky, Union of Soviet Socialist Republics.

2–7. **Fourth Gregynog Symposium on Differential Equations**, Gregynog Conference Center, University of Wales, United Kingdom. (December 1988, p. 1588)

2–8. **Twelfth International Conference on General Relativity and Gravitation**, Boulder, Colorado. (February 1989, p. 179)

2–16. **Fifth Workshop on Nonlinear Evolution Equations and Dynamical Systems**, Kolymbari near Chania, Crete. (November 1988, p. 1386)

*3–7. **IFAC/IMACS/IFORS International Symposium on Advanced Information Processing in Automatic Control**, CRAN, Nancy, France.

INFORMATION: CRAN-IFAC Congress Secretary, Faculte des Sciences - B.P. 239, 54506 Vandoeuvre Cedex, France.

3–7. **NSF-CBMS Regional Research Conference in the Mathematical Sciences: Harmonic Analysis and Real Function Spaces**, Auburn University, Auburn University, Alabama. (February 1989, p. 179)

3–7. **Annual General Meeting of the Australian Mathematical Society**, Macquarie University, Sydney, New South Wales, Australia. (December 1988, p. 1589)

3–7. **The Third Hungarian Colloquium on Limit Theorems in Probability and Statistics**, Sopron, Hungary. (November 1988, p. 1386)

3–7. **Computational Ordinary Differential Equations**, London, England. (April 1988, p. 638)

3–7. **Fourteenth IFIP Conference on System Modelling and Optimization**, Leipzig, German Democratic Republic. (November 1988, p. 1386)

3–7. **International Category Theory Meeting 1989**, Bangor, Wales, United Kingdom. (November 1988, p. 1386)

3–7. **Fourth International Conference on the Teaching of Mathematical Modeling and Applications**, Roskilde University Centre, Denmark. (November 1988, p. 1386)

3–7. **Twelfth British Combinatorial Conference**, Norwich, England. (November 1988, p. 1386)

3–7. **International Symposium on Approximation, Optimization, and Computing**, Dalian University of Technology, Dalian, China. (November 1988, p. 1386)

3–11. **CIME Course on Microlocal Analysis and Applications**, Villa "La Quercetа," Montecatini Terme (Pistoia), Italy. (January 1989, p. 68)

*3–13. **Surfaces Minimales**, Marseille, France.

CHAIRMAN: A. Rosenberg, Paris.
INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

3–21. **SMS-NATO ASI: Fractal Geometry and Analysis**, Université de Montréal, Montréal, Canada. (January 1989, p. 68)

*5–7. **Workshop on Hardware Specification, Verification and Synthesis: Mathematical Aspects**, Cornell University, Ithaca, New York.

PURPOSE: This workshop will present current research into formal methods for hardware design. The goal of research into formal methods for hardware design is to develop methods for improving the design process and the quality of the resulting designs.
INVITED SPEAKERS: D. Basin; G. Birtwistle; R. Bryant; R. Campesano; S-K. Chin, E. Clarke; W. Hunt; S. Johnson; J. Joyce; C. Lengauer; P. Lowenstein; A. Martin; G. Milne; M. Sheeran; M. K. Srivas; P. A. Subramanyam; D. Weise.
INFORMATION: For more information on the scientific program, contact G. Brown, 406 Phillips Hall, Cornell University, Ithaca, New York 14853, 607-255-8804. To attend the workshop, contact the Mathematical Sciences Institute, 201 Caldwell Hall, Cornell University, Ithaca, New York 14853, 607-255-7740, 8005, or 7763. (Note: Limited funding is available for partial support of predoctoral and young postdoctoral attendees.)

5–19. **Microprogram on Noncommutative Rings**, Berkeley, California. (February 1989, p. 180)

*6–9. **Third Mathematicians and Education Reform Network Workshop**, University of Minnesota, Minneapolis.

ORGANIZERS: The MER Network, supported by a grant from the National Science Foundation, is directed by P. Wagreich, University of Illinois at Chicago, and H. B. Keynes, University of Minnesota.
PURPOSE: The aim of the network is to strengthen ties among mathematicians involved in precollege educational activities and to encourage more mathematicians to become active in educational projects at the precollege level.
INFORMATION: N. Fisher, Associate Director, MER Network, University of Illinois at Chicago, Office of Mathematics and Computer Education (M/C 249), Box 4348, Chicago, Illinois 60680, 312-996-2439.

10. **Tutorial Short Courses**, Trinity College, Dublin, Ireland. (November 1988, p. 1386)

10–14. **Fifteenth Australasian Conference on Combinatorial Mathematics and Computing**, University of Queensland, Brisbane, Australia. (November 1988, p. 1386)

10–21. **NATO Advanced Study Institute: Computation of Curves and Surfaces, Puerto de la Cruz**, Canary Islands, Spain. (February 1989, p. 180)

10–21. **Microprogram on Noncommutative Rings**, Mathematical Sciences Research Institute, Berkeley, California. (May/June 1988, p. 731)

10–30. **AMS Summer Research Institute on Several Complex Variables and Complex Geometry**, University of California, Santa Cruz, California.

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

10–September 1. **IMA Summer Program in Robustness, Diagnostics, Computing and Graphics in Statistics**, Institute for Mathematics and its Applications, Minneapolis, Minnnesota. (December 1988, p. 1589)

11–14. **The Sixth International Conference on Numerical Analysis of Semiconductor Devices and Integrated Circuits**, Trinity College, Dublin, Ireland. (November 1988, p. 1387)

12–14. **Robotics: Applied Mathematics and Computational Aspects**, Loughborough, England. (February 1989, p. 180)

16–29. **1989 NATO Advanced Study Institute: Fourier Analysis and its Applications**, Tuscany, Italy. (February 1989, p. 180)

*17–21. **NSF-CBMS Conference on Algebraic Ideas in Ergodic Theory**, University of Washington, Seattle, Washington.

LECTURER: K. Schmidt.
INFORMATION: D. Lind, Department of Mathematics, University of Washington, Seattle, Washington 98195, 206-543-1723.

17–21. **SIAM Annual Meeting**, San Diego, California. (November 1988, p. 1387)

* 17–22. **Journées Arithmétiques**, Marseille, France.

CHAIRMAN: G. Lachaud, Marseille.
INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

17–August 4. **Conference on Matrix Theory for Applications**, University of Wyoming, Laramie, Wyoming. (December 1988, p. 1589)

* 19–22. **Workshop on Mathematical Theory of Modern Financial Markets**, Cornell University, Ithaca, New York.

PURPOSE: This workshop will focus on how mathematical research has contributed to the understanding of financial markets. The approach will be theoretical and, therefore, of interest primarily to researchers involved in probability and financial theory.
TOPICS: Optimal consumption; portfolio management; mathematical models of financial markets, including arbitrage and martingale measures.
INVITED SPEAKERS: P. Artzner; K. Back; T. Cover; F. Delbaen; D. Duffie; P. Dybvig; H. Föllmer; T. Ho; C.-F. Huang; R. Jarrow; I. Karatzas; T. Kurtz; J. Lehoczky; A. Morton; S. Pliska; P. Protter; S. Richard; S. Shreve; C. Stricker; W. Willinger.
INFORMATION: For more information on the scientific program, contact D. Heath, 318 Upson, Cornell University, Ithaca, New York 14853, 607-255-9125. To attend the workshop, contact the Mathematical Sciences Institute, 201 Caldwell Hall, Cornell University, Ithaca, New York 14853, 607-255-7740, 8005, or 7763. (Note: Limited funding is available for partial support of predoctoral and young postdoctoral attendees.)

* 23–24. **Conference on Logic and Linguistics**, University of Arizona, Tucson, Arizona.

PURPOSE: The conference, held in conjunction with the LSA/MLA Linguistic Institute, will focus on theoretical interactions of linguistics and logic.
PROGRAM COMMITTEE: D. T. Langendoen; V. McGee; R. T. Oehrle; J. L. Pollock.
CALL FOR PAPERS: The deadline for submission of one-page abstracts of contributed papers is April 1, 1989.
INFORMATION : R. T. Oehrle, Department of Linguistics, Douglass 200E, University of Arizona, Tucson, Arizona 85721.

24–27. **Gauss Symposium on Mathematics and Theoretical Physics**, Guarujá, SP, Brazil. (November 1988, p. 1387)

* 24–29. **NSF-CBMS Conference on Heat Equations in Geometry**, University of Hawaii, Honolulu, Hawaii.

LECTURER: R. S. Hamilton.
INFORMATION: J. Weiner, Department of Mathematics, University of Hawaii, Honolulu, Hawaii 96822, 808-948-8595.

* 24–August 5. **1989 European Summer Meeting of the Association for Symbolic Logic**, West Berlin. (Please note date change from November 1988, p. 1387)

27–29. **International Symposium on Cauchy and the French Mathematical World**, Paris, France. (November 1988, p. 1387)

* 28–September 1. **Homologie des Groupes et K-Theorie: Applications Geometriques**, Marseille, France.

CHAIRMEN: M. Cathelineau, Nice; P. Cartier, Palaiseau; J. Dupont, Aarhus; M. Sah, Stony Brook.
INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

29–August 12. **Conference on Groups–Saint Andrews 1989**, Saint Andrews, Scotland. (December 1988, p. 1589)

30–August 12. **Harmonic Analysis on Reductive Groups**, Bowdoin College, Brunswick, Maine. (January 1988, p. 160)

31–August 4. **Sixteenth Annual Conference on Computer Graphics and Interactive Techniques**, Boston, Massachusetts. (December 1988, p. 1590)

31–August 4. **Thirty-ninth Gordon Research Conference on Statistics in Chemistry and Chemical Engineering**, New Hampton, New Hampshire. (October 1988, p. 1245)

August 1989

1–9. **Eighteenth International Congress of the History of Science**, Hamburg, 1–5; Munich, 6–9, Federal Republic of Germany. (April 1988, p. 639)

* 2–5. **Seventh International Congress on Mathematical and Computer Modeling**, Chicago, Illinois.

CALL FOR PAPERS: Send two copies of abstracts (300 words for full-length papers, 100 words for short reports) to the address given below.
INFORMATION: Xavier J. R. Avula, Department of Mechanical and Aerospace Engineering, University of Missouri-Rolla, Rolla, Missouri 65401, 314-341-4661.

6–7. **AMS Short Course on Cryptology and Computational Number Theory**, Boulder, Colorado.

INFORMATION: M. Foulkes, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

6–10. **1989 Joint Statistical Meetings**, Washington, District of Columbia. (March 1988, p. 466)

* 6–12. **Kommutative Algebra Und Algebraische Geometrie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: E. Kunz, Regensburg; H.-J. Nastold, Münster; L. Szpiro, Paris.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

7. **AMS-SIAM-SMB Symposium on Some Mathematical Questions in Biology: Sex Allocation and Sex Change, Experiments and Models**, University of Toronto, Toronto, Ontario, Canada. (February 1989, p. 181)

* 7–11. **Thirteenth Johns Hopkins Mathematical Sciences Summer Lecture Series**, Johns Hopkins University, Baltimore, Maryland.

PRINCIPAL SPEAKER: A. F. Veinott, Jr., Lattice Programming.
INFORMATION: J. Pang, Department of Mathematical Sciences, Maryland Hall, Johns Hopkins University, Baltimore, Maryland 21218, 301-338-7216.

7–11. **Fourth International Seminar on Random Graphs and Probabilistic Methods in Combinatorics and Computer**

Science, Poznan, Poland. (November 1988, p. 1387)

7–17. **Annual CMS Seminar: Lie Theory, Differential Equations and Representation Theory**, Centre de Recherches Mathématiques (CRM) Université de Montréal. (January 1989, p. 69)

10–12. **International Conference on Computational Techniques and Applications**, Brisbane, Australia. (February 1989, p. 181)

* 13–18. **Fifth International Conference on Stochastic Programming**, University of Michigan, Ann Arbor, Michigan.

PROGRAM: This conference will focus on stochastic programming theory and applications with particular emphasis on computation. A tutorial session will introduce new investigators and users to the field.
CALL FOR PAPERS: Anyone wishing to submit a paper should send a title and abstract by March 31, 1989, to the address below.
INFORMATION: J. R. Birge, Department of Industrial and Operations Engineering, 1205 Beal, the University of Michigan, Ann Arbor, Michigan 48109-2117, 313-764-9422.

* 13–19. **Kombinatorische Und Reell Algebraische Geometrie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: E. Becker, Dortmund; A. Dress, Bielefeld; J. Wills, Siegen.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

* 13–19. **Combinatorical Convexity and Algebraic Geometry**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: G. Ewald, Bochum; P. McMullen, London; R. Stanley, Cambridge.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

13–19. **Colloquium on Universal Algebra**, Szeged, Hungary. (November 1988, p. 1387)

13–19. **Fourth Conference on Differential Equations and Applications**, Rousse, Bulgaria. (May/June 1988, p. 731)

* 16–September 2. **Nineteenth Summer Session on Probability Theory**, Saint-Flour (Cantal), France.

INVITED SPEAKERS: D. L. Burkholder, University of Illinois at Urbana-Champaign; E. Pardoux, Université de Provence (Aix-Marseille I); A. S. Sznitman, Courant Institute of Mathematical Sciences.
CONFERENCE TOPICS: Explorations in martingale theory and its applications; nonlinear filtering and the associated stochastic partial differential equations; propagation of chaos.
INFORMATION: P. L. Hennequin, Mathématiques Appliquées F63177 Aubiere Cedex. Telephone: 73.26.41.10, Poste 34-07.

20–24. **Ninth Annual Crypto Conference**, University of California at Santa Barbara, Santa Barbara, California. (February 1989, p. 181)

20–25. **Second Conference of the Canadian Number Theory Association**, University of British Columbia, Vancouver, Canada. (December 1988, p. 1590)

20–26. **Eleventh International Joint Conference on Artificial Intelligence**, Detroit, Michigan. (October 1988, p. 1245)

20–September 6. **Nineteenth Ecole d'ete de Calcul des Probabilities**, Saint-Flour, Cantal. (March 1988, p. 466)

21–24. **International Conference on Recent Developments in Statistical Data Analysis and Inference In Honor of C. R. Rao**, Neuchâtel, Switzerland. (November 1988, p. 1387)

* 21–25. **International Conference on Algebra in Memory of A. I. Mal'tsev**, Novosibirsk, Union of Soviet Socialist Republics.

ORGANIZERS: Institute of Mathematics of the Siberian Branch of the Academy of Sciences of the USSR and Novosibirsk State University.
INFORMATION: Novosibirsk State University, 90, Ul. Pirogov, 2, 630090, Novosibirsk, Union of Soviet Socialist Republics. Telephone: 65-62-44.

21–25. **EQUADIFF 7**, Prague, Czechoslovakia. (February 1989, p. 181)

21–25. **First Canadian Conference on Computational Geometry**, McGill University, Montreal, Quebec, Canada. (February 1989, p. 181)

* 24–26. **Twenty-fourth Actuarial Research Conference**, Concordia University, Montréal, Canada.

SPONSOR: The Society of Actuaries.
PROGRAM: The intent is to include preliminary reports on the research projects recently funded by the Society of Actuaries.
CALL FOR PAPERS: The deadline for abstracts of contributed papers is July 1, 1989.
INFORMATION: J. Garrido, Twenty-fourth Actuarial Research Conference, Department of Mathematics and Statistics, Concordia University, 1455 De Maisonneuve Boulevard W, Montréal, Quebec, H3G 1M8, Canada. Telephone: 514-848-3222.

* 24–September 1. **NSF-CBMS Conference on Singular Integral Operators**, University of Montana, Missoula, Montana.

LECTURER: F. Michael Christ.
INFORMATION: W. Derrick, Department of Mathematics, University of Montana, Missoula, Montana 59812, 406-243-5569.

* 28–31. **IFAC/IFORS/IMACS Symposium on Large Scale Systems: Theory and Application**, Berlin, German Democratic Republic.

INFORMATION: H. Fuchs, Academy of Sciences of the German Democratic Republic, Kurstrasse 33, D-1086 Berlin, German Democratic Republic.

* 28–September 1. **Homologie des Groupes et K-Theorie: Applications Geometriques**, Marseille, France.

CHAIRMEN: M. Cathelineau, Nice; P. Cartier, Palaiseau; J. Dupont, Aarhus; M. Sah, Stony Brook.
INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

28–September 1. **International Conference on Symplectic Geometry and Computational Hamiltonian Dynamics**, Beijing, China. (January 1989, p. 69)

28–September 1. **IFIP 89: Eleventh World Computer Conference**, San Francisco, California. (April 1988, p. 639)

28–September 2. **Second International Conference on Function Spaces**, Poznań, Poland. (November 1988, p. 1387)

28–September 8. **Topical Meeting on Variational Problems in Analysis**, Trieste, Italy. (October 1988, p. 1245)

29–September 6. **Forty-seventh Session of the International Statistical Institute**, Paris, France. (April 1988, p. 639)

September 1989

1–10. **Summer School of Algebra and Ordered Sets**, The Jeseniky Mountains, Czechoslovakia. (January 1989, p. 69)

* 4–8. **Twelfth CNMAC Brazilian Congress on Computational and Applied Mathematics**, São José Do Rio Preto, São Paulo State, Brazil.

PROGRAM: The meeting will consist of minicourses, plenary lectures and minisymposia (still to be scheduled) and contributed papers. All papers must be mailed to the address given below by the end of May 1989.
INFORMATION: Twelfth CNMAC, Instituto De Matematica, 9500 Bento Goncalves, 91500 Porto Alegre RS Brazil.

4–8. **Centenary Workshop of Heun's Equation: Theory and Applications**, Rottach-Egern, Federal Republic of Germany. (November 1988, p. 1388)

4–8. **Colloquium on Computational Number Theory**, Debrecen, Hungary. (November 1988, p. 1388)

* 5–8. **Third European Simulation Congress**, Edinburgh, Scotland.

INFORMATION: United Kingdom Simulation Council, c/o D. J. Murray-Smith, Department of Electronics and Electrical Engineering, University of Glasgow, Glasgow G12 800, Scotland, United Kingdom.

5–15. **Opening Workshop: An Introduction to Dynamical Systems**, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (December 1988, p. 1590)

6–8. **Fourteenth Symposium on Operations Research**, Universität Ulm, Federal Republic of Germany. (January 1989, p. 70)

8–14. **COSMEX '89: International Conference on Stochastic Methods in Experimental Sciences**, Technical University of Wroclaw, Poland. (November 1988, p. 1388)

* 11–13. **Supercomputers: Emerging Applications in Manufacturing**, Minneapolis, Minnesota.

INFORMATION: Program Review Committee, Minnesota Supercomputer Center, Inc., 1200 Washington Avenue South, Minneapolis, Minnesota 55415, 612-626-1888.

* 11–14. **Analyse des Donnes**, Antibes, France.

INFORMATION: Institut National de Recherche en Informatique et en Automatique, Domaine de Voluceau, Rocquencourt, F-78153 Le Chesnay cedex.

* 11–15. **Journées de Probabilités**, Marseille, France.

CHAIRMAN: J. Azema, Paris.
INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

11–15. **Fifth International Conference on Numerical Methods in Engineering**, Lausanne, Switzerland. (November 1988, p. 1388)

11–16. **Trends in Functional Analysis and Approximation Theory**, Acqua Fredda di Maratea (Potenza), Italy. (February 1989, p. 182)

16–October 20. **Sixth World Congress on Medical Information**, Beijing, China. (April 1988, p. 639)

17–22. **The ICME Conference on the Popularization of Mathematics**, Leeds, England. (January 1989, p. 70)

18–21. **Traffic Theories for New Telecommunications Services**, Adelaide, Australia. (November 1988, p. 1388)

18–21. **SIAM Conference on Mathematics of Geophysical Sciences**, Houston, Texas. (November 1988, p. 1388)

* 18–22. **Bifurcations et Orbites Periodiques des Champs de Vecteurs du Plan**, Marseille, France.

CHAIRMEN: R. Roussarie, Dijon; J. P. Francoise, Paris.
INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

18–23. **Conference on Integral Equations and Inverse Problems**, Varna, Bulgaria. (November 1988, p. 1388)

* 19–23. **1830–1930 Un Siecle de Geometrie, De C. F. Gauss et B. Riemann A. H. Poincaré et E. Cartan: Epistemologie et Histoire**, Paris, France.

CHAIRMEN: A. Chenciner, Paris; C. Houzel, Paris; J. Petitot, Paris; B. Teissier, Paris.
INFORMATION: L. Boi, Centre d'Analyse et de Mathématiques Sociales, Ecole des Hautes Etudes en Sciences Sociales, 54 Boulevard Raspail, F-75270 Paris, Cedex 06.

21–22. **Mathematics in the Car Industry**, Warwick, England. (November 1988, p. 1388)

* 24–30. **Kryptographie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: A. M. Odlyzko, Murray Hill; C. P. Schnorr, Frankfurt; A. Shamir, Rehovot.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

* 24–October 6. **Extrapolation et Approximation Rationelle**, Marseille, France.

CHAIRMAN: C. Brezinski, Lille.
INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

* 25–27. **SSA-IMACS 1989 Biennial Conference on Modelling and Simulation**, Canberra, Australia.

CONFERENCE TOPICS: Air quality modelling; bushfire modelling; ecosystem modelling; modelling for forestry and agriculture; catchment modelling; groundwater modelling.
INFORMATION: SSA-89 Secretariat, A. J. Jakeman, Centre for Resource and Environmental Studies, Australian National University, GPO Box 4, Canberra ACT 2601, Australia. Telephone: (062) 49 4277.

* 25–28. **SIAM Conference on Mathematical and Computational Issues in Geophysical Fluid and Solid Mechanics**, Houston, Texas.

CONFERENCE THEMES: Systems of Conservation Laws; Reactive Flow; Fluid and Solid Mechanics of Geological Materials; Partial Differental Equations of Geosciences; Wave Propagation and Materials Response.
CALL FOR PAPERS: A brief description of each talk, not exceeding 100 words,

must be submitted on a SIAM abstract form, which can obtained from the address given below. A contributed presentation consists of a 17-minute talk, followed by three minutes of questions. The deadline for abstracts is April 12, 1989.
INFORMATION: SIAM Conference Coordinator, 117 S. 17th Street, 14th Floor, Philadelphia, Pennsylvania 19103, 215-564-2929.

25–29. **Third International Conference on the Theory of Groups and Related Topics**, Australian National University, Canberra. (May/June 1988, p. 732)

26–28. **Third International Workshop on Distributed Algorithms**, La Colle-sur-Loup, France. (February 1989, p. 182)

* 29–October 1. **Sixth IFAC/IFIP/IFORS /IMACS Symposium on Information Control Problems in Manufacturing Technology**, Madrid, Spain.

CONFERENCE PURPOSE: The aim of the symposium is to present, discuss, and summarize research on new theories, as well as advanced applications, of automatic systems used in Computer Integrated Manufacturing.
INFORMATION: E. A. Puente, Head of Systems Engineering Department, UPM, Jose Gutierrez Abascal 2, E-28006 Madrid, Spain.

October 1989

*2–6. **IMACS-GAMM International Symposium on Computer Arithmetic and Self-Validating Numerical Methods**, University of Basel, Basel, Switzerland. (Please note date change from November 1988, p. 1388)

INFORMATION: C. Ullrich, Institut fur Informatik, Universitat Basel, Mittlere Strasse 142, CH-4056 Basel, Switzerland.

* 4–6. **Geometry and Mathematical Physics: John H. Barrett Memorial Lectures**, The University of Tennessee, Knoxville, Tennessee.

INVITED SPEAKERS: M. F. Atiyah; I. M. Singer; C. Taubes; K. Uhlenbeck.
PROGRAM: The lectures are aimed to cover both a survey of developments in mathematical physics and geometry in recent years as well as material of current research. A one-hour lecture will be presented by each of the four speakers on each of the three days.
INFORMATION: H. Simpson, G. Baker, R. Svirsky, Department of Mathematics, the University of Tennessee, Knoxville, Tennessee 37996-1300, 615-974-4261, 974-2461, or 974-4350.

12–14. **Second Interdisciplinary Conference on Natural Resource Modeling and Analysis**, Florida State University, Tallahassee, Florida. (January 1989, p. 70)

15–18. **Fourth International Workshop on High-Level Synthesis**, Kennebunkport, Maine. (December 1988, p. 1590)

16–20. **Sixth World Congress on Medical Informatics**, Beijing, China. (February 1989, p. 182)

16–20. **Workshop: Patterns and Dynamics in Reactive Media**, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (February 1989, p. 182)

20–24. **Hamiltonian Systems, Transformation Groups and Special Transform Methods**, Centre de Recherches Mathématiques (CRM) Université de Montréal. (January 1989, p. 70)

21–22. **Eastern Section Meeting of the AMS**, Stevens Institute of Technology, Hoboken, New Jersey. (May/June 1988, p. 732)

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

* 23–26. **Beijing International Conference on System Simulation and Scientific Computing**, Beijing, China.

INFORMATION: BICSC Conference Secretary Group, Automatic Control Department, Beijing Institute of Aeronautics and Astronautics, Beijing 100083, China.

26–28. **The Riccati Equation In Control, Systems and Signals**, Villa Gallia, Como, Italy. (January 1989, p. 70)

27–28. **Central Section Meeting of the AMS**, Ball State University, Muncie, Indiana. (May/June 1988, p. 732)

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

* 29–November 4. **Computational Methods in Solid Mechanics**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: D. Braess, Bochum; P. Ciarlet, Paris; E. Stein, Hannover.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

* 30–November 2. **Workshop on Homotopy Theory**, Mathematical Sciences Research Institute, Berkeley, California.

PROGRAM: This is the first of three workshops planned as part of MSRI's yearlong 1989-1990 program on Algebraic Topology and its Applications.
ORGANIZER: G. Carlsson.
INFORMATION: I. Kaplansky, Director, Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley, California 94720.

* 30–December 1. **College on Differential Geometry**, Trieste, Italy.

CHAIRMEN: J. P. Bourgignon; B. Lawson; M. Do Carmo; R. Tribuzy.
INFORMATION: International Center for Theoretical Physics, Post Office Box 586, Miramare, Strada Costiera 11, I-34100 Trieste.

November 1989

* 2–4. **Second Annual Conference on Technology in Collegiate Mathematics**, The Ohio State University, Columbus, Ohio.

PROGRAM: The conference will feature lectures by nationally recognized technology innovators, papers describing current work in colleges across the United States, workshops, and minicourses.
CALL FOR PAPERS: Individuals wishing to present a paper at the conference should send a one-page abstract and two self-addressed, stamped envelopes to the address below by June 1, 1989. Papers accepted for presentation will be included in the Conference Proceedings. Papers are restricted to at most four pages in length.
INFORMATION: F. Demana and B. Waits, 1989 Technology Conference, the Ohio State University Department of Mathematics, 231 W. 18th Avenue, Columbus, Ohio 43210.

6–10. **SIAM Conference on Applied Geometry**, Tempe, Arizona. (November 1988, p. 1388)

* 6–10. **SIAM Conference on Geometric Design**, Tempe, Arizona.

ORGANIZER: R. E. Barnhill, Arizona State University.
CALL FOR PAPERS: The deadline for abstracts is June 1, 1989.
CONFERENCE TOPICS: Teleological modeling; computer graphics; parametric curves and surfaces in CAGD; images of matrices; domain processing and manipulation; surface fitting and other related subjects.
INVITED SPEAKERS: A. Barr, California Institute of Technology; P. J. Davis, Brown University; R. Farouki, IBM; D. Gossard, Massachusetts Institute of Technology; J. Gregory, Brunel University; C. Moler, Ardent Computer Corporation; J. Rice, Purdue University; L. Schumaker, Vanderbilt University; T. Sederberg, Brigham Young University; P. Wilson, General Electric; M. Wozny, Rensselaer Polytechnic Institute.
INFORMATION: SIAM Conference Coordinator, 117 S. 17th Street, 14th Floor, Philadelphia, Pennsylvania 19103-5052, 215-564-2929.

13–17. **Workshop: Dynamical Issues in Combustion Theory**, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (December 1988, p. 1591)

18–19. **Far Western Section Meeting of the AMS**, University of California, Los Angeles.

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

December 1989

* 10–16. **Asymptotic Methods for Computer-Intensive Procedures in Statistics**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: R. Beran, Berkeley; D. W. Müller, Heidelberg.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

* 11–13. **Fourth SIAM Conference on Parallel Processing for Scientific Computing**, Chicago, Illinois.

CONFERENCE TOPICS: Massively parallel computing; visualization of scientific computation; tools for parallel algorithm development, and other related subjects.
INVITED SPEAKERS: W. D. Hillis, The Thinking Machines Corporation; J. Sethian, University of California, Berkeley; A. Egolf, United Technologies Research Center; K. A. Winkler, Los Alamos National Laboratory; A van Dam, Brown University; W. Goddard, California Institute of Technology; D. B. Gannon, Indiana University, Bloomington; K. Kennedy, Rice University; D. Gelernter, Yale University.
ORGANIZER: J. J. Dongarra, Argonnne National Laboratory.
ABSTRACT DEADLINE: June 1, 1989.
INFORMATION: SIAM Conference Coordinator, 117 S. 17th Street, 14th Floor, Philadelphia, Pennsylvania 19103-5052, 215-564-2929.

* 17–23. **Theory and Numerical Methods for Initial-Boundary Value Problems**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: H. O. Kreiss, Los Angeles; J. Lorenz, Pasadena.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

January 1990

* 1–6. **Zeitreihenanalyse**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: P. L. Davies, Essen; J. Franke, Berlin; G. Neuhaus, Hamburg.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

* 7–13. **Mathematische Optimierung**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: B. Korte, Bonn; K. Ritter, München.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

* 14–20. **Nonlinear Evolution Equations, Solitons and the Inverse Scattering Transform**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: M. J. Ablowitz, Potsdam; B. Fuchssteiner, Paderborn; M. Kruskal, Princeton.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

17–20. **96th Annual Meeting of the AMS**, Louisville, Kentucky. (April 1987, p. 553)

INFORMATION: H. Daly, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02940.

* 21–27. **Modelltheorie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: L. van den Dries, Urbana; A. Prestel, Konstantz; P. Roquette, Heidelberg.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

* 28–February 3. **Regelungstheorie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: H. W. Knobloch, Würzburg; M. Thoma, Hannover.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

February 1990

* 4–10. **Funktiontheoretische Methoden Bei Partiellen Differential Und Integralgleichungen**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: H. Begehr, Berlin; E. Meister, Darmstadt.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

* 4–10. **Nukleare Frechet-Räume**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: E. Dubinsky, Potsdam; R. Meise, Düsseldorf; D. Vogt, Wuppertal.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

* 11–17. **Funktiontheorie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: F. Gehring, Ann Arbor; E. Mues, Hannover; Ch. Pommerenke, Berlin.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

* 18–24. **Mathematische Modelle in Der Biologie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: W. Alt, Bonn; K. P. Hadeler, Tübingen; U. an der Heiden, Witten.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

* 25–March 3. **Eigenwertaufgaben In Natur Und Ingenieurwissensachaften Und Ihre Numerische Behandlung**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: J. Albrecht, Clausthal; L. Collatz, Hamburg; P. Hagedorn, Darmstadt; W. Velte, Würzburg.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

March 1990

* 4–10. **Interval Methods for Numerical Computation**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: O. E. Lanford, Zürich; A. Neumaier, Freiburg.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

5–7. **SIAM Conference on Applied Probability in Science and Engineering**, New Orleans, Louisiana. (November 1988, p. 1389)

* 11–17. **Mathematische Stochastik**, Oberwolfach, Federal Republic of Germany.

CHAIRMAN: H. Föllmer, Bonn.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

16–17. **Central Section Meeting of the AMS**, Kansas State University, Manhattan, Kansas.

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

* 18–24. **Masstheorie**, Oberwolfach, Federal Republic of Germany.

CHAIRMAN: D. Kölzow, Erlangen.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

18–24. **Third Centenary Celebration of the Mathematische Gesellschaft in Hamburg**, Bundesstraße, Hamburg. (January 1989, p. 71)

* 25–31. **Kontinuumsmechanik der Festen Körper**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: G. Herrmann, Stanford; H. Lippmann, München.
INFORMATION: Mathematisches Forschungsinstitut Oberwolfach Geschäftsstelle: Alberstrasse 24 D-7800 Freiburg im Breisgau.

May 1990

21–25. **Eleventh United States National Congress of Applied Mechanics**, Tucson, Arizona. (November 1988, p. 1389)

25–31. **Tenth International Conference on Pattern Recognition**, Resorts Hotel, Atlantic City, New Jersey. (March 1988, p. 466)

June 1990

6–12. **1990 Barcelona Conference on Algebraic Topology**, Centre de Recerca Matematica, Barcelona, Spain. (September 1988, p. 1060)

* 11–14. **World Organization of Systems and Cybernetics Eighth International Congress**, New York, New York.

INFORMATION: C. V. Negoita, Congress Chairman, Department of Computer Science, Hunter College, City University of New York, 695 Park Avenue, New York, New York 10021.

* 13–15. **Seventh Annual Quality and Productivity Research Conference**, Madison, Wisconsin.

INFORMATION: T. J. Snodgrass, Department of Engineering Professional Development, 801 Extension Building, University of Wisconsin, Madison, Wisconsin 53706, 608-263-3371.

* 18–20. **Joint WNAR-IMS Regional Meeting**, Montana State University, Bozeman, Montana.

INFORMATION: WNAR information from G. Morris Southward, Department of Experimental Statistics, New Mexico State University, Las Cruces, New Mexico 88003, 505-646-2936. IMS information from L. Billard, Department of Statistics and Computer Science, University of Georgia, Athens, Georgia 30602, 404-542-5232.

July 1990

* 1–18. **Twentieth Summer Session on Probability Theory**, Saint-Flour (Cantal), France.

INVITED SPEAKERS: D. Donoho, University of California, Berkeley; M. Friedlin, University of Maryland; J. F. Legall, Université de Paris VI.
CONFERENCE TOPICS: Open problems related to statistical applications; large deviations and nonlinear differential equations; fine analysis of Brownian motion.
INFORMATION: P. L. Hennequin, Mathématiques Appliquées, F63177 Aubiere Cedex. Telephone: 73.26.41.10, Poste 34-07.

16–20. **SIAM Annual Meeting**, Chicago, Illinois. (November 1988, p. 1389)

August 1990

6–9. **1990 Joint Statistical Meetings**, Anaheim, California. (March 1988, p. 466)

8–11. **93rd Summer Meeting of the AMS**, Ohio State University, Columbus, Ohio.

INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

12–18. **Pre-Congress Topology Conference**, University of Hawaii, Honolulu, Hawaii. (February 1989, p. 183)

21–29. **The International Congress of Mathematicians 1990**, Kyoto, Japan. (November 1988, p. 1389)

* 28–30. **IMACS European Simulation Meeting on Problem Solving by Simulation**, Esztergom, Hungary.

INFORMATION: A. Javor, Central Research Institute for Physics of the Hungarian Academy of Sciences, H-1525 Budapest 114, Post Office Box 49, Hungary.

September 1990

* **Neuronet-90: IMACS International Symposium on Neural Nets and Neural Computers**, Prague, Czechoslovakia.

INFORMATION: V. Hamata, General Computing Center, Czechoslovak Academy of Sciences, 182 07 Prague 8, Post Office Box 5, Czechoslovakia.

* **IMACS Symposium on Modelling and Simulation of Electrical Machines**, ENSEM - Nancy, France.

INFORMATION: J. Robert, Institut Monteflore, B-28, Sart Tilman, B-4000 Liege, Belgium or R. LeDoeuff, ENSEM 2, Rue de la Citadelle, BP850-54100 Nancy, France.

* 3–6. **Fourth Asian Logic Conference**, Tokyo, Japan.

CALL FOR PAPERS: Submissions to the conference are invited from areas relating to mathematical logic. The deadline for submissions will be March 1990.

INFORMATION: Send all correspondence, including requests for further information, to K. Kakehi, Department of Mathematics, Waseda University, 3-4-1 Okubo, Shinjuku-ku, Tokyo, 160, Japan.

* 3–7. **IMACS Symposium on Intelligent Models in Systems Simulation**, Brussels, Belgium.

INFORMATION: S. Tzafestas, National Technical University of Athens, Division of Computer Science, Department of Electrical Engineering, 157 73 Zographou, Athens, Greece.

November 1990

2–3. **Central Section Meeting of the AMS**, University of North Texas, Denton, Texas.

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

December 1990

3–7. **1990 Australasian Conference on Combinatorics**, Palmerstown North, New Zealand. (February 1989, p. 183)

January 1991

16–19. **97th Annual Meeting of the AMS**, San Francisco, California.

INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

July 1991

8–12. **Second International Conference on Industrial and Applied Mathematics**, Washington, District of Columbia. (November 1988, p. 1389)

* 22–26. **Thirteenth IMACS World Congress on Computing and Applied Mathematics**, Trinity College, Dublin University, Dublin, Ireland.

INFORMATION: J. H. Miller, University of Dublin, School of Mathematics, 39 Trinity College, Dublin 2, Ireland.

August 1991

8–11. **94th Summer Meeting of the AMS**, University of Maine, Orono, Maine.

INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

19–22. **1991 Joint Statistical Meetings**, Atlanta, Georgia. (March 1988, p. 466)

January 1992

8–11. **98th Annual Meeting of the AMS**, Baltimore, Maryland.

INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

June 1992

* 29–July 1. **Joint Meeting with the London Mathematical Society**, Cambridge, England.

INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

January 1993

13–16. **99th Annual Meeting of the AMS**, San Antonio, Texas.

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

January 1994

5–8. **100th Annual Meeting of the AMS**, Cincinnati, Ohio.

INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

New AMS Publications

ABELIAN GROUP THEORY
Laszlo Fuchs, Rüdiger Göbel, and Phillip Schultz, Editors
(Contemporary Mathematics, Volume 87)

The traditional biennial international conference of abelian group theorists was held in August, 1987 at the University of Western Australia in Perth. With some 40 participants from five continents, the conference yielded a variety of papers indicating the healthy state of the field and showing the significant advances made in many areas since the last such conference in Oberwolfach in 1985. This volume brings together the papers presented at the Perth conference, together with a few others submitted by those unable to attend.

The first section of the book is concerned with the structure of p-groups. It begins with a survey on H. Ulm's contributions to abelian group theory and related areas and also describes the surprising interaction between set theory and the structure of abelian p-groups. Another group of papers focuses on automorphism groups and the endomorphism rings of abelian groups. The book also examines various aspects of torsion-free groups, including the theory of their structure and torsion-free groups with many automorphisms. After one paper on mixed groups, the volume closes with a group of papers dealing with properties of modules which generalize corresponding properties of abelian groups.

Contents

1980 *Mathematics Subject Classifications*: 20KXX, 06B15, 13C05, 16A21, 16A65
ISBN 0-8218-5068-7, LC 89-163
ISSN 0271-4132
312 pages (softcover),
Individual member $20, List price $33,
Institutional member $26
To order, please specify CONM/87N

LARGE DERIVATIONS, FREE ENERGY FUNCTIONAL AND QUASI-POTENTIAL FOR A MEAN FIELD MODEL OF INTERACTING DIFFUSIONS
D. A. Dawson and J. Gärtner
(Memoirs of the AMS, Number 398)

Large exchangeable systems of reversible diffusions in R^d with mean field interaction serve as useful models for studying the dynamical aspects of the phenomena of phase transitions, tunneling, and metastability in statistical physics. The nonlinear McKean-Vlasov equation describes the limiting behavior of the empirical measure process in a fixed time interval as the number of particles increases to infinity.

The objective of this work is to study large deviations for such systems in order to investigate such dynamical behavior as metastability in longer time scales. The main result deals with the relationship between the quasipotential, which is related to the large deviation behavior of the nonequilibrium dynamics, and the free energy functional, which is related to the equilibrium distribution of the system. The quasipotential of a measure with repect to a stable stationary state of the McKean-Vlasov equation is obtained by minimizing the action along all paths joining the stationary state to the measure. The authors show that this quasipotential coincides with the domain of attraction of the stationary state with additive constant. Moreover, they establish that the time reversed trajectory of the McKean-Vlasov dynamics attains the minimum action. These results make precise the heuristic fact that the free energy functional serves as a potential for the McKean-Vlasov dynamics with respect to a weak Riemannian structure on the space of probability measures on R^d, viewed as an infinite-dimensional manifold.

Contents

1980 *Mathematics Subject Classifications*: 60K35, 60F10; 82A05
ISBN 0-8218-2461-9, LC 89-164
ISSN 0065-9266
100 pages (softcover), March 1989
Individual member $8, List price $13,
Institutional member $10
To order, please specify MEMO/398N

SEMICLASSICAL THEORY OF SHAPE RESONANCES IN QUANTUM MECHANICS

P. D. Hislop and I. M. Sigal

(Memoirs of the AMS, Number 399)

Semiclassical methods have helped greatly to expand understanding of the discrete spectrum of Schrödinger operators. Recently, these methods have been combined with geometric perturbation theory and the method of spectral deformation in order to study the spectral resonances of certain Schrödinger operators. These resonances describe metastable states of a physical system: they behave as localized bound states over short time periods, but are coupled to the continuum and therefore eventually move off to infinity.

This work focuses on one example of resonances, that of shape resonances, which are formed by potentials that are attractive inside a compact set and repulsive outside of it. In this case, the coupling to the continuum is achieved by quantum mechanical tunneling through the potential barrier. In the classical limit—which corresponds to the situation in which the height of the barrier becomes infinite—all tunneling is suppressed, and the analogous quantum mechanical system, described by a Hamiltonian H_0, has eigenvalues embedded in its continuous spectrum. As soon as the coupling is restored by lowering the height of the barrier, these eigenvalues disappear.

By comparing this approximate Hamiltonian H_0 to the full Hamiltonian H in the semiclassical regime of small Planck's constant, the authors show that the embedded eigenvalues of H_0 move into the lower half of the complex plane and become spectral resonances of H. Moreover, they prove that the imaginary part of these resonances, which has the physical interpretation of the inverse of the lifetime of the state, is exponentially small. The exponential factor has a geometric interpretation: it is the geodesic distance, in the Agmon metric associated with the potential, through which the particle must tunnel in order to become free. This is the multidimensional generalization of the one-dimensional result obtained by the WKB theory.

Contents

1980 *Mathematics Subject Classifications*: 81C12, 35J10; 81F99
ISBN 0-8218-2462-7, LC 89-182
ISSN 0065-9266
132 pages (softcover), March 1989
Individual member $10, List price $16,
Institutional member $13
To order, please specify MEMO/399N

SCATTERING OPERATOR, EISENSTEIN SERIES, INNER PRODUCT FORMULA AND "MAASS-SELBERG" RELATIONS FOR KLEINIAN GROUPS

Nikolaos Mandouvalos

(Memoirs of the AMS, Number 400)

In this work, the author introduces and studies the Eisenstein series and scattering operator for Kleinian groups. He also formulates and proves the inner product formula and the "Maass-Selberg" relations for Kleinian groups. Two different points of view in the present theory are particularly emphasized. The first considers the theory as part of the Selberg-Langlands program concerning the analytic continuation of Eisenstein series for nonarithmetic groups. The second point of view is related to the spectral theory of certain hyperbolic manifolds. This spectral theory becomes, in light of Thurston's work, especially significant in the case of 3-dimensional manifolds. The techniques the author has developed also form the main ingredients for producing a trace formula and a zeta function for such groups.

Contents

1980 *Mathematics Subject Classifications*: 10D20, 11F72, 58G25, 35P25; 30F40, 22E40, 53C20
ISBN 0-8218-2463-5, LC 89-180
ISSN 0065-9266
96 pages (softcover), March 1989
Individual member $8, List price $13,
Institutional member $10
To order, please specify MEMO/400N

PROBABILISTIC PROBLEMS OF DISCRETE MATHEMATICS

V. F. Kolchin, Editor

(Proceedings of the Steklov Institute, Volume 177)

The papers in this collection are devoted to probabilistic questions in discrete mathematics and focus mainly on three areas: random mappings of finite sets, problems connected with the polynomial distribution, and the theory of branching processes.

Contents

1980 *Mathematics Subject Classifications*: 05, 15, 20, 40, 41, 60, 62; 12, 13, 26, 43, 82
ISBN 0-8218-3123-2, LC 88-36875
ISSN 0081-5438
224 pages (softcover), March 1989
Individual member $59, List price $98,
Institutional member $78
To order, please specify STEKLO/177N

SPACE MAPPINGS WITH BOUNDED DISTORTION

Yu. G. Reshetnyak

(Translations of Mathematical Monographs, Volume 73)

This book is intended for researchers and students concerned with questions in analysis and function theory. The author

provides an exposition of the main results obtained in recent years by Soviet and other mathematicians in the theory of mappings with bounded distortion, an active direction in contemporary mathematics. The mathematical tools presented can be applied to a broad spectrum of problems that go beyond the context of the main topic of investigation. For a number of questions in the theory of partial differential equations and the theory of functions with generalized derivatives, this is the first time they have appeared in an internationally distributed monograph.

Contents

1980 *Mathematics Subject Classifications*: 30-02, 30C60; 30C20, 30C35, 30C85, 46E35, 53B20, 31B15, 35J99, 53A30
ISBN 0-8218-4526-8, LC 89-72
ISSN 0065-9282
380 pages (hardcover), March 1989
Individual member $77, List price $129,
Institutional member $103
To order, please specify MMONO/73N

SOME MAJOR RESEARCH DEPARTMENTS OF MATHEMATICS
Saunders Mac Lane

With a biting wit and an engaging manner, Saunders Mac Lane, elder statesman of the American mathematical community, provides a historical perspective on the development of mathematics research departments in this country in this videotaped presentation. Starting with Berlin at the turn of the century and Göttingen in the 1930s, Mac Lane chronicles the influence of these departments on the development of mathematics in this country. He describes the strengths of some of the most influential American departments and evaluates the theory of "mathematical inheritance" as a method of building an excellent research department. He also provides interesting commentary on such issues as "objective rankings" of departments, some science policy issues, and the ills of calculus textbooks. In addition, Mac Lane's well-known affinity for verse comes into play as he enlivens the lecture with a number of humorous poems illustrating various themes in his talk.

1980 *Mathematics Subject Classification*: 01
VHS format, approx. one hour, March 1989
Price $59
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GEORG CANTOR: THE BATTLE FOR TRANSFINITE SET THEORY
Joseph W. Dauben

In this lively and engaging videotaped lecture, Dauben presents a fascinating look at Georg Cantor and the development of transfinite set theory. Dauben traces the evolution of Cantorian set theory with an emphasis on the opposition it met from Cantor's contemporaries. This meticulously researched lecture covers the mathematical, technical, philosophical, theological, and even psychological aspects of Cantor's struggle. Dauben describes Cantor's mental illness, the personal and mathematical attacks he endured, and his single-minded approach to his work. The use of photographs and other illustrations bring the subject to life as Dauben paints a gripping portrait of the brilliant but tormented life of Georg Cantor.

1980 *Mathematics Subject Classifications*: 01, 00
VHS format, approx. one hour, March 1989
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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 W. Beals (1991), Sylvain E. Cappell (1991), and Michael E. Taylor (1991) were appointed by Past President G. D. Mostow to the *Editorial Board for Contemporary Mathematics*. Daniel M. Burns, Jr. (1989) was appointed chairman. Continuing members of the committee are David Eisenbud (1989), Jonathan Goodman (1990), Gerald J. Janusz (1989), and Jan Mycielski (1990).

Boris Schein has been appointed by President William Browder to the *Advisory Committee for the Russian-English Dictionary*. Continuing members of the committee are Joseph N. Bernstein, Ralph P. Boas, chairman, James R. Bunch, Courtney S. Coleman, Joseph L. Doob, Bogdan Dudzik, Eugene Dynkin, Mark I. Freidlin, Paul R. Halmos, Edwin Hewitt, John R. Isbell, John McCarthy, Boris Mityagin, Eric John Fyfe Primrose, Lawrence A. Shepp, and Ben Silver (ex officio).

President William Browder has appointed Morris W. Hirsch (1990), Rhonda J. Hughes (1990), and Irwin Kra (1990) to the *Committee on Committees*. Continuing members of the committee are William Browder (ex officio) and Robert M. Fossum (ex officio).

Hugh L. Montgomery (AMS), David P. Roselle (MAA), Mary Ellen Rudin (MAA), and Peter Sarnak (AMS) have been appointed by Presidents William Browder (AMS) and Lida K. Barrett (MAA) to the *Joint Program Committee for the Louisville Meeting*. Professor Sarnak will serve as chairman.

Reports of Past Meetings

The October Meeting in Lawrence

The eight-hundred-and-forty-fifth meeting of the American Mathematical Society was held at the University of Kansas in Lawrence, Kansas on Friday, October 28, and Saturday, October 29, 1988. There were 333 registrants, including 289 members of the Society.

Invited Addresses

By invitation of the Committee to Select Hour Speakers for Central Sectional Meetings, there were four invited one-hour addresses as follows: BJØRN DAHLBERG, Washington University, *Elliptic boundary value problems in nonsmooth domains*, introduced by JILL PIPHER, STEVEN E. HURDER, University of Illinois at Chicago, *Geometry and the index theory of foliations*, introduced by NORBERTO SALINAS, PETER SCOTT, University of Michigan, Ann Arbor, *Least area surfaces in 3-manifolds*, introduced by DARRYL MCCULLOUGH, and SIDNEY M. WEBSTER, University of Minnesota, Minneapolis, *The integrability problems of complex analysis*, introduced by CHARLES HIMMELBERG.

Special Sessions

By invitation of the same committee, there were twelve special sessions of selected twenty-minute papers. The topics, organizers, and speakers follow: *Partial differential equations – Geometric theory*, ANDREW ACKER, Wichita State University. Speakers included Andrew Acker, Alan Elcrat, Victor Isakov, Kirk E. Lancaster, Gary Lieberman, Kenneth Miller, Harold R. Parks, George Paulik, Edward W. Stredulinski, Gerhart Stromer, Thomas Vogel, and Henry C. Wente

Geometry and mathematical physics, JOHN K. BEEM, University of Missouri and PHILLIP E. PARKER, Wichita State University. Speakers included Ian M. Anderson, Tevian Dray, G. G. Emch, Paul Ehrlich, Francis J. Flaherty, Gregory J. Galloway, Justin C. Huang, David Lerner, Corrine A. Manogue, Bahram Mashhoon, Adrian Melott, F. R. Miller, David G. Retzloff, John R. Urani, S. Walter Wei, and Steve Wilkinson.

Numerical linear algebra, RALPH BYERS, University of Kansas. Speakers included Gregory S. Ammar, Jessie L. Barlow, Chris Beattie, Michael Berry, Christian H. Bischof, G. A. Geist, William B. Gragg, Nicholas J. Higham, E. R. Jessup, Stephen G. Nash, Alex Pothen, N. H. Rhee, D. C. Sorensen, Daniel B. Szyld, and Robert van de Geijn.

Algebraic geometry, BRUCE CRAUDER and SHELDON KATZ,

Oklahoma State University. Speakers included Donu Arapura, James A. Carlson, Susan Jane Colley, Brucer Crauder, Anthony V. Geramita, Brent B. Gordon, Brian Harbourne, Sheldon Katz, Gary Kennedy, William E. Lang, Gennady Lyubeznik, Juan C. Migliore, A. P. Rao, Roy Smith, and Robert Varley.

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

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

Real analysis, JAMES FORAN, University of Missouri at Kansas. Speakers included Ali Alikani, Edward M. Arnold, Jack B. Brown, P. S. Bullen, Krzysztof Ciesielski, Geraldo De Souza, Chris Freiling, Henry Fast, James Foran, Richard Gibson, B. Garrett, Lee Hart, Hans P. Heinig, Paul D. Humke, Kenneth R. Kellum, Lee Larson, Sandra Meinershagen, Krzysztof Ostaszewski, Gyuri Petruska, Zbigniew Piotrowski, Brian S. Thomson, and Daniel Waterman.

Flat bundles and geometric structures, WILLIAM MARK GOLDMAN, University of Maryland. Speakers included Daniel M. Burns, Jr., James A. Carlson, Suh Young Choi, Yves Carriere, Daniel Gallo, William Goldman, Richard Hain, Yoshinobu Kamishima, Ravi S. Kulkarni, Karl Luttinger, and Larry Lok.

Operator theory and applications to geometry, STEVEN E. HURDER, and NORBERTO SALINAS, University of Kansas. Speakers included Kevin F. Clancey, Jeffrey Fox, James L. Heitsch, Gary R. Jensen, Palle Jorgensen, Franz W. Kamber, Jerome Kaminker, Michael Lamoureaux, Paul S. Muhly, Andrew Rich, Richard Rochberg, Walter Rudin, Philippe Tondeaur, Albert J. L. Sheu, Keren Yan, and Kehe Zhu.

Commutative algebra, DANIEL KATZ and JEFFREY LANG, University of Kansas. Speakers included S. S. Abhyankar, D. D. Anderson, Hara Charalambous, Sangki Choi, Shankar Dutta, John A. Eagon, William Heinzer, Craig Huneke, Melvin Hochester, Bernard Johnston, David Lantz, Gennady Lyubeznik, Stephen McAdam, Matthew Miller, T. T. Noh, Christel Rotthaus, Sunsook Troh, Bernd Ulrich, Roger Wiegand, and Sylvia Wiegand.

Potential theory and partial differential equations in nonsmooth domains, JILL PIPHER, University of Chicago and GREGORY VERCHOTA, University of Illinois at Chicago. Speakers included Christopher J. Bishop, Russell M. Brown, Jonathan Cohen, Eugene Fabes, Robert Fefferman, Carlos E. Kenig, John L. Lewis, Charles Moore, A. M. Murray, Jill Pipher, Zhong-Wei Shen, Gregory Verchota, and Jang-Mei Wu.

3-manifolds, PETER SCOTT, University of Michigan. Speakers included Colin Adams, Mark D. Baker, Dave Gabai, Cameron Gordon, Joel Hass, John Hempel, John Kalliongis, Ravi Kulkarni, D. D. Long, Darryl McCullough, Robert Meyers, Ulrich Oertrel, Alan W. Reid, Martin Scharlemann, Abigail Thompson, and Wilbur Whitten.

Contributed Papers

There were 3 sessions for contrubuted papers. The session times, numbers of papers, and names of presiders follow: Friday afternoon, 1 paper, Sherry Gale of the University of Kansas. Saturday morning, 4 papers, Al Jenab of the University of Kansas. Saturday afternoon, 5 papers, Dave Nelson of the University of Kansas.

Local Arrangements

Local arrangements wer handled by Philip Montgomery of the University of Kansas.

Andy Roy Magid
Associate Secretary
Norman, Oklahoma

The Council Meeting in Phoenix

The Council met at 5:00 p.m. on 10 January 1989 in the Phoenix Ballroom of the Hyatt Regency Hotel. President William Browder was in the chair.

The Council approved the Minutes of Business by mail of 21 December 1988 in which it approved Michael Crandall, D. J. Lewis, and Robert E. L. Turner for membership on the Editorial Committee of *Notices*.

The Council received the report of the Tellers for the 1988 Election. (The results are noted elsewhere in this issue of *Notices*.) It received the report of the Teller for the Election to the Nominating Committee. The new members of the Nominating Committee are

Joan S. Birman
James E. Humphreys
Victor Klee
Alan D. Weinstein

The Council received reports from several committees, among them the Committee on Science Policy, the Committee on Human Rights of Mathematicians, the Committee on Fellowship Policy, the AMS-MAA Committee on Employment and Educational Policy, the AMS-AAAS-MAA Committee on Opportunities in Mathematics for Underrepresented Minorities, the Committee on Election Scheduling (see below), and the Committee to Review Procedures of the Council in Considering Issues.

The Council, on recommendation of the Chairman of the Bulletin Editorial Committee, Roger Howe, authorized the Bulletin Editorial Committee to treat Research Announcements for the Bulletin in a manner in which it feels appropriate, for a period of two years. The Committee proposed a "shift in focus, to more heavily weighted expository values" and this shift has been approved by the Council for a trial period.

In the 1988 Election, the membership approved an amendment to the bylaws that removed the selection of editors from the election ballot to the membership. The selection of editors is now lodged with the Council according to Council action of 5 January 1988. The Council has established an Editorial Boards Committee (EBC) that will be elected by the membership in a manner similar to that in which the Nominating Committee is elected. In the steady state, two members of the EBC are elected by the membership by 10 November of each year. Since the bylaw affecting this change was not in place for the 1988 Election, but is in place now, the manner in which an Editorial Boards Committee should be named was referred to the Council. The Council recommended that the President immediately appoint six members of the EBC, two with terms through 1989, two with terms through 1990, and two with terms through 1991.

The Council supported and endorsed the vision of school mathematics contained in the National Council of Teachers of Mathematics "Curriculum and Evaluation Standards for School Mathematics" by passing the following resolution:

The AMS recognizes and appreciates the quality and quantity of effort of the Working Groups of the Commission on Standards for School Mathematics of the National Council of Teachers of Mathematics. The Society welcomes the proposal of these Standards as a model set of valued outcomes for school mathematics (K-12) and supports and endorses the vision of school mathematics contained in the Standards.

The Society joins in calling for:

i. considerable strengthening of programs to train teachers of school mathematics;

ii. efforts to promote sufficient funding and support by local, state, federal and private sources to ensure that the Standards can be effectively implemented;

iii. active involvement by AMS members in joining with local groups to work for the betterment of school mathematics.

The Council approved participation of the Society for Industrial and Applied Mathematics (SIAM) in the AMS-MAA joint publication **UME** TRENDS, a newsletter for collegiate mathematics.

The Council considered several items from the report of the Committee on Election Scheduling. (A detailed account of this report appears elsewhere in this issue of *Notices*.) It approved the report's recommendation on the term and number of members of the Nominating Committee. The term of office for the Nominating Committee will be three years, the term will begin on September 1 the year after election, and three members will be elected each year.

The Council tabled a motion that would increase the term of office of the Vice-President to three years. The Council agreed to consider further the recommendations in the report at its meeting in April 1989.

The Council heard a report from Kenneth Hoffman, the Head of the Office of Governmental and Public Affairs of the Joint Policy Board for Mathematics. Also, Marcia Sward, the Executive Director of the Mathematical Sciences Education Board, reported on Mathematics Education in the National Spotlight.

The Council and the Board of Trustees have agreed on one new publishing venture and a modification of an already existing series. The Council agreed to establish a series entitled *Proceedings of Regional Conferences of the USSR* that the Board of Trustees had provisionally approved. It agreed to co-publish, with the London Mathematical Society, the series *History of Mathematics*, again following the Board of Trustees' provisional approval.

The Council approved the following resolution (at the request of ArborText, Inc.):

> The Council agrees that orders from South Africa for ArborText, Inc. products sold by the Society be returned to the sender along with a statement that ArborText, Inc. does not allow sales in South Africa.

Finally, the Council agreed with the Board of Trustees to establish

an annual prize to be administered by Pi Mu Epsilon, the national honorary mathematics society, with the stipulation that the name of the Society be associated with the prize.

The Council had recessed for dinner from 7:00 p.m. to 8:00 p.m. and adjourned at 12:50 a.m. the following day.

Robert M. Fossum
Secretary
Urbana, Illinois

The Business Meeting in Phoenix

The Business Meeting was held on 12 January 1989 in the Ballroom of the Civic Plaza immediately following the session for the award of the Bôcher Prize. President Browder was in the chair.

The President announced that Herbert Freedman of the Canadian Mathematical Society had presented the Society with a copy of the Fields Medal struck from the original molds as a gift from the Canadian Mathemtical Society in honor of the Centennial of the Society.

The President then gave the floor to Ronald L. Graham who in turn introduced Dr. Boris Stechkin, member of the Steklov Institute and Secretary of the Soviet Committee of the Bernoulli Society for Mathematical Statistics and the Theory of Probability. In commemoration of the Society's Centennial, Dr. Stechkin presented it with a bronze medal struck in the Soviet Union on the occasion of the First General World Congress on Mathematical Statistics and the Theory of Probability held in Tashkent, Soviet Union, in 1986.

The Secretary reported that Professor Marshall Stone, President 1943-1944, had died earlier that week (see the article in the front of this issue of *Notices*) and that Dr. Gordon Walker, Executive Director of the Society from 1959 to 1977, had died in December 1988 (see page 139 of the February 1989 issue of *Notices*). After brief mention that the Society is embarking on its second century, the Secretary reported on the actions of the Council as detailed above.

The meeting then dissolved itself into a Committee of the Whole, with Andrew Gleason in the chair, to discuss the report to the Council of the Society by the ad hoc Election Scheduling Committee. (This report is discussed elsewhere in this issue of *Notices*.)

After rising from the Committee of the Whole (with no report) and with President Browder in the chair, the Meeting thanked the Local Arrangements Committee for it efforts in arranging the 95th Annual Meeting and then adjourned.

Robert M. Fossum
Secretary
Urbana, Illinois

Election Results of 1988

The Tellers for the 1988 Election reported counting 3741 and 2/3 ballots. The newly elected Vice-President is Sun-Yung Alice Chang. The newly elected Members-at-Large of the Council are Jonathan L. Alperin, Fan R. K. Chung, Lawrence J. Corwin, Michael C. Reed, and Hugo Rossi. The newly elected Trustee is Paul J. Sally, Jr.

All candidates in uncontested elections were elected to their respective offices.

The candidates elected to the Nominating Committee of 1989-1990 are Joan S. Birman, James E. Humphreys, Victor L. Klee, Jr., and Alan D. Weinstein.

The two proposed amendments to the bylaws, the one concerning sexist language and the other concerning the Editorial Boards Committee, were approved.

The composition of the Council for 1989 follows.

COUNCIL FOR 1989

Ex-President
George Daniel Mostow

President
William Browder

Vice Presidents
Sun-Yung Alice Chang
Barry Simon
William P. Thurston

Former Secretary
Everett Pitcher

Secretary
Robert M. Fossum

Associate Secretaries
Joseph A. Cima
W. Wistar Comfort
Andy Roy Magid
Lance W. Small

Treasurer
Franklin P. Peterson

Associate Treasurer
Steve Armentrout

Members-at-Large
Jonathan L. Alperin
Fan R. K. Chung
Lawrence J. Corwin
Richard K. Guy
Rhonda J. Hughes
Robion C. Kirby
Irwin Kra
H. Blaine Lawson, Jr.
Albert Marden
Yiannis N. Moschovakis
Linda A. Ness
Michael C. Reed
Marc A. Rieffel
Hugo Rossi
Harold M. Stark
William A. Veech
Carol S. Wood

Representatives of Committees

Committee to Monitor Problems in Communication
Richard S. Palais, Chairman

AMS Representative, Board of Editors of American Journal of Mathematics
M. Salah Baouendi

Bulletin Editorial Committee
Roger E. Howe, Chairman

Colloquium Editorial Committee
Raoul H. Bott, Chairman

Journal of the AMS Editorial Committee
Michael Artin, Chairman

Mathematical Reviews Editorial Committee
Melvin Hochster, Chairman

Mathematical Surveys Editorial Committee
M. Susan Montgomery, Chairman

Mathematics of Computation Editorial Committee
Walter Gautschi, Chairman

Proceedings Editorial Committee
William J. Davis, Chairman
Andrew Odlyzko

Transactions and Memoirs Editorial Committee
Ronald L. Graham, Chairman

Science Policy Committee
Ronald G. Douglas, Chairman

TRUSTEES FOR 1989
M. Susan Montgomery, Chairman
Ronald L. Graham, Secretary
Franklin P. Peterson, ex officio
Steve Armentrout, ex officio
William Browder, ex officio
Ramesh A. Gangolli
Frederick W. Gehring
Paul J. Sally, Jr.

Miscellaneous

Personal Items

Zhao Yi Chun, of the People's Republic of China, will be a visiting professor at Appalachian State University during the spring semester of 1989. His area of research interest is operator theory.

Lawrence H. Cox, Director, Board on Mathematical Sciences, National Academy of Sciences, has been elected to membership in the International Statistical Institute.

Otomar Hajek, Professor of Mathematics at Case Western Reserve University, has received a joint appointment as Professor of Systems Engineering at this same institution.

Benoit Mandelbrot was one of the joint recipients of the newly created Moet Hennessy-Louis Vuitton (LVMH) Science for Art prize. He was honored for his work in fractal geometry.

Patrick L. Reilly, of Alcatel Network Systems, was appointed a reviewer for *IEEE Transactions on Communications* and listed in *Who's Who in the South and Southwest*, 1989.

Ellen Torrance, formerly of M & R Services, Inc., is now an Associate Actuary at First Colony Life Insurance Company in Lynchburg, Virginia.

Deaths

Elliot T. Adams, of Newtonville, Massachusetts, died on January 3, 1989, at the age of 89. He was a member of the Society for 11 years.

J. Frank Adams, Lowndean Professor of Astronomy and Geometry at the University of Cambridge, died on January 7, 1989, at the age of 58. He was a member of the Society for 31 years. (See the News and Announcements section of this issue of *Notices*.)

Luther Thomas Conner, Jr., Associate Professor Emeritus of the College of William and Mary, died on November 4, 1988, at the age of 56. He was a member of the Society for 23 years.

Ronald J. DiPerna, of the University of California, Berkeley, died on January 8, 1989, at the age of 41. He was a member of the Society for 18 years. (See the News and Announcements section of this issue of *Notices*.)

Manfred Kochen, of Ann Arbor, died on January 7, 1989, at the age of 60. He was a member of the Society for 35 years.

Kenneth P. McDowell, formerly of Wilfred Laurier University, died on September 26, 1988, at the age of 41. He was a member of the Society for 14 years.

Marshall H. Stone, Professor Emeritus of the University of Massachusetts, Amherst, died on January 9, 1989, at the age of 85. He was a member of the Society for 62 years. A memorial service will be held for him on Sunday, April 8, 1989 at the University of Massachusetts, Amherst. For details, please contact T. A. Cook, 413-545-0874, or M. K. Bennett, 413-549-0545, at the Department of Mathematics and Statistics. (See the item at the beginning of this issue of *Notices*.)

New Members of the AMS

ORDINARY MEMBERS

Alexander B Abacus
La Jolla, California

Lara L Aist
Catonsville, Maryland

Alton L Amidon
Havelock, North Carolina

E Ya Arnaudova
Higher Institute of Architecture and Construction
Sofia, Bulgaria

Czeslaw Baginski
University of Warsaw
Bialystok, Poland

Randall K Bahr
Tucson, Arizona

Lucas M Bernard
New York, New York

David P Blecher
University of Houston
Houston, Texas

Dona V Boccio
Bayside, New York

Jerald S Brodkey
Beachwood, Ohio

Alton R Brown
Mitre
McLean, Virginia

Michael J Bryan
Terre Haute, Indiana

Elmer J Bryson
National City, California

I-Liang Chern
New York University, Courant Institute of Mathematical Sciences
New York, New York

Zhong Wu Chu
Harbin Institute of Technology
Harbin, People's Republic of China

Victor V Cifarelli
University of California, San Diego
La Jolla, California

Joseph N Closs
Philadelphia, Pennsylvania

Stéphane Blaise Collart
Zurich, Switzerland

J Kevin Colligan
Silver Spring, Maryland

Manuel De Leon
Consejo Superior de Investigaciones Cientificas
Madrid, Spain

Matthew J Dempsey
St Louis, Missouri

Tong Ren Ding
Peking University
Beijing, People's Republic of China

Do Van Luu
Hanoi, Socialist Republic of Vietnam

Michael A Eckhoff
Bay St Louis, Mississippi

Alexandre Ern
Ecole Polytechnique
Palaiseau, France

Marian Fabian
Prague, Czechoslovakia

Jin Xuan Fang
Nanjing, People's Republic of China

S S Goncharov
Novosibirsk, U S S R

Carol Harris
Lexington, Kentucky

John C Hedreen
Baltimore, Maryland

Robert E Heyman
University of Maryland
College Park, Maryland

Robert N Hightower
Ann Arbor, Michigan

Kris L Holderness
Grand Junction, Colorado

Bruce D Holenstein
Compucon Service
West Chester, Pennsylvania

Askol'd Georgievic Hovanskii
VNIISI
Moscow, U S S R

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San Leandro, California

Paul M Hunt
Williamston, Michigan

Cheryl L Ingram
Joplin, Missouri

Antal Ivanyi
Eotvos Lorand University
Budapest, Hungary

Piotr Jaworski
University of Warsaw
Warsaw, Poland

Nitin S Joshi
Flushing, New York

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Leningrad, U S S R

John F Kinkel
Irvine, California

I A Klipker
Tbilisi, U S S R

Kenneth A Koblun
San Ramon, California

Ulle Kotta
Estonian SSR Academy of Sciences
Tallinn, U S S R

Dimitry A Leites
University of Stockholm
Stockholm, Sweden

S Z Levendorskii
Rostov-on-Don, U S S R

Florence J Lin
Upton, New York

Long Wei Lin
Zhongshan University
Guangzhou, People's Republic of China

Paul R Lowe
Monterey, California

Adam Lozowicki
Szczecin, Poland

Rodney Neal Lynch
Crawfordsville, Indiana

Satyagopol Mandal
University of Kansas
Lawrence, Kansas

Dragan Marusic
Koper, Yugoslavia

Deborah Gibson McAtee
Montana State University
Bozeman, Montana

Phillip E McNeil
Norfolk State University
Norfolk, Virginia

Albert J Milani
University of Wisconsin-Milwaukee
Milwaukee, Wisconsin

Ralph J Money Jr
Bridgeport, Connecticut

Michael S Moore
Pomona, California

Richard P Morris
Centreville, Virginia

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Stanford University
Stanford, California

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State University of New York at Buffalo
Buffalo, New York

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Newton Square, Pennsylvania

David M Obrzut
Laurel, Maryland

Anatol Odzijewicz
Warsaw University
Biatystok, Poland

Haluk Ogmen
University of Houston
Houston, Texas

John Pais
Webster University
St Louis, Missouri

Tim F Parrott
Easley, South Carolina

Cornel Pasnicu
INCREST
Bucharest, Romania

Luca F Pavarino
New York University, Courant Institute of Mathematical Sciences
New York, New York

Wieslaw Pawlucki
Jagiellonian University
Krakow, Poland

Pham Huy Dien
Institute of Mathematics
Hanoi, Socialist Republic of Vietnam

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Sacramento, California

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King of Prussia, Pennsylvania

Charles C Quillen
Gate City, Virginia

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Fudan University
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Yishao Zhou
Royal Institute of Technology
Stockholm, Sweden

Ken C Ziejewski
Chicago, Illinois

Jorge Passamani Zubelli
University of California, Berkeley
Berkeley, California

RECIPROCITY MEMBERS

Allahabad Mathematical Society
M S Mittal
Balasubramanian Natarajan

Deutsche Mathematiker-Vereinigung e. V.
Wilhelm Plesken
Horst R Thieme

Gesellschaft für Angewandte Mathematics und Mechanik
Herbert Niessner

Iranian Mathematical Society
Ali A Alikhani

Sociedade Portuguesa de Matemática
Olga Azenhas

Svenska Matematikersamfundet
Henrik O. Egnell

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Tames Lengyel

Bowdoin College
Susan M L Anderson

Bowling Green State University
Alphonse K A Amey
Gregory A Bastian
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Kaddour Boukaabar
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Scott Alan Mitchell
Claudia M Neuhauser
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Charles M Vuono

Duquesne University
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Florida Atlantic University
Manny B DeCastro
Arumugam Muhundan
Xuegong Wu
Xuan Xu

Franklin & Marshall College
Marjolein de Wit

Harvard University
Eric David Belsley
Srdjan Divac
Kefeng Liu
Michael Liam McQuillan
Luca Migliorini
Wei-Dong Ruan
Jeffrey Silver
Donald C Weitzman

Haverford College
Marc J Melitz

Institute for Defense Analyses
David L desJardins

Loyola Marymount University
Connie J Weeks

Mankato State University
Tim Braam
Shu-Ling Chang
Chien-Chow Chen
Charles J Felber
Chien-Chuan Tang
Shu-Chin W Weng

McMaster University
Anita Bhardwaj
Xiangdong Chen
Yannis Papageorgiou
Peter Teichner
Qiang Zhu

Miami University, Oxford
Jeremy S Case
Joan Elizabeth Hart
David L Stuckey

Michigan State University
Faouzi Azzouz
Richard Weston Beverly
Brian K Bury
Benjamin E Caldwell
Douglas Olaf Carlson
Halil I Celik
Tsyr-Min Chang
Jing-Fen Chen
Dawn Alisha Crumpler
Patrick M Garrity
Cynthia Gwilym
Ming Jin
Stanley S Johnson
Jack A Jordan
Mirjana S Jovovic
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Timothy M Koponen
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SITUATIONS WANTED ADVERTISEMENTS from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-556-7774 and speak to Paula Montella for further information.

SEND AD AND CHECK TO: Advertising Department, Attn: Paula Montella, AMS, P.O. Box 6248, Providence, Rhode Island 02940. AMS location for express delivery packages is 201 Charles Street, Providence, Rhode Island 02904. Individuals are requested to pay in advance, institutions are not required to do so. AMS FAX 401-331-3842.

POSITIONS AVAILABLE

UNIVERSITY OF NEBRASKA-LINCOLN
Department of Mathematics and Statistics
Lincoln, NE 68588-0323

Tenure-track position at the Assistant Professor level (Associate Professor level considered for exceptionally strong cases) available Fall 1989. Ph.D. required with strong potential for research and quality teaching. Subject to the requirement that the candidates be outstanding, preference will be given to candidates in commutative algebra or algebraic geometry, then to candidates in areas related to those already in the department. Send vita and three letters of recommendation to Professor Roger Wiegand, Hiring Committee Chair, Department of Mathematics and Statistics, University of Nebraska-Lincoln, Lincoln, NE 68588-0323. AA/EOE. Application deadline March 3, or until position is filled. Women and minorities are especially encouraged to apply. 402-472-3731

UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE
Department of Mathematics
Charlotte, NC 28223

At least two tenure-track positions at Asst./Assoc./Full Prof. level in Mathematics and Statistics. Rank and salary depend on qualifications. A Ph.D. and a serious commitment to teaching and research are required. Preferred specialties are: Analysis, Algebraic Topology, Control Theory, Numerical Analysis, Smooth Dynamical Systems, Statistics, but strong candidates in other areas are encouraged to apply. Also possible are visiting and lecturer (one or two year renewable; M.A./M.S. required) positions. Send vitae, list of four references, and abstracts of current research to Prof. Ram Tiwari for Statistics position and to Prof. Hae-Soo Oh for all other positions at the above address. Closing date: Feb 3, 1989, but applications will be considered until the positions are filled. UNCC IS AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER.

VIRGINIA TECH

The Department of Mathematics is actively seeking applications in the area of discrete mathematics and combinatorics. We anticipate making several tenure-track appointments at the assistant professor level or above beginning in the fall of 1989. A Ph.D. is required. Applications will be accepted until March 15, 1989, or until a successful candidate is found. A formal letter of application expressing interest, a resume, and names, addresses, and telephone numbers of three references should be sent to Chairman, Discrete Mathematics Search Committee, Department of Mathematics, Virginia Tech, Blacksburg, VA 24061-0123. Virginia Tech is an Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF SOUTH CAROLINA
Department of Mathematics

Applications are invited for anticipated tenure-track faculty positions at all ranks. Applications in all areas of mathematics will be considered. The Department seeks to build on existing research strengths and to increase the scope of its programs, particularly in applied and computational mathematics. Faculty research is supported by excellent in-house library and computing facilities. The Department's computer center supports network access to the University's FPS array processor and 1.024 node hypercube supercomputer. The Ph.D. degree or its equivalent is required, and all appointments will be consistent with the Department's commitment to excellence in research and teaching at the undergraduate and graduate levels. A detailed resume, containing a summary of research accomplishments and goals, and four letters of recommendation should be sent to:

Dr. Colin Bennett, Chairman
Department of Mathematics
University of South Carolina
Columbia, South Carolina 29208

The University of South Carolina is an Affirmative Action/Equal Opportunity Employer.

POSITIONS AVAILABLE

UNIV. OF N.C. AT CHAPEL HILL
Dept. of Mathematics
Chapel Hill, NC 27599

Applications are invited for a senior level tenured appointment in the general area of applied and computational mathematics, effective Fall 1989. Rank and salary depend on qualifications. A Ph.D. and demonstrated excellence in research and teaching are required. Applications will be accepted until the position is filled. Contact Jon Tolle, Mathematics Department, Box 3250 Phillips Hall, UNC at Chapel Hill, Chapel Hill, NC 27599. EO/AA Employer. Women and minorities are encouraged to identity themselves voluntarily.

UNIVERSITY OF ROCHESTER
Department of Mathematics

Several tenure-track positions at all levels will be available beginning September 1989. Applicants showing significant research accomplishments or exceptional research promise, as well as evidence of a commitment to excellent teaching, are invited to apply. Initial tenure-track appointment is for four years. There is no restriction as to field. In addition to a **curriculum vitae**, candidates should send a summary of research plans, available preprints or reprints, and have at least three reference letters sent to:

Samuel Gitler, Chairman
Mathematics Department
University of Rochester
Rochester, New York 14627

An equal opportunity/affirmative action employer.

CANISIUS COLLEGE
Department of Mathematics

A second tenure track position (Assistant Professor) in mathematics is available in late August 1989. Applicants must have a Ph.D. in mathematics and a strong commitment to quality teaching. Salary and fringe benefits are competitive commensurate with credentials and experiences.

Applicants should send resume, transcripts and three letters of recommendation to Dr. Richard Escobales, Chairman, Dept. of Mathematics, Canisius College, Buffalo NY 14208.

The Department is looking to expand its offerings and options while at the same time maintaining its sound preparation for students with mathematical potential. EOE/AA.

POSITIONS AVAILABLE

CASE WESTERN RESERVE UNIVERSITY
Department of Mathematics and Statistics

Tenure-track, possibly senior, positions anticipated to begin August 15, 1989. Outstanding research record and/or proven research potential and teaching excellence required. Preferred areas: statistics and probability (including applications in physics, chemistry and computer science) but candidates in areas of global analysis, dynamical systems, functional analysis, partial differential equations, and numerical analysis will also be considered. Women and minority groups candidates are especially encouraged to apply. Visiting positions in the above areas also possible. Send vita plus three letters of recommendation to Professor W. A. Woyczynski, Chairman, Department of Mathematics and Statistics. Case Western Reserve University, Cleveland, OH 44106. An affirmative action equal opportunity employer.

UNIVERSITY OF OKLAHOMA

Applications are invited for one or more anticipated tenure or tenure-track positions in Mathematics beginning Fall 1989. Candidates must have a Ph.D. degree, demonstrated excellence in research, and potential for high-quality teaching. Strong candidates in all areas will be considered with preference given to research interests compatible with those of our current faculty. Duties include research, normally teaching six hours per semester, and Departmental and University service appropriate to rank. Salary and rank will be commensurate with qualifications and experience. There may also be visiting positions. Applicants should send their vita and have at least three letters of reference sent to **Dr. Darryl McCullough, Search Committee Chair, Department of Mathematics, University of Oklahoma, 601 Elm Avenue, Norman, Oklahoma 73019**. Closing dates are December 15, 1988 and every two weeks thereafter, until the final closing on April 20, 1989. **The University of Oklahoma is an Affirmative Action/Equal Opportunity Employer**.

THE COLLEGE OF INSURANCE POSITION AVAILABLE

The Actuarial Science Department of The College of Insurance invites applications for a full time, tenure track position at the rank of Assistant Professor, beginning September 1, 1989.

A Ph.D. in Mathematics or a related discipline is required as is a demonstrated commitment to teaching excellence. Candidates in Statistics, Probability or a field of Applied Mathematics related to Actuarial Science are particularly encouraged as are those interested in developing and pursuing a career in Actuarial Science.

The College of Insurance is a private, selective institution located in New York City's Financial District. The salary is competitive and the fringe benefits excellent.

Applications will be accepted until the position is filled. Send letter of application, curriculum vitae and letters of recommendation to: S. Ramanujam, Chairman, Actuarial Science Division, The College of Insurance, 101 Murray Street, New York, New York 10007. EOE/AA

FLORIDA INTERNATIONAL UNIVERSITY
The State University of Florida at Miami

The Department of Mathematics announces tenure track positions at the assistant professor level beginning August 1989. Candidates must have a Ph.D. in Mathematics and a commitment to research and quality teaching. Preferred areas of specialization include harmonic analysis, logic, representation theory, several complex variables, and functional analysis. Qualified candidates in other areas will be considered.

Teaching load consists of 15 semester hours per academic year. Send resume and 3 letters of recommendation to Recruitment Committee, Department of Mathematics, Florida International University, Miami, FL 33199.

Florida International University is the State University of Florida at Miami. The University is an equal opportunity/affirmative action employer.

ST. MARY'S COLLEGE OF MARYLAND ST. MARY'S CITY, MARYLAND 20686

St. Mary's College of Maryland invites applications for a one-year sabbatical replacement in mathematics beginning in August 1989. The position may lead to a permanent appointment pending approval of an additional line for mathematics/computer science.

St. Mary's is a four-year state-supported liberal arts college of about 1400 students located 68 miles southeast of Washington, DC. The mathematics faculty consists of five full-time teachers. The program provides a general studies mathematics course for all students and many mathematics and computer science courses for science and mathematics majors. We would like to employ a person with a Ph.D. in mathematics who is interested in teaching undergraduates and willing to teach a wide variety of courses ranging from college algebra to upper-division courses for mathematics majors. Teaching in computer science is also possible. The teaching load is three courses (twelve credits) per semester, and the State of Maryland provides a good package of fringe benefits. St. Mary's College is an AA/EOE employer.

Rank and salary are open. Applications will be considered until the position is filled. Send letter and resume to Dr. Paul Blanchette, Head, Division of Natural Science and Mathematics, St. Mary's College of Maryland, St. Mary's City, Maryland 20686. (301-862-0362)

GEORGIAN COURT COLLEGE

Applications are invited for position at the assistant professor level starting Fall 1989. Ph.D. in mathematics, algebra preferred, other areas considered. Publications and record of successful college teaching essential. Applicant will teach both graduate and undergraduate courses. Tenure-track; salary and fringe benefits competitive. Send letter of application, resume, transcripts, names, addresses and telephone numbers of three references to Chair, Mathematics Department, Georgian Court College, Lakewood, NJ 08701. Georgian Court College is an EO/AA employer.

POSITIONS AVAILABLE

UNIVERSITY OF ALBERTA
Department of Mathematics

Applications are invited for a tenure-track position, in Approximation Theory (File AP-2) at the Assistant or Associate Professor level, beginning July 1, 1989. Requirements are a Ph.D. and proven ability or demonstrated potential for research and teaching. Current salary range is from $33,144 (Canadian) per annum depending upon qualifications. Send vitae and arrange for three letters of reference to be sent to: Professor L. H. Erbe, Chairman, Department of Mathematics, University of Alberta, Edmonton, Canada, T6G 2G1. In accordance with Canadian Immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada. Closing date for applications is April 30, 1989. Please quote file number when responding to this advertisement. The University of Alberta is committed to the principle of equity in employment.

THE CITADEL

Applications are invited for a tenure track position at the assistant or associate level. Qualifications include a Ph.D. in a mathematical science with a strong dedication to undergraduate teaching and a continuing interest in research. Preference will be given to individuals in applied or computational areas of mathematics. Salary negotiable.

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 offer the B.S. and B.A. degrees in mathematics and a B.S. degree in computer science. Please send resume and three letters of reference to Charles E. Cleaver, Head Department of Mathematics/Computer Science, The Citadel, Charleston, S.C. 29409. Review of applications will begin April 15 and continue until position is filled.

Minorities and women are encouraged to apply. The Citadel is an equal opportunity/affirmative action employer.

AMERICAN UNIVERSITY OF BEIRUT

TEACHING OVERSEAS: The Department of Mathematics at the American University of Beirut, Beirut, Lebanon (AUB) invites applications for faculty positions at the level of Assistant Professor, available October 1, 1989, in the following fields: Analysis, Mathematical Statistics (Probability Theory), and Topology.

Applicants should hold the Ph.D. degree in mathematics and will be expected to engage in undergraduate and graduate teaching, as well as research. Postdoctoral experience is preferred.

Appointments are normally made for a three-year period. Interested persons should send a curriculum vitae and three letters of recommendation by March 31, 1989 to: Dean, Faculty of Arts & Sciences, American University of Beirut, c/o New York Office of AUB, 850 Third Avenue, 18th Floor, New York, New York 10022, USA.

AUB is an EO/AA employer.

U.S. passports are presently invalid for travel to, in or through Lebanon, and for residence in Lebanon, by order of the Department of State, and therefore applications from individuals who would travel to reside in Lebanon on a U.S. passport cannot at this time be considered.

VIRGINIA TECH

The Department of Mathematics is actively seeking applications in the area of computational mathematics and numerical analysis. We anticipate making several tenure-track appointments at the assistant professor level or above beginning in the fall of 1989. A Ph.D. is required. Applications will be reviewed as they are received and will be accepted until the positions are filled. A formal letter of application expressing interest, a resume, and the names, addresses, and telephone numbers of three references should be sent to Chairman, Numerical Analysis Search Committee, Department of Mathematics, Virginia Tech, Blacksburg, VA 24061-0123. Virginia Tech is an Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF CALIFORNIA AT BERKELEY
Department of Mathematics
Berkeley, CA 94720
TEMPORARY POSTDOCTORAL POSITIONS

Several temporary positions beginning in Fall 1989 are anticipated for new and recent Ph.D.s of any age, in the areas of algebra, analysis, applied mathematics, foundations, or geometry and topology. The terms of these appointments may range from one to three years. Applicants for NSF or other postdoctoral fellowships are encouraged to apply for these positions; combined teaching/research appointments may be made for up to three years. Mathematicians whose research interests are close to those of regular department members will be given some preference. Send by April 1, 1989, a resume, and reprints, preprints, and/or a dissertation abstract. Ask three people to send letters of recommendation to Marc A. Rieffel, Vice Chair for Faculty Affairs, at the above address. (Applications received for our earlier January 15, 1989, deadline will automatically be considered for this deadline also.) The University of California is an Equal Opportunity/Affirmative Action Employer.

AUGUSTANA COLLEGE

MATHEMATICS: Augustana College (South Dakota) invites applications for an Assistant Professor of Mathematics. Two year appointment with possible conversion to tenure track. Teach undergraduate mathematics courses, lower and upper division courses and involvement in student research projects. Exact assignment will depend on qualifications. Ph.D. in Mathematics, or ABD preferred. Masters degree required. A commitment to the mission of a church-related liberal arts college expected. Preference given to applications received prior to April 1, 1989. Send letter of application, vita, complete graduate transcripts (direct from registrar's office), names, telephone numbers, an identities of at least three current references, and a statement of personal and professional goals to: Jeanne Kruse, Administrative Assistant, Augustana College, Sioux Falls, SD 57197. EOE/AA employer.

POSITIONS AVAILABLE

UNIVERSITY OF NORTH TEXAS
DIRECTOR
TEXAS ACADEMY OF MATHEMATICS AND SCIENCE

The University of North Texas invites nominations and applications for the position of director of the Texas Academy of Mathematics and Science to begin August 1, 1989.

The Texas Legislature established the Texas Academy of Mathematics and Science in 1988 within the University of North Texas in Denton. The Academy is a two-year, public, coeducational, tuition-free institution which functions as an early admission program for Texas high school students who are particularly talented in science and mathematics.

A maximum of 200 students who have completed the tenth grade can be accepted on a competitive basis each year. The curriculum consists of freshman and sophomore university courses taught by full-time University of North Texas faculty and provides the students with a rigorous program in science and mathematics and innovative study in the humanities. Graduates receive a high school diploma as well as two years of university credits. The Academy students are in residence at the University of North Texas campus. The University of North Texas is an emerging national research institution in the vibrant and rapidly expanding Dallas-Fort Worth metropolitan area with over 700 regular faculty and over 24,000 students.

Applicants should hold a Ph.D. preferably in science or mathematics, have earned tenure at the University level, and be willing to give long-term commitment to working with talented young freshmen. The duties of the director will include student recruitment, resource development and fund raising, working with constituents external to the university—local, state and national, overall curriculum development and the general direction and leadership of the Academy. Salary will be on a 12-month basis and will be commensurate with qualifications and experience. Applications should include a letter of interest, resume, and the names, addresses and phone numbers of three to five references to:

Jean B. Schaake, Chair; TAMS Search Committee, College of Arts and Sciences, University of North Texas, P.O. Box 5187, Denton, Texas 76203.

Review of applications will begin April 1, 1989, and continue until the position is filled.

The University of North Texas is an Affirmative Action/Equal Opportunity Employer.

UNIVERSITY OF OKLAHOMA
CHAIRPERSON
DEPARTMENT OF MATHEMATICS

Nominations and applications are invited for the position of Chairperson in the Department of Mathematics effective Fall, 1989. Candidates must possess an earned doctorate, a substantial record of research achievement, a commitment to excellence in teaching, and leadership and administrative abilities appropriate to a growing department that is dedicated to a balanced program of quality research and teaching. The Mathematics Department has over thirty faculty members, most of whom are actively involved in research, and offers programs for the bachelors, masters, and Ph.D. degrees. There is also an extensive program of scientific activity supplemented by a substantial endowment for discretionary funds. Candidates should send a cover letter, vita, selected reprints, and arrange to have four letters of reference (including at least one concerning administrative abilities) sent to: Dr. Kevin Grasse, Chair Search Committee, Department of Mathematics, 602 Elm-Phsc 423, Norman, Oklahoma 73019. Phone 405-325-2903.

Closing dates for applications are March 15, 1989, and every two weeks thereafter until either the position is filled or the final closing date of June 1, 1989. The University of Oklahoma is an Affirmative Action/Equal Opportunity Employer.

THE UNIVERSITY OF TOLEDO
DEAN
College of Arts and Sciences

The College of Arts and Sciences at The University of Toledo seeks a new dean. The college enrolls 5,224 students in 19 departments and offers seven doctoral programs. The University of Toledo is the fourth largest public university in Ohio with a total enrollment of 22,086 in 8 colleges with 21 doctoral programs, including the J.D. and Pharm.D. It is a member of the National Association of State Universities and Land Grant Colleges.

Candidates should have an earned Ph.D. in one of the disciplines in the college, substantial teaching and research experience. They should be prepared to lead the college to continued growth in the quality of instruction and the volume of research.

Salary is negotiable. The position is available on July 1, 1989. Nominations and applications should be sent to:

Dr. William N. Free
Vice President for Academic Affairs
THE UNIVERSITY OF TOLEDO
Toledo, OH 43606

The University of Toledo is an Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF CALIFORNIA
DEPARTMENT OF MATHEMATICS
RIVERSIDE, CALIFORNIA

Applications are invited for temporary faculty positions beginning in September 1989. These positions are funded at the Assistant Professor level, but there is some slight flexibility in salary. They are open to applicants from all research areas within Mathematics and Computer Science with significant accomplishments or high potential in both research and teaching.

Candidates should send a vita and arrange for at least three letters of recommendation to be sent to: John de Pillis, Chair, Search Committee, Department of Mathematics and Computer Science, University of California, Riverside, CA 92521. The University of California is an Equal Opportunity/Affirmative Action Employer.

POSITIONS AVAILABLE

THE CATHOLIC UNIVERSITY OF AMERICA
Mathematics Department
Washington, DC 20064

Several *Assistant Professor* positions are expected subject to final budgetary approval. All are tenure track with salary $27,000 to $30,000 for 8.5 month to teach undergrad. and grad. courses in Mathematics 3 courses per semester starting 9-1-89. Requirements: Ph.D. in Mathematics with good research potential and dedication to teaching. All areas of mathematics are of interest. Send resume, graduate transcripts, and letters of recommendation to: *Dr. P. Saworotnow, Search Committee Chairman, Mathematics Department, CUA, tel.* 202-635-5222. Dealine: April 7, 1989, or until positions are filled.

CUA is an AA/EO employer. Applications from women and minority group members are encouraged.

THE WITCHITA STATE UNIVERSITY
Wichita, KS 67208

Professor Stephen W. Brady, Search Committee Chairman Department of Mathematics and Statistics
Assistant Professor tenure eligible position starting August 1989. Specialization in Complex Analysis and Several Complex Variables will be given special consideration. All areas of Applied Mathematics will be considered. A Ph.D. in Mathematics is required. Candidate is expected to be active in research, participate in the doctoral program, and have a strong interest in teaching. Salary competitive. Send application letter, detailed resume, and arrange to have three reference letters sent. Deadline March 15, 1989, then monthly until position is filled. The Wichita State University is an Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF WISCONSIN-MADISON
Department of Mathematics
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, 1989. 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 noncredit 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 March 1, 1989. 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.
Note: The Immigration Reform and Control Act of 1986 requires the University to verify the identity and work authorization of the successful applicant. Offer of employment is contingent upon verification.

POSTE EN MATHEMATIQUES APPLIQUES

Le Département de mathématiques et de statistique sollicite des candidatures pour un poste de professeur en mathématiques appliquées. Les tâches principales sont:
-Professeur au Département de mathématiques et de statistique;
-Enseignement aux trois cycles et encadrement d'étudiants;
-Recherche et direction d'étudiants des 2e et 3e cycles;
-Participation au fonctionnement général du Département.
Critère de sélection:
-Le candidat devra posséder un doctorat en mathématiques ou dans une discipline connexe, avec une orientation marquée en mathématiques appliquées.
-L'aptitude du candidat à développer de nouveaux axes de recherche ou à s'intégrer aux secteurs forts déjà existants (analyse numérique, mécanique des milieux continus, optimisation) sera considérée comme un atout majeur tout comme un intérêt marqué pour le recherche pluridisciplinaire.
-Le candidat devra être apte à dispenser, en langue française, des cours s'adressant à une clientèle variée composée, non seulement d'étudiants en mathématiques mais aussi d'étudiants d'autres secteurs des sciences et du génie.

Conformément aux exigences relatives à l'immigration au Canada, cet avis de concours s'adresse en premier lieu aux citoyen(ne)s canadien(ne)s et aux résident(e)s permanent(e)s du Canada.

Un curriculum vitae doit parvenir avant le 1er mai à l'adresse suivante:

Robert Côté, Directeur
Département de mathématiques
et de statistique
Faculté des sciences et de génie
Pavillon Alexandre Vachon
Université Laval, Québec
G1K 7P4

POSITIONS AVAILABLE

JOHANNES KEPLER UNIVERSITY
Tenured Position of a Full Professor for Symbolic Computation at the Johannes Kepler University in Linz (Austria) (Research Institute for Symbolic Computation)

Applications are invited for a newly created tenured position of a full professor at the School of Technical Sciences, Johannes Kepler University in Linz, Austria. Candidates should have an outstanding research record in at least one of the main areas of symbolic computation (computer algebra, computer analysis, computational geometry, computational logic, automatic programming etc.), a commitment to excellence in graduate teaching, and the ability and willingness to combine, in their field of expertise, mathematical/algorithmic foundations with potential industrial applications (for example, expert systems, geometrical modeling, robot programming, scientific software). Teaching and supervising of students may also be in English. Candidates from foreign countries are explicitly encouraged.

The School of Technical Sciences has installed an independent institute for symbolic computation (RISC-LINZ, Research Institute for Symbolic Computation) with an 8 member faculty under the direction of Prof. Bruno Buchberger. RISC-LINZ operates in close interaction with the Department of Computer Science (a twenty-six member faculty) and the Department of Mathematics (a twenty-two member faculty).

At Johannes Kepler University, the symbolic computation effort is a part of and a major driving force for a planned expansion (by 10 full professorships) of the School of Technical Science in the direction of "mechatronics" (intelligent control of technical production) in close cooperation with Austrian industry.

The new site of RISC-LINZ, a medieval castle 15 minutes from Linz, equipped with excellent computing facilities, combines the advantages of city life with the pleasures of a rural environment in one of the most beautiful landscapes and in the cultural heart of Austria and Europe.

Applicants should send a résumé (together with a few important publications representing the candidates research expertise) to the Dean of the School of Technical Sciences, Prof. Dr. Peter Weiß, Johannes Kepler University, A4040 Linz (Austria). (Telephone Austria (732) 2468-312), by March 31, 1989. Futher information can also be obtained from the Chairman of RISC-LINZ, Prof. Dr. Bruno Buchberger, Johannes Kepler University, A4040 Linz. (Tel: Austria (732) 2468-9219. Electronic mail: K313370@AEARN.bitnet.)

NATIONAL ACADEMY OF SCIENCES
BOARD ON MATHEMATICAL SCIENCES
Senior Program Officer

The BOARD ON MATHEMATICAL SCIENCES is preparing a project to update the 1984 David Report, "Reviewing U.S. Mathematics: Critical Resource for the Future," for the National Science Foundation. The update will analyze the current state of support for research in the mathematical sciences and assess progress against the recommendations of the original David Report. It will go further to briefly scientifically assess the field and identify promising opportunities for interdisciplinary research.

Incumbent will be responsible for organizing and supporting the work of the committee, chaired by Dr. Edward E. David, Jr., former presidential science advisor. Requires excellent organizational, writing, and interpersonal skills and familiarity with mathematical sciences research and issues. A Ph.D. or equivalent experience in a mathematical science is required. The National Research Council is an Equal Opportunity/Affirmative Action Employer.

The closing date is March 15, but applications will be accepted until a suitable candidate is identified. Please submit a resume or cv with salary history and the names of three references to:

NATIONAL RESEARCH COUNCIL
Board on Math Sciences
NAS 312 (LC)
2101 Constitution Ave., N.W.
Washington, DC 20418
EOE

UNIVERSITY OF BRISTOL
England

Under the New Academic Appointments Scheme the University expects to appoint a Professor of Pure Mathematics in the Department of Mathematics from 1 August 1989 or as soon as possible thereafter. Suitable candidates will be considered from any area of pure mathematics. The successful candidate will be expected to provide academic leadership in both teaching and research. It is intended that further expansion in the general research area of the new professor will take place after the appointment.

Applications, including a curriculum vitae and the names and addresses of three referees, should be sent, to arrive not later than 24 March 1989 to the Registrar (for the attention of Nesta Babb), Senate House, University of Bristol, Bristol BS8 1TH, UK, quoting Ref 0188/A. Further particulars can be obtained by Tel: 010-44-272 303030 or FAX: (0272) 251424. For informal enquires, telephone Prof D V Evans on 010-44-272-303532.

THE UNIVERSITY OF ALABAMA
SENIOR POSITION

The department anticipates filling a senior level position (Full Professor or, possibly, senior Associate Professor), to begin August 16, 1989. Applications are invited from mathematicians whose credentials demonstrate excellence in both teaching and research and an ability to provide programmatic leadership. Areas of special interest are: algebra, analysis, continuum mechanics, computational mathematics, differential equations, differential geometry, optimization, stochastic modeling, and toplogy. In the event that a permanent appointment is not made, we also invite applications from visitors. Women and minorities are particularly encouraged to apply. Send a curriculum vitae, a sample of recent reprints and/or preprints, and the names of at least three references to: Professor Alan Hopenwasser, Department of Mathematics, The University of Alabama, Box 870350, Tuscaloosa, AL 35487-0350. The University of Alabama is an Equal Opportunity Employer.

POSITIONS AVAILABLE

UNIVERSITY OF WISCONSIN-SUPERIOR
Mathematical Sciences
Superior, WI 54880

One tenure track position in Mathematics beginning September 1989. A Ph.D. in a Mathematical Science is required. Excellence in teaching and continuing scholarly activity is expected. All areas considered but preference given to areas of analysis or operations research. A Computer Science Option is offered within the department. Computer experience is desirable. Rank and salary are negotiable/competitive. Applications will be accepted until March 15, 1989, or until a successful candidate is found. Submit a formal letter of application expressing interest, a resume, and arrange for three letters of recommendation to be sent to Dr. Ronald Roubal, Division of Sciences and Mathematics, University of Wisconsin-Superior, Superior, WI 54880. AA/EO Employer.

UNIVERSITY OF IOWA
IOWA CITY, IOWA 52242

The Department of Mathematics of the University of Iowa invites applications for at least one tenure-track position, beginning August, 1989. All levels will be considered. Priority will be given to candidates whose presence would complement or strengthen existing research groups or who specialize in harmonic or stochastic analysis. Applicants should send a vita and have three letters of recommendation sent to: William A. Kirk, Chair, Department of Mathematics, University of Iowa, Iowa City, Iowa 52242. By making this appointment the department hopes to attain diversity on the faculty. Minority and women candidates are especially urged to apply. The University of Iowa is an Affirmative Action/Equal Opportunity Employer.

FAIRFIELD UNIVERSITY

The Department invites applications for a tenure track position at the Assistant Professorship level beginning in Sept. 1989. The normal teaching load is 3 courses a semester with some research expected. A Ph.D. in Mathematics is required with teaching competence in Numerical analysis or Statistics desirable. Fairfield is a Jesuit University located on the Connecticut coast 60 minutes from New York City. For full consideration, send curriculum vitae and 3 letters of reference to Joseph B. Dennin, Chair, Department of Mathematics and Computer Science, Fairfield University, Fairfield, CT 06430-7524. Fairfield is an Equal Opportunity/Affirmative Action Employer.

PUBLICATIONS

NEW PUBLICATION

The Red Book: 100 Practice Problems for Undergraduate Mathematics Competitions, compiled with hints and solutions by Kenneth S. Williams and Kenneth Hardy.

Copies of **The Red Book** and its earlier companion **The Green Book** available at $20 per copy from:
Integer Press, P.O. Box 6613, Station J, Ottawa, Ontario, Canada. K2A 3Y7

MATH SCI PRESS, 53 Jordan Rd., Brookline, MA 02146, 617-738-0307. TOPICS IN PHYSICAL GEOMETRY, by R. Hermann. $80. Sale on selected back list titles.

The Foundations of Mathematics Based Upon a Cosmological Constant New to Natural Science By John Lawrence Waters

ABSTRACT

Analysis of the counting process yields the equilibration formula for the natural unity. The author introduces a two dimensional dynamic model for unity which replaces the traditional static segment of the number line. The author constructs the correct mathematical model for natural space.

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TOPOLOGICAL INVARIANTS OF QUASI-ORDINARY SINGULARITIES
by Joseph Lipman

EMBEDDED TOPOLOGICAL CLASSIFICATION OF QUASI-ORDINARY SINGULARITIES
by Yih-Nan Gau

is dedicated to the memory of PETER SCHERK. We regret that this dedication was inadvertently omitted from the book.

American Mathematical Society

Mathematical Research

Combine a self-directed program of mathematical research with participation in team-oriented, interdisciplinary R&D projects by joining MITRE's Signal Processing and Mathematical Research Group.

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Mathematicians in all areas of specialization are invited to apply. Qualifications include a Ph.D. or equivalent in mathematics, superior research ability in a chosen field, and a broad background in many fields of mathematics. Practical knowledge of Fourier analysis, probability, numerical analysis, or statistics would be helpful but is not necessary. U.S. citizenship is required.

To apply submit a curriculum vitae to: Signal Processing and Mathematical Research Group, EO25, The MITRE Corporation, Burlington Rd., Bedford, MA 01730.

To apply for positions in the Washington DC area, write to M.X. Mason, The MITRE Corporation, 7525 Colshire Drive, McLean, VA 22102.

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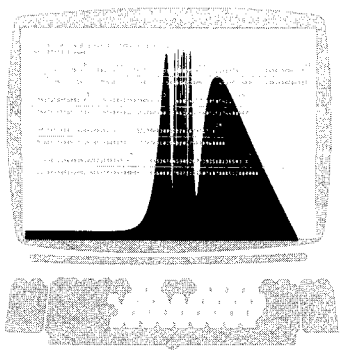

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Computers & Mathematics

June 13 - 17, 1989, MIT, Cambridge, Mass

A conference focusing on the relationship of computers to research and education in the mathematical sciences

The conference will serve as a forum for the interaction between developers of computer-related tools for mathematics and those interested in their use.

KEYNOTE ADDRESS

Sir Peter Swinnerton-Dyer (Cambridge)

SPECIAL EVENTS

Scientific Visualization: Lecture and Video Program
Maxine Brown (Illinois)

Computer Art, Music, and Video Show
Carol Chiani (NYC/SIGGRAPH), Producer

Wine and Demo Buffet (The Computer Museum)
Demos of mathematical software

Boston Schools Computer Contest Awards

INVITED TALKS

Computers & Mathematical Education
Judah Schwartz (Harvard), Dennis Stanton (Minnesota)

Computers & Physics
Rodney J. Baxter (Aust. Nat. Univ), Alan H. Guth (MIT), Michael J. Creutz (Brookhaven), Richard H. Miller (Chicago)

Mathematics & Supercomputing
David V. & Gregory V. Chudnovsky (Columbia), Monty M. Denneau (IBM Research), Joseph W. Goodman (Stanford)

Computers & New Directions in Mathematics
George Andrews (Penn State), Peter Borwein (Dalhousie), Alexandre Chorin (Berkeley), R. William Gosper

Mathematics & Computer Graphics
George K. Francis (Illinois), Michael F. Barnsley (Georgia Tech), Donna Cox (Illinois), Alvey Ray Smith (Pixar, Inc)

Computers & Combinatorics
J. H. Conway (Princeton), N. J. A. Sloane (AT&T Bell Labs), Andrew Odlyzko (AT&T Bell Labs), Herbert S. Wilf (Pennsylvania)

TUTORIAL MINICOURSES

Comp. Graphics & Diff. Geometry in 2-, 3-, & 4-Space
Thomas Banchoff (Brown)

Groebner Bases: Foundation for Constructive Algebra
Lorenzo Robbiano (Genoa)

The Regrettable Failure of Automated Error Analysis
William M. Kahan (Berkeley)

Computers in Undergraduate Mathematics
Stanley Devitt (Saskatchewan), Michael Henle (Oberlin)

Symbolic Integration is Algorithmic!
Manuel Bronstein (IBM Research), James H. Davenport (Bath), Barry M. Trager (IBM Research)

An Introduction to Computational Group Theory
John Cannon (Sydney), Gregory Butler (Sydney)

The HP-28S: A Bridge Between Theory & Applications
Yves Nievergelt (E. Washington)

The Science of Fractal Images
Heinz-Otto Peitgen (Bremen), Richard F. Voss (IBM)

DEMONSTRATIONS

CAYLEY (Sydney), **DELIA** (Acad. Sciences, USSR)
Derive (Soft WareHouse), **MACSYMA** (Symbolics)
Macaulay (Columbia), **Maple** (Waterloo),
Mathematica (Wolfram Research), **Milo** (Paracomp),
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EXHIBITS

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Telephone: (914) 769-2725

Pure and Applied Mathematics

NUMBER THEORY, TRACE FORMULAS AND DISCRETE GROUPS

Symposium in Honor of Atle Selberg, Oslo, Norway, July 14–21, 1987

edited by
Karl Egil Aubert, Enrico Bombieri, and Dorian Goldfeld

One of the most powerful mathematicians of this century, Atle Selberg has almost single handedly changed the course of modern analytic number theory. This volume contains the proceedings of an international conference that was held in honor of his 70th birthday in Oslo, July 14–21, 1987. The aim of the conference was to survey Selberg's principle contributions to mathematics in the areas of prime number theory and zeta functions, sieve methods, trace formulas and discrete groups, and also to focus on their most recent development. The nine survey papers can serve as a graduate-level introduction to the field.

February 1989, c. 536 pages
$69.95 (tentative)
ISBN: 0-12-067570-6

INFINITE CROSSED PRODUCTS

Donald Passman

Crossed products are another meeting place for group theory and ring theory. Historically, they first occurred in the study of finite dimensional division algebras and central simple algebras. More recently, they have become closely related to the study of infinite group algebras, group-graded rings, and the Galois theory of noncommutative rings. This book is mainly concerned with these newer developments.

January 1989, c. 483 pages
$54.50/ISBN: 0-12-546390-1

INITIAL-BOUNDARY VALUE PROBLEMS

Heinz-Otto Kreiss and Jens Lorenz

This book provides a systematic treatment of time dependent partial differential equations of parabolic, hyperbolic or mixed type. Written for graduate students and researchers in mathematics and engineering, the book covers the theory of an important class of evolutionary systems and provides background material for their numerical treatment. The Navier–Stokes equations of fluid dynamics—compressible and incompressible—serve as an important example to illustrate the results. Constructive methods (difference schemes, iterations) are used throughout the text to show the existence of solutions.

March 1989, c. 400 pages
$49.50 (tentative)
ISBN: 0-12-426125-6

ALGEBRAIC ANALYSIS

Papers Dedicated to Professor Mikio Sato on the Occasion of His Sixtieth Birthday

Volumes I and II

edited by
Masaki Kashiwara and Takahiro Kawai

This is a collection of very high level research papers in the area of analysis and mathematical physics edited by two outstanding Japanese mathematicians on the occasion and in honor of Professor Mikio Sato's 60th birthday.

Volume I
February 1989, 494 pages, $59.95
ISBN: 0-12-400465-2

Volume II
March 1989, 504 pages, $59.95
ISBN: 0-12-400466-0

VERTEX OPERATOR ALGEBRAS AND THE MONSTER

Igor B. Frenkel, James Lepowsky, and Arne Meurman

This book is motivated by and develops connections between several branches of mathematics and physics—the theories of Lie algebras, finite groups and modular functions in mathematics, and string theory in physics. The first part of the book presents a new mathematical theory of vertex operator algebras, the algebraic counterpart of two-dimensional holomorphic conformal quantum field theory. The remaining part constructs the Monster finite simple group as the automorphism group of a very special vertex operator algebra, called the "moonshine module" because of its relevance to "monstrous moonshine."

March 1989, 512 pages, $69.95
ISBN: 0-12-267065-5

REPRESENTATIONS OF FINITE GROUPS

Hirosi Nagao and Yukio Tsushima

This book is a self-contained exposition of the general theory of ordinary and modular representations of finite groups, including some recent results. It provides sufficient preparation for reading recent research articles on this subject. The authors have kept their explanations as comprehensive as possible by only assuming familiarity with the basic undergraduate algebra and some Galois theory.

April 1989, c. 448 pages
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ISBN: 0-12-513660-9

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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

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*For **ordinary members** whose annual professional income is below $38,000, the dues are $66; for those whose annual professional income is $38,000 or more, the dues are $88.*

*The **CMS Cooperative Rate** applies to ordinary members of the AMS who are also members of the Canadian Mathematical Society and reside outside of the U.S. For members whose annual professional income is $38,000 or less, the dues are $56 and for those whose annual professional income is above $38,000, the dues are $75.*

*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).*

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*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.*

1989 Dues Schedule

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Contributing member (minimum $132) ..... ○

Student member (please verify)[1] ..... ○ $22

Unemployed member (please verify)[2] ..... ○ $22

Reciprocity member (please verify)[3] ..... ○ $44 ○ $66 ○ $88

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3 Reciprocity Membership Verification (sign below) *I am currently a member of the society indicated on the right and am therefore eligible for reciprocity membership.*

Reciprocating Societies

- ○ Allahabad Mathematical Society
- ○ Asociación Matemática Española
- ○ Australian Mathematical Society
- ○ Berliner Mathematische Gesellschaft e.V.
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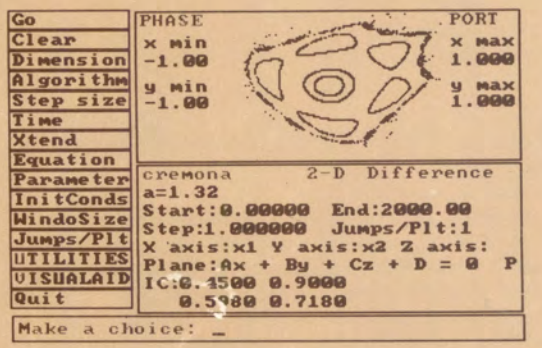

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