NOTICES

OF THE

AMERICAN MATHEMATICAL SOCIETY

1988 Steele Prizes page 965

The AMS Centennial: Social and Mathematical Festivities page 970

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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
845	*	October 28-30, 1988	Lawrence, Kansas	Expired	October
846	*	November 12-13, 1988	Claremont, California	Expired	October
847	*	January 11-14, 1989 (95th Annual Meeting)	Phoenix, Arizona†	October 12 **	December
	*	April 15-16, 1989	Worcester, Massachusetts	January 25	March
	*	May 19-20, 1989	Chicago, Illinois	March 1	April
		August 7-10, 1989 (92nd Summer Meeting)	Boulder, Colorado	May 16	July/August
		October 21-22, 1989	Hoboken, New Jersey	August 30	October
		October 27-28, 1989	Muncie, Indiana	August 30	October
		January 17-20, 1990 (96th Annual Meeting)	Louisville, Kentucky		
		January 16-19, 1991 (97th Annual Meeting)	San Francisco, California		

* Please refer to page 1052 for listing of special sessions
† Preregistration/Housing deadline is November 10
** MAA Contributed Paper deadline is September 30

Deadlines

	October Issue	November Issue	December Issue	January Issue
Classified Ads*	Aug 31, 1988	Oct 3, 1988	Oct 31, 1988	Nov 30, 1988
News Items	Sept 6, 1988	Oct 7, 1988	Nov 4, 1988	Nov 25, 1988
Meeting Announcements**	Aug 24, 1988	Sept 26, 1988	Oct 24, 1988	Nov 17, 1988

* 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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NOTICES OF THE AMERICAN MATHEMATICAL SOCIETY

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MR and *CMP* on CD-ROM

One of the highlights of the Centennial Celebration in Providence was the AMS preview of a new information medium: a CD-ROM (Compact Disc-Read Only Memory) which contains records from *Mathematical Reviews* (*MR*) and *Current Mathematical Publications* (*CMP*). The actual CD-ROM, called MathSci Disc, will be available to the public in January 1989 and will contain all reviews and abstracts from *MR* 1985 through 1988 and over 50,000 entries from *CMP*. This first release in January will be followed by semi-annual discs that will incorporate the current six months of *MR* and *CMP* into material on the previous disc. Although a CD-ROM has tremendous storage capacity, as more and more records are added the disc becomes full, and eventually new discs will be started which include a portion of the previous CD-ROM. Archival discs with MR records from years before 1985 may also be produced in the future.

The CD-ROM technology is essentially the same as that used for audio compact discs, where information is encoded on the disc in a digitized form through a series of pits impressed into the disc. A "reader" retrieves the digital information by using the scattered light from a laser focused on the pits. A CD-ROM is only 4 3/4 inches across, but it holds up to 500 megabytes of data, which is the equivalent of about 275,000 pages of printed material. It is this storage capacity that makes it possible to put four years, or almost five linear feet, of *MR* on a single disc and still leave room for software and indexes that will allow for quick and efficient searching of the information. A CD-ROM, like a magnetic disk, provides random access to the data, and the search software will allow an individual to find items by using a variety of descriptors that would identify a particular item. In the case of *MR* these identifiers will include: author names, classification codes, words in the title of an article or book, words from the reviewer abstract, journal names, publishers, and other data elements. The only hardware necessary to use a CD-ROM is a PC, such as an IBM-AT with a hard disk, and a CD-ROM reader. Shortly, software and hardware will be available for connecting a reader to a Macintosh.

The MathSci Disc will be produced for the AMS by SilverPlatter, a company specializing in information products on CD-ROM's. SilverPlatter will provide search software and do the indexing of the *MR* and *CMP* files, and they will carry the product through to the actual cutting of the master disc and the duplication of copies for distribution. SilverPlatter will also provide documentation and toll-free help services to the user. Records selected from MathSci Disc can be downloaded to the microcomputer for editing or can be processed with TEX software to convert the records into the typeset form in which they appear in *MR*, with the actual mathematical expressions. Between the semi-annual updates of MathSci Disc, the online service of MathSci from the vendors BRS, DIALOG, and ESA, can be used to search the most recent monthly records which are concurrent with the printed journal.

The MathSci Disc will be distributed by the AMS, through an annual lease arrangement, to both institutions and individuals, with substantial discounts to individuals at subscribing institutions. More information about the pricing structure for MathSci Disc can be found on page 1039.

Letters to the Editor

Mathematics in the News

I've just taught Number Theory; it was a fortuitous time. I never before had "current events" or "show and tell" in a class in pure mathematics, but this Spring several of my students brought newspaper clippings on the day the *Boston Globe* told of Miyaoka's proof of the Fermat conjecture.

I'd had enough advance warning to prepare a lecture proving Miyaoka's Theorem (for so I called it) in the special case $n = 4$, using Fermat's well known argument by descent.

I kept my class informed of the status of the theorem as those entitled to an opinion debated in wandering email. In time, as we now know, doubt overwhelmed belief, Miyaoka withdrew his claim, and the Conjecture stands as before.

But there's more to the story. One of the hardest things we teach students is to prove theorems. Most mathematics majors calculate well enough. Many can solve problems. Some can formulate conjectures if given appropriate experimental material. But all too few can prove even things they know to be true.

What I have always found most frustrating is not my students' inability to prove a theorem—we all have our limits—but their inability to recognize when they've written what I call nonsense. I'm irrationally offended by blatant faulty logic in student papers: theorems proved by example ("for all" read as "there exists"), statements construed as their converses, arguments which, if correct, would show that $1 = 0, \ldots$. We all know the litany.

But several weeks of this, following Miyaoka's dashed hopes, led me to apologize to my students, as I hope you will to yours. It dawned on me, all too belatedly, that they struggle quite as hard at the edge of what they can comprehend as we do when we do new mathematics. We know that believing something is the first step toward proving it. While doubt is a more reliable ultimate testing mode, without hope nothing is possible. So they and we and Miyaoka all hope. We're not angry at Miyaoka, nor ashamed of him, nor do we consider him foolish or ignorant or dumb or careless. Let's remember to treat our students' struggles with the same respect we accord his.

Ethan Bolker
University of Massachusetts, Boston
(Received May 25, 1988)

Policy on Letters to the Editor

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

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

The committee reserves the right to edit letters.

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

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

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

Military Funding

On the Referendum, etc.

As a Naval officer still serving in the Navy Reserve, and as an industrial mathematician working principally on Navy contracts, I feel a deep commitment to the nation's defense. I put up with the negative aspects of industrial mathematics, such as long hours, lack of funding for publication, and lack of representation in the mathematical community because I feel that the work I do is useful and important to the Navy. Therefore I was disappointed—even dejected, maybe—to read the triumphant letter regarding the results of the referendum (*Notices*, p. 675).

Even though I voted for some of the motions, it is very hard not to take the vote as a condemnation of what I do and believe. Not only am I not represented, but the organization I once aspired to join doesn't seem to want my kind around anymore. I thought our common bond was mathematics, not politics.

The adjacent letter from Professor Gurevič also hit home. I, too, looked in vain at the Atlanta meetings for people to talk mathematics with. The meetings are the only time I even get to *see* other mathematicians. I have uncovered some interesting network theory problems in my work in position-finding, command and control networks, and software design, but I'll be darned if I could get anyone to talk to me about them. I'm reduced to ordering books through the mail, teaching myself, and slowly building a theory from scratch. This is not unlike the military trying to find someone to help it with *its* mathematical problems, and I would like to briefly discuss that analogy.

From the point of view of the military, each branch of the armed services has one or more agencies—which usually employ some mathematicians—whose job it is to analyze the requirements of the operational forces and provide hardware and software to meet those requirements. These agencies let contracts to civilian firms, usually "defense contractors" who specialize in such work because of the extraordinary demands of specification, testing, etc. These firms also employ mathematicians. Employees of these firms, including mathematicians, must account for each hour spent by attributing it to a particular task of a particular contract.

Failure to do so accurately can become something that you read about in the newspapers. These mathematicians are not supposed to be doing "basic research"; in reality, they do a great deal of it because they can't meet the contract requirements without it. Unfortunately, contracts are rarely so well funded that they can support publication of the results—they pay only to get an "answer."

As one such mathematician, I rarely find in the literature the mathematics I need to solve problems. If my experience is typical, it makes sense for the government to fund efforts to create the mathematics. The irony is that the research funding agencies, such as ONR, *do not know what the problems to be solved are.* Their employees are civilians, and often do not have security clearances allowing them access to information about ongoing projects. I have never heard of them visiting contractor facilities. They have a lot of employee turnover. They seem to operate *in response to proposals from the academic community.*

Because of this, I used to think that the reason for having such research funding agencies was to promote goodwill and to foster the growth of a talent pool—the same reason the military might want to support the Boy Scouts or amateur radio, for example. To accuse them of coercion because they do not submit the proposals they receive to peer review seems absurd. In my opinion, the greatest criticism that can be made against them is that *they are making too little contribution to solving the military's mathematical problems.*

If the academic mathematical community doesn't want military funding, and military agencies are unable to attract attention to their mathematical problems, both mathematics and the taxpayer would be better served by changing the way the military spends its research dollars. I would recommend enfranchising the Mathematics Section of ONR, for example, to

- provide funding to enable defense industry mathematicians to finish and publish their findings. I think money spent in this way would produce more useful mathematics than money spent anywhere else;
- provide funding to outside mathematicians to work with Navy personnel or contractors in solving particular problems;
- act as a mathematical "Board of Inspection and Survey," visiting Navy Systems Commands, laboratories, and contractors to see what research is being done; exposing defective mathematics, if necessary, but generally fostering better mathematics at these sites;
- publish an informal journal—a newsletter or electronic bulletin board, perhaps—which would allow defense engineers and mathematicians to broach problems and make suggestions without the intimidating requirements of formal publication;
- sponsor informal conferences on topics of broad interest, and otherwise put mathematicians and engineers doing similar work in touch with each other.

The mathematicians administering such a program within ONR would themselves need to be gifted, broadly educated, and be granted access to classified information. The mathematics itself is usually unclassified, but as any applied mathematician knows, recognizing what the problem is, or even that it is a *mathematical* problem, is often the most difficult step in the solution. It is also the step which usually requires a security clearance.

It was distressing to see the results of the referendum, but perhaps some good will come of it.

R. Peter DeLong
Hughes Aircraft Company,
Fullerton, California
(Received June 27, 1988)

Politicization of the Society

When I joined the AMS in 1965, I considered the Society to be a professional organization devoted to the furtherance of study and research in mathematics. Mathematics is, in and of itself, devoid of political content. I always felt that the AMS, or any professional society for that matter, should be similarly apolitical, to the extent that I believe that the Society should not ever make political statements of any kind, whether about the treatment of Jews in Russia, Palestinians in Israel, Greeks in Anatolia, blacks in South Africa, women anywhere, or whales by the Japanese.

With the recent passage of the referendum issues by a large majority of the membership of the Society, it is apparent to me that not only has the Society become extremely more politicized than my worst fears, but that the ship of state of the AMS has taken a sudden and sharp turn to the left and become a ship of fools. I do not suffer fools gladly and have no wish to be associated with them, be they mathematicians or politicians. Accordingly, I shall not renew my membership in the AMS in December, nor shall I seek to rejoin the Society at any time in the future unless I learn that it has cleansed itself of this political folly and made structural changes which would prevent such from ever happening again.

It is with great sorrow that I find it necessary to write this letter. I may hope that the Society will come to its senses and correct this egregious error which it has made, but I do not hold out much hope for this. From the size of the vote, it appears that I am in a minority which is too small to influence the course the Society is taking. I can now only suggest that in the interests of "truth in labelling," the Society should now change its name to "The Left-wing American Mathematical Society." Even if I were a leftwinger, which, as you may have guessed, I am not, I would not want to be a member of such a society.

Randolph Constantine
Bayfield, Colorado
(Received June 3, 1988)

1988 Steele Prizes Awarded at Centennial Celebration in Providence

Three Leroy P. Steele Prizes were awarded at the Society's ninety-first Summer Meeting and Centennial Celebration in Providence, Rhode Island.

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

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

The recipients of the Steele Prizes for 1988 are Sigurdur Helgason for the expository award; Gian-Carlo Rota for research work of fundamental importance; and Deane Montgomery for the career award.

The Steele Prizes are awarded by the Council of the Society, acting through a selection committee whose members at the time of these selections were Frederick J. Almgren, Luis A. Caffarelli, Hermann Flaschka, John P. Hempel, William S. Massey (chairman), Frank A. Raymond, Neil J. A. Sloane, Louis Solomon, Richard P. Stanley and Michael E. Taylor.

The text that follows contains the Committee's citations for each award, the recipients' responses at the prize session in Providence, and a brief biographical sketch of each of the recipients. Professor Montgomery was unable to attend the Summer Meeting to receive the prize in person. He did, however, send a written response to the award.

Expository Writing

Sigurdur Helgason

Citation

The 1988 Steele Prize for expository writing is awarded to Sigurdur Helgason for his books *Differential Geometry and Symmetric Spaces* (Academic Press, 1962), *Differential Geometry, Lie Groups, and Symmetric Spaces* (Academic Press, 1978), and *Groups and Geometric Analysis* (Academic Press, 1984).

In 1962 Sigurdur Helgason published a book which has become a classic. The subject matter included central topics in geometry and Lie group theory, with important ramifications for harmonic analysis. More recently this material has been revised and expanded into a two volume treatment.

Proceeding at a leisurely pace, the author first leads the reader through the basic theory of differential geometry, emphasizing an invariant, coordinate-free development. Next is a careful treatment of the foundations of the theory of Lie groups, presented in a manner which since 1962 has served as a model for the treatment of this subject by a number of subsequent authors. The central theme of symmetric spaces is related in a clear fashion to the study of semisimple Lie groups and tools are assembled for the classification of these objects, first into large classes, e.g., compact and noncompact symmetric spaces, Hermitian symmetric spaces, then the fine classification. The last volume covers numerous significant topics in harmonic analysis, from the Radon transform, to invariant differential operators, to Harish-Chandra's c-function, ending with a quick overview of harmonic analysis on compact symmetric spaces in terms of the representation theory of compact Lie groups.

The exposition throughout is a model of clarity. Arguments in proofs are very clean, the organization is superb, and the material ranges over a wide vista of important topics of interest to a broad segment of the mathematical community.

Response

I feel deeply grateful and honored to receive the Steele Prize at this Centennial Celebration.

The first book in question, *Differential Geometry and Symmetric Spaces* from 1962, represents my efforts (originating in 1955) at combining Elie Cartan's differential geometric work on symmetric spaces with some of Harish-Chandra's algebraic and analytic work on representation theory of semisimple Lie groups. The ultimate purpose, however, was to develop geometric analysis on symmetric spaces in analogy with Fourier analysis and Radon transforms on R^n and partial differential operators with constant coefficients. My 1984 book, *Groups and Geometric Analysis*, treats the simplest examples and then deals with the first part of the general project.

As this geometric analysis on symmetric spaces has developed, some unexpected feedback in classical analysis has materialized. For example, the familiar Poisson integral formula

$$u(x) = \int_B P(x,b)F(b)db$$

for harmonic functions u in the unit disk D with boundary B becomes a special result in non-Euclidean Fourier analysis on D considered as the hyperbolic plane. This circumstance then suggested that each eigenfunction u of the Laplace-Beltrami operator L on the hyperbolic plane, (say $Lu = c(c-1)u$), should have the form

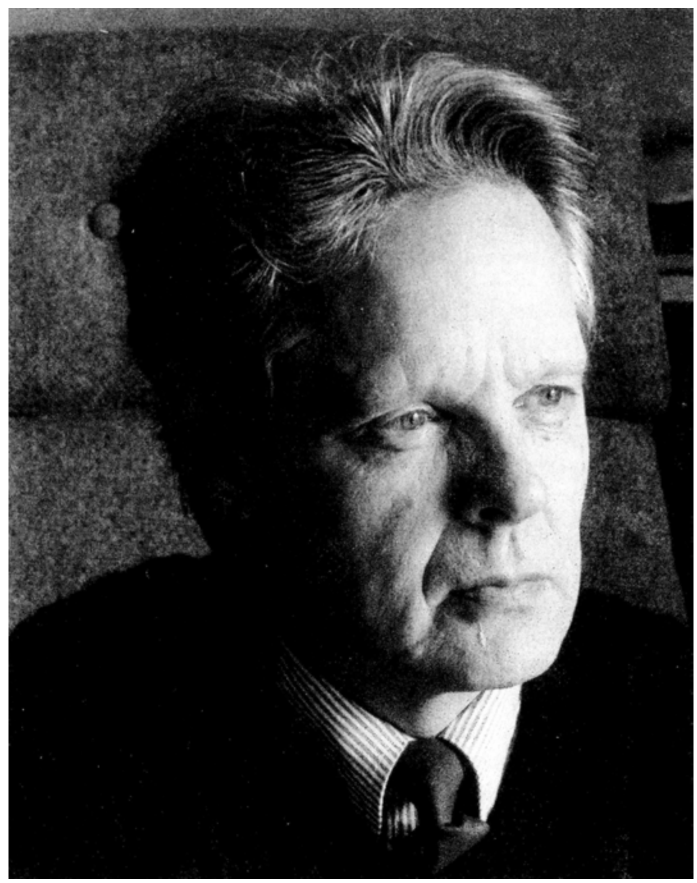
$$u(x) = \int_B P(x,b)^c dT(b)$$

with a certain functional T on the boundary B. *A priori* one would expect that the needed class of functionals T would depend on the eigenvalue $c(c-1)$, but to my surprise I found that the functionals needed were always exactly the hyperfunctions on B, independently of c. Thus hyperfunctions, which at that time (1970) had existed as rather isolated objects outside the mainstream of analysis, showed themselves to be firmly attached to basic analysis on symmetric spaces. This connection has been explored much further in the outstanding work of several Japanese mathematicians.

During the fifties when I embarked on this work, differential geometry had not acquired the great popularity which it enjoys today. Thus I felt compelled in my 1962 book to write an exposition of basic Riemannian geometry, particularly the Hadamard-Cartan's theory of manifolds of negative curvature, and Cartan's theory of symmetric spaces and semisimple Lie groups. It was an interesting experience trying to understand his work in these areas. While his thesis from 1894 was not too difficult to fathom, his papers during the late 1920's on symmetric spaces reflected his accumulated experience with Lie groups, combined with a remarkable geometric intuition; as a result some of his proofs were rather baffling in their informality. When I have taught this material on later occasions I have been embarassed by the clumsiness of some of my proofs. It seems that my exposition of these results was more intended to convince myself that the results were true rather than to explain them to others. In this pursuit I was helped by many mathematicians through personal contact, seminar activity and written papers; here I would like to mention A. Borel, S-S. Chern, J.I. Hano, Harish-Chandra, R. Hermann, A. Korányi, B. Kostant, J. L. Koszul, A. P. Mattuck, G. D. Mostow, K. Nomizu, R. Palais, J. Wolf. I remember this association with deep gratitude.

Harish-Chandra's papers offered an interesting contrast to Cartan's work. While his papers reflected deep originality and accumulated technical power, his proofs were careful in details so that motivation and patience were sufficient for understanding, at least on the local level. It was a source of great satisfaction to me to integrate some of the works of these two great mathematicians in my 1962 book.

The original project, geometric analysis on Riemannian symmetric spaces, is the subject of the 1984 volume and of a further volume in preparation. It is gratifying also to see analysis on nonRiemannian symmetric spaces progressing vigorously in several quarters in recent years.



Sigurdur Helgason

Biographical Sketch

Sigurdur Helgason was born on September 30, 1927 in Akureyri, Iceland. He received his Ph.D. from Princeton University in 1954.

During his academic career, Professor Helgason has served as Moore Instructor of Mathematics at the

Massachusetts Institute of Technology (1954-1956) and Louis Block Lecturer at the University of Chicago (1957-1959). At MIT, he moved from Assistant Professor of Mathematics to Associate Professor of Mathematics (1959-1965). He held visiting positions at Princeton University (1956-1957) and at Columbia University (1959-1960). Since 1965, he has been Professor of Mathematics at MIT. He has also been, on leave, at the Institute for Advanced Study (1964-1966, 1974-1975, and Fall 1983), and at the Institut Mittag–Leffler (1970-1971).

Professor Helgason has been a member of the American Mathematical Society for 35 years and has given the following addresses: Invited Address, Summer Meeting, Boulder, August 1963; Summer Institute on Harmonic Analysis on Homogeneous Spaces, Williamstown, July 1972; Invited Address, Annual Meeting, Washington, D.C., January 1975; Special Session on Representations of Lie groups, Washington, D.C., October 1979. He gave an Invited Address at the 1970 International Congress of Mathematicians in Nice. He also served on the Organizing Committee for the 1972 Summer Research Institute and the 1984 AMS Summer Research Conference on Integral Geometry.

Professor Helgason received the Gold Medal of the University of Copenhagen in 1951 and held a Guggenheim Fellowship at the Institute for Advanced Study in 1964-1965. He was awarded a *Doctor Honoris Causa* from the University of Iceland in 1986 and from the University of Copenhagen in 1988. He is a member of the Icelandic Academy of Sciences, the Royal Danish Academy of Sciences and Letters, and the American Academy of Arts and Sciences.

Professor Helgason's research interests include Lie groups and differential geometry, integral geometry, and harmonic analysis and differential equations on Lie groups and coset spaces.

Fundamental Paper

Gian-Carlo Rota

Citation

The 1988 Steele Prize for a paper which has proved to be of fundamental or lasting importance in its field is awarded to GIAN-CARLO ROTA for his paper:

On the foundations of combinatorial theory, I. Theory of Möbius functions.
Zeitschrift für Wahrscheinlichkeitstheorie und Verwandte Gebiete, **2** (1964), pages 340-368.

Only 25 years ago the subject of combinatorics was regarded with disdain by "mainstream" mathematicians, who considered it as little more than a bag of *ad hoc* tricks. Now, however, the new subject of "algebraic combinatorics" is a highly active and universally accepted discipline. Two of its most prominent features are its unifying techniques which bring together a host of previously disparate topics, and its deep connections with other branches of mathematics, such as algebraic topology, algebraic geometry, commutative algebra, and representation theory. The single paper most responsible for bringing on this revolution is the paper of Rota cited above. It showed how the theory of Möbius functions of a partially ordered set, as developed earlier by L. Weisner, P. Hall, and others, could be used to unify and generalize a wide selection of combinatorial results. Moreover, it hinted at connections with algebra, topology, and geometry which were later to be extensively developed by Rota and his followers. Today the theory of Möbius functions occupies a central position within algebraic combinatorics and has found many applications outside combinatorics. Perhaps more importantly, Rota's paper has inspired many mathematicians to develop systematic techniques for solving combinatorial problems and to apply them to problems outside combinatorics.

Response

I feel deeply honored by the Steele Prize which the Society has voted to award me this year, and I am delighted to accept it.

The generalization of the Möbius function of number theory to locally finite partially ordered sets is an idea whose time has come. The fact that I should have been the one to first point out the timeliness of this idea is a historical accident.

I am sure that some combinatorialists of the early part of this century who leafed through Dickson's *History of the Theory of Numbers* had realized that many of the identities collected in that book relating to the number-theoretic Möbius function depended only on the divisibility partial order on the integers. Hans Rademacher once told me that he had been struck by this fact, and admitted that he had not been able to carry through a proper generalization. What he missed was an insight that came almost simultaneously to Louis Weisner and to Philip Hall in the thirties. They realized that the generalization could be carried out using functions of *two* variables on a partially ordered set, rather than using analogs of the arithmetic functions of number theory. Functions of two variables on a partially ordered set (under certain restrictions) form an algebra, which in my paper I called the *incidence algebra*. This algebra can be viewed as a generalization of the algebra of upper triangular matrices.

Applications of the Möbius inversion formula on a partially ordered set keep cropping up. We may recall T. P. Speed's theory of statistical cumulants, the generalization to all finite group actions of the Moreau-Witt formula for the number of primitive necklaces, Zaslavsky's theory of enumeration of regions in arrangements of hyperplanes in R^n, and the more recent flurry of activity on the algebraic topology of finite topological spaces defined by partially ordered sets, where the Möbius function computes some homology and homotopy invariants.

Gian-Carlo Rota

More than fifty years ago, G. D. Birkhoff succeeded in associating to every graph a polynomial in one variable x, now called the chromatic polynomial. When evaluated at $x = n$, the chromatic polynomial gives the number of ways of coloring the graph in n colors. Garrett Birkhoff, in the second edition of his "Lattice Theory", remarked that the chromatic polynomial can be computed by Möbius inversion on the lattice of contractions of the graph. A similar, more general polynomial, the characteristic polynomial, can be defined on any finite partially ordered set by Möbius inversion. The values of the characteristic polynomial give combinatorial information on the partial order. In the case of lattices of flats of matroids (for example, for arrangements of hyperplanes), the zeros of the characteristic polynomial can be given explicit combinatorial interpretations in terms of the existence or non-existence of certain extremal configurations, much like Hadwiger conjectured in the case of graphs. Thanks to the characteristic polynomial of a partially ordered set, of which the chromatic polynomial of a graph is a special case, the problem of coloring a graph is seen to be only one instance (which, by chance, happened to be historically the first) of a wide class of combinatorial problems, old and new, all of them presenting difficulties of the same kind. This set of problems is known as the *critical problem*. Although much work has been done on the critical problem, it remains beyond the reach of today's mathematics, and we may at best wish we will live long enough to see it solved.

Biographical Sketch

Gian-Carlo Rota was born on April 27, 1932 in Italy. He came to the United States in 1950 and became an American citizen in 1961. He received his Ph.D. from Yale University in 1956 under the direction of Jacob T. Schwartz.

Professor Rota began his academic career as a Fellow at the Courant Institute of Mathematical Sciences (1956-1957). At Harvard University, he served as a Benjamin Peirce Instructor of Mathematics (1957-1959). At the Massachusetts Institute of Technology he progressed from Assistant Professor of Mathematics to Associate Professor of Mathematics (1959-1965). In 1965 Professor Rota transferred to Rockefeller University, where he was a Professor of Mathematics until 1967. Professor Rota returned to MIT in 1967, where he served as Professor of Mathematics until 1974. Since 1974, he has been Professor of Applied Mathematics and Philosophy at this same institution.

Professor Rota has been a member of the American Mathematical Society for 33 years. He was a Member-at-large of the Council (1967-1968) and was Editor of the *Bulletin of the American Mathematical Society* (1968-1973).

Professor Rota gave Invited Addresses at the International Congresses of Mathematicians in Nice in 1970 and in Helsinki in 1978. He was the Hardy Lecturer, London Mathematical Society (1972); Professore Linceo, Scuola Normale Superiore, Pisa (1979 and 1984); and gave the Hedrick Lectures, Mathematical Association of America (1967). Professor Rota has also given the following AMS addresses: Symposium on Stochastic Processes, New York, April 1963; Special Session on Combinatorial Mathematics, Annual Meeting, Chicago, January 1966; Symposium on Combinatorics, Los Angeles, March 1968; Invited Address, New York, March 1972; Special Session on Combinatorial Algorithms, New York, April 1974; Invited Address, Wellesley, October 1977; Special Session on Combinatorics, Fairfield, October 1983.

Professor Rota was an Alfred P. Sloan Fellow (1963-1965). He is a member of the National Academy of Sciences, and a Corresponding Member of the Academia Argentina de Ciencias. He is a Fellow of the American Academy of Arts and Sciences, of the Institute of Mathematical Statistics, of the American Association for the Advancement of Science, and of the Los Alamos National Laboratory. In 1984, he received an honorary degree from the University of Strasbourg. Professor Rota is the founder of the *Journal of Combinatorial*

Theory (1967), *Advances in Mathematics* (1967), and of *Advances in Applied Mathematics* (1980).

His areas of research interest include combinatorial theory, probability, and phenomenology.

Career Award

Deane Montgomery

Citation

The 1988 Steele Prize for cumulative influence is awarded to DEANE MONTGOMERY for his lasting impact on mathematics, particularly mathematics in America. Montgomery is one of the founders of the modern theory of transformation groups. This subject has its roots in the 19th century with the work of Sophus Lie, Felix Klein, and Henri Poincaré.

The work by many renowned mathematicians on Hilbert's fifth problem during the first half of our century was a catalyst to the development of much of the theory of the structure of topological and Lie groups. Montgomery's contributions, which extended over fifteen years, to the solution of Hilbert's fifth problem are very well known. His book, *Topological Transformation Groups*, coauthored with Leo Zippin, provides a complete and accessible account of the problem and its solution. In the course of working on this and related problems, Montgomery and his collaborators provided much of the terminology, basic constructions, foundational ideas, and standard machinery of transformation groups.

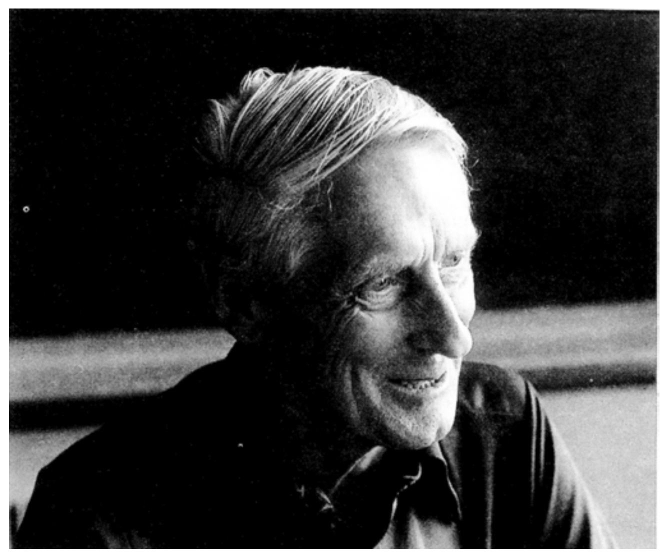
As the subject matured, Montgomery and his collaborators led the way with influential papers that incorporated the latest developments of topology. These seminal papers opened up entirely new areas for investigation. Today the subject has a symbiotic relationship with many parts of mathematics and often serves as a testing ground for the efficacy of new ideas in mathematics. In all its ramifications it is difficult to find pieces of the subject that do not bear Montgomery's imprint.

Montgomery's influence is pervasive at the Institute for Advanced Study. He made a special effort to search out promising young American mathematicians and bring them to the Institute. He acquainted himself with all the young visitors and cordially offered much mathematical and moral support. He worked very hard to have the Institute provide the best environment for the development of the young visitors' talents. Many will testify how this helped them to live up to their promise. His legacy, on this score, is with the postdoctoral students at the Institute.

Montgomery has also been active and visible in professional organizations for mathematicians. Two indications of this are his terms as President of the American Mathematical Society in 1961 and 1962 and as President of the International Mathematical Union from 1975 to 1978. He has been a member of the National Academy of Sciences since 1955. All these honors and obligations testify to his standing in the international mathematical community.

Response

It is gratifying to receive a Steele prize for my work in a profession which has given me so much pleasure. It has been my good fortune to have had the help of first rate collaborators and congenial and eminent colleagues and friends. Mathematics has managed to remain a rather unified subject; mathematicians don't always agree, but they have usually come together in supporting the main goals of the subject in spite of its breadth and diversity.



Deane Montgomery

Biographical Sketch

Deane Montgomery was born on September 2, 1909 in Weaver, Minnesota. He received his Ph.D. from the University of Iowa in 1933.

Professor Montgomery began his professional career as a National Research Council Fellow at Harvard University (1933-1934) and at the Institute for Advanced Study (1934-1935). He moved from Assistant Professor of Mathematics to Associate Professor of Mathematics at Smith College (1935-1946) and also, during this period, was a Guggenheim Fellow (1941-1942). While teaching at Smith College, Professor Montgomery held a concurrent position as a Visiting Associate Professor of Mathematics at Princeton University (1943-1945). During 1945-1946 he worked for John von Neumann on a project concerning numerical analysis. He has also served as an Associate Professor of Mathematics at Yale University (1946-1948). Since 1948 Professor Montgomery has been at the Institute for Advanced Study. He began as a permanent member and, in 1951, he was named Professor of Mathematics. Since 1980, he has been Professor Emeritus of Mathematics.

Professor Montgomery has been a member of the American Mathematical Society for 55 years and has served the Society as Vice President (1952-1953), as Trustee (1955-1961) and as President (1961-1962). He was president of the International Mathematical Union from 1975 to 1978.

Professor Montgomery has served on the following AMS committees: *Bulletin* Editorial Committee (1946-1949); Committee to Nominate Officers and Committees for the International Congress of Mathematicians (1948); Committee to Select Hour Speakers for Eastern Sectional Meetings (1948-1949); Committee to Nominate Officers and Members of the Council (1951, 1956); Committee to Select Hour Speakers for Annual and Summer Meetings (1951-1952); Committee to Nominate a Representative of the Society on the Policy Committee for Mathematics (1953); *Colloquium* Editorial Committee, 1953-1958; Committee on Publications (1954-1958); Executive Committee (1955-1956); Committee on the Relationships Between Headquarters and Mathematical Reviews (1957); Committee on Expository Books (1958, 1959); Committee to Consider Publishing Collected Works of Mathematicians (1959); Committee to Select Gibbs Lecturers (1961, 1962); Nominating Committee (1965).

Professor Montgomery has given the following addresses: Topological Transformation Groups in Euclidean Spaces, at a meeting of Section A, American Association for the Advancement of Science, Durham, June 1941; Invited Address, New York, October 1943; Colloquium Lecture, Summer Meeting, Minneapolis, September 1951; Invited Address, International Congress of Mathematicians, September 1954; Presidential Address, Annual Meeting, Miami, January 1964; Special Session on Semi-groups and Topological Algebras, Lexington, November 1965.

Professor Montgomery is also a member of the National Academy of Science, the International Mathematical Union (President, 1974-1975), and the American Philosophical Society. His areas of research interest include topology and topological groups.

THE AMS CENTENNIAL: SOCIAL AND MATHEMATICAL FESTIVITIES

Almost 1700 people attended the AMS Centennial Celebration, held August 8-12, 1988, in Providence, Rhode Island, home of the AMS headquarters. An array of festivities, both mathematical and social, made this 100th birthday party a very special event.

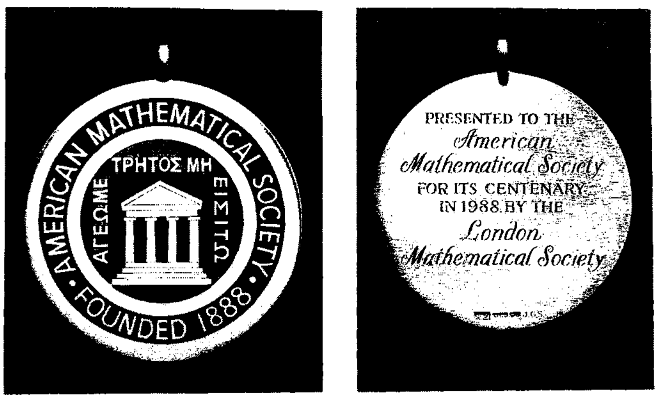
The Opening Ceremonies were held in the opulent Providence Performing Arts Center, which originally opened in 1928. In this grand setting embellished with brass, bronze, marble, and gilt, several hundred mathematicians listened to a selection of songs chosen to showcase the Arts Center's Mighty Wurlitzer pipe organ.

AMS President George Daniel Mostow, serving as the master of ceremonies, introduced a succession of representatives from state and local government, Brown University, and other mathematical societies, who presented their felicitations to the AMS. Christopher Zeeman, President of the London Mathematical Society, exuded British charm when he presented to the Society a gold medal to commemorate the Centennial and to be worn by the President on ceremonial occasions. Rhonda Hughes, President of the Association for Women in Mathematics, presented the Society with a contribution to the AMS Centennial Research Fellowship Fund. The audience was also addressed by Charles W. Gear, President of the Society for Industrial and Applied Mathematics.

Leonard Gillman, President of the Mathematical Association of America (MAA), told the crowd that he could not bring the MAA's gift because it weighs about 550 pounds. The gift is a sculpture in white Carrara marble from the mountains of northern Italy. Entitled "Torus with Cross-cap and Vector Field," it was made by Helaman Rolfe Pratt Ferguson, a topologist and sculptor at Brigham Young University. Ferguson says his inspiration was a theorem saying that compact surfaces are determined by the number of holes and the number of cross-caps. The sculpture was dedicated at a special ceremony the day before the Centennial Celebration began.

The MAA graciously yielded the time it would ordinarily have had at a joint meeting in order to allow time for the Society to have a full program of lectures. The MAA was represented in the program only by its seven Minicourses, held the weekend before the Centennial.

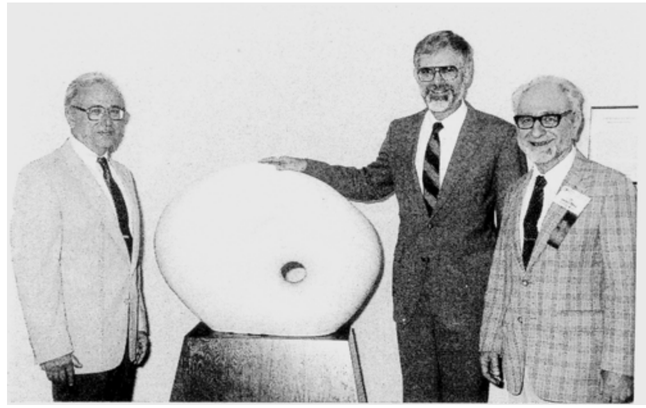
The AMS was not the only one to receive gifts at the Opening Ceremonies. Mostow presented the representatives of the other societies with specially engraved Revere bowls commemorating their cooperation. In one of the most touching moments, Everett Pitcher received a special plaque and a standing ovation for his 21 years of service as AMS Secretary. Participants seemed to find the Opening Ceremonies enjoyable. "It was very sweet and charming," said Lance Small, AMS Associate Secretary.



Front and back views of the medal presented to the AMS by the London Mathematical Society.

The keynote address was presented by Edward E. David, Jr., President of EED Inc. and former Science Adviser to the President. David, who was chairman of the committee that produced the influential report, "Renewing U.S. Mathematics" (usually called the David Report), surveyed its impact and made some recommendations for future action. In particular, he stressed the importance of education and of attracting young people to the field. (The Managing Editor hopes to be able to publish the full text of David's speech soon in *Notices*).

That evening, the Opening Reception was held at the Rhode Island State House, which was built in 1900 of white Georgian marble and which boasts the third largest unsupported marble dome in the world. There were balloons and three birthday cakes—one decorated with "1888," one with "1988," and one with the special AMS Centennial logo. Adding flair to the reception were the color guard of the Kentish Guards of the Rhode Island militia. A high point came when Mostow cut the cake with a saber borrowed from one of the guards. "It was done with a very light, happy touch," said AMS President-elect William Browder, adding that "the whole meeting is a fantastic organizational job, I just can't say enough about how well it's been done."



The MAA's gift to the AMS. Left to right: AMS President G. D. Mostow, sculptor Helaman R. P. Ferguson, and MAA President Leonard Gillman.

A Star-studded Symposium

The scientific program featured a special symposium which brought together some of the nation's brightest mathematical stars who are likely to significantly influence mathematical research into the year 2000. William P. Thurston, one of the symposium speakers, praised the "broad sweep" of mathematical areas covered in the symposium and the fact that, because of the historical nature of the meeting, the speakers seemed to be making a real effort to present the talks at a level that many could understand and appreciate. Frank Gilfeather said this kind of program should appear more often. "It doesn't have to be the Centennial to get people to give good expository talks," he said. "This is just what mathematicians love to listen to and learn from."

In addition to the symposium, there were AMS-MAA Joint Invited Addresses by three seasoned mathematicians. Raoul Bott provided a warm, personal view of his days at Princeton from 1955 to 1957, with vivid descriptions of the mathematics and the mathematical personalities he found there. Peter Lax described some of the major lines of development of applied mathematics in the United States and touched on some science policy issues of importance to the mathematical community. With a biting wit and an engaging style, Saunders Mac Lane spoke on the history of mathematics research departments in this country.

AMS President G. D. Mostow presides over the Opening Ceremonies.

AMS Short Course

The weekend before the meeting, the AMS sponsored an enormously successful short course on chaos and fractals. The course attracted a record crowd of about 500. The audience heard presentations on such topics as the horseshoe map, chaotic attractors, Julia sets, and iterated function systems. In addition, they saw computer generated illustrations and films representing the mathematical objects explored in the course. The course attracted an especially diverse crowd, with many graduate students, participants from industry and laboratories, and even some high school teachers.

Everett Pitcher accepts a plaque commemorating his 21 years of service as AMS Secretary.

Semicentennial Reception

For those who attended the AMS Semicentennial in 1938, there was a special reception in the elegant Alderman's Chambers at the Providence City Hall. The convivial crowd numbered around 60 people, 35 of whom were Semicentennial attendees. John W. Green, Saunders Mac Lane, and William Ted Martin spoke to the crowd about the Semicentennial and the now-legendary "ungala" dinner, organized by about 20 mathematicians who refused to pay $3 for the "gala" Semicentennial dinner. Mac Lane said that the "ungala" group also sent a telegram to the official dinner, telling the diners that their meal was too expensive. Martin noted that about 30% of the Semicentennial attendees are still alive. "I'm no statistician," he said, "but I think there's a theorem there that says that attendance at the Semicentennial is good for longevity."

There was also a special reception to mark the official transfer of the Society archives to Brown University. Held at the Bell Gallery of Brown's List Art Center, the reception also honored the symposium speakers, each of whom received a specially engraved Revere bowl. Mostow and a representative of the Brown University library addressed the crowd of about 100 people.

AMS President G. D. Mostow cuts the cake at the Opening Reception.

Social and Cultural Events

Between 300 and 400 people took tours of the AMS headquarters office. According to the tour guides, the participants found the warehouse and print shop especially interesting. There were also tours of Providence's historic areas and of Newport, Rhode Island, with its dazzling turn-of-the-century mansions. The social high point was an outdoor clambake, featuring live music and sports. The clams, fish, potatoes, corn, onions, and sausage were baked in the traditional manner with layers of seaweed to add extra flavor. The tables were covered with white butcher paper, and Irving Segal took advantage of it as he scribbled a little mathematics during his dinner conversation with Peter Lax.

Centennial Coordinator Tricia Cross and AMS Director of Meetings H. Hope Daly did a superb job organizing the Centennial.

The Semicentennial attendees gather in the Providence City Hall for a commemorative photo.

There were several special exhibits at the Centennial, including a display of AMS archival materials at Brown University. Brown also commemorated the Centennial with an exhibit of rare mathematical books that included 16th century editions of Euclid's *Elements of Geometry.* In addition, the Rhode Island School of Design sponsored a showing of drawings of magic squares and other designs by Royal Vale Heath (1883-1960).

The AMS archival exhibit was put together by AMS staff member Tricia Cross, who, as the Centennial Coordinator, was responsible for most of the special Centennial events. At the AMS Business Meeting, she received a special gift of an engraved Revere bowl as a thank-you from the Society. William J. LeVeque, who is retiring this month from his position as Executive Director, was also presented with an engraved bowl to commemorate his eleven years of service to the Society.

The Business Meeting was the last event in the Centennial. As the Celebration came to a close, Secretary Pitcher provided a perspective on the importance of the Society's history when he said, "The officers of the Society look to the accomplishments of the past as a foundation on which the Society may build its future service to research in mathematics."

Allyn Jackson
Staff Writer

Inside the AMS

Report on the Council Meeting, August 1988

The AMS Council is the official policymaking body of the AMS. With around 45 members, it is composed of members-at-large and a range of other AMS officials including the president, the secretary, the treasurer, and chairs of various AMS committees. Members of the staff, including the executive director and the executive editor of *Mathematical Reviews*, attend to assist the Council. The Council generally meets three times a year to discuss and make decisions about various Society functions.

Although the Council plays an important role in the Society, many members are unaware of how it functions and the kinds of issues it discusses. In order to better acquaint the membership with the workings of the Council, *Notices* prepared this report on the most recent Council meeting, which took place on August 7, 1988, in conjunction with the AMS Centennial Celebration in Providence, Rhode Island. At the meeting, about 30 Council members were in attendance.

A New Lecture Series

President G. D. Mostow opened the discussion with the idea of establishing a new lecture series entitled Progress in Mathematics. To be held during the summer meetings, the series would be similar to the well-known Séminaire Bourbaki. The plan is to identify a particular area the series would cover and to choose excellent expositors who would speak on work not their own. Lecturers would prepare in advance a detailed manuscript which would be distributed to attendees and which would later become part of a book series. To make room in the meeting schedule, the number of regular AMS Invited Addresses would be reduced by two or three.

The idea for the lecture series first surfaced last May, when the AMS Executive Committee and Board of Trustees gave its approval to the idea. The Council's task was to give its opinion of the idea and possibly approve it formally.

Some Council members expressed concern that the series would emphasize more established researchers while removing opportunities for younger people, who traditionally present the AMS Invited Addresses. However, some pointed out that because the lecturers would be chosen for excellence in exposition rather than for an established research reputation, younger mathematicians would not be excluded.

Many members particularly favored the idea of identifying the scientific area before choosing the speakers, and some went on to suggest that there could be more coordination of the various sessions, with, for example, both a short course and the lecture series on the same mathematical theme. In addition, many felt that, because the lectures would be expository, they would increase communication between subfields in the mathematical sciences by informing a broad cross-section of the community about new developments in particular areas. The Council ended its discussion of the matter by giving its formal approval to the idea.

Structure of the JPBM

The Council reviewed a report from the Ad Hoc Committee on the Proposed Structure of the JPBM (Joint Policy Board for Mathematics). The JPBM consists of the presidents and executive directors of the AMS, the Mathematical Association of America (MAA), and the Society of Industrial and Applied Mathematics (SIAM), together with an appointed representative of each body, presently the secretary of the AMS, the treasurer of the MAA, and the chair of the Board of Trustees of SIAM. The purpose of the JPBM is to work on projects of common interest to the three societies. One of its main purposes is to direct the Office of Governmental and Public Affairs, headed in Washington, DC by Kenneth M. Hoffman.

One of the ad hoc committee members, Marc Rieffel, summarized the report by saying that the committee had found that the JPBM spent much of its time on budgetary and other managerial details of the "Washington presence" and was lacking a focus on science policy matters. Recently, the three executive directors of the societies formed a committee to handle these managerial details, and the report said that this arrangement seemed to be working well. The ad hoc committee therefore recommended that the managerial committee be institutionalized and that the AMS substitute its secretary's representation on the JPBM by the representation of a person elected by the Council. The main role of the elected member would be to provide a strong AMS-JPBM connection on policy matters.

Some discussion of the recommendations followed. William J. LeVeque, executive director of the AMS, circulated a memorandum expressing some of his views on and experience with the JPBM. In particular, he felt that the chair of the AMS Science Policy Committee and the secretary should be members of the JPBM. Mostow suggested that the Council could elect the chair of the Science Policy Committee, who would then become the elected representative on the JPBM. However, president-elect William Browder said that he believed such a mechanism would lessen the policy influence of the president, who ordinarily appoints the chair of the Science Policy Committee. After some deliberation over when the first term of the proposed elected member should begin, the Council approved the ad hoc committee's original recommendation.

The report also recommended that the executive directors of the three societies should be nonvoting members of the JPBM. Jean Taylor, one of the ad hoc committee members, explained that the executive directors should implement rather than set policy, so a nonvoting status was appropriate. Some Council members felt, however, that a nonvoting status would make the directors less involved and less active, or might make them feel "second class." LeVeque pointed out that he was appointed to the JPBM by the president of the MAA, not by the Council, so it was unclear who was to decide on his voting status. In addition, some pointed out that the voting status of the JPBM members should be parallel for the three societies, but it was not clear how the MAA and SIAM felt about this question. The Council seemed to agree that they should take a "wait and see" attitude and assess the effects of having an elected member on the JPBM before making any further changes in the Board's composition. However, a straw vote revealed that a majority was in favor of retaining the voting status of the executive directors.

Reports to the Council

Ronald G. Douglas, chair of the Science Policy Committee, presented a brief report to the Council on various topics the committee had been addressing. The topics included: the update of the "David Report," which the National Science Foundation has formally requested of the Board on Mathematical Sciences of the National Research Council (NRC); the NRC's MS2000 project, a comprehensive assessment of collegiate and university mathematics; the Collegiate Mathematics Education newsletter, which is jointly sponsored by the AMS and the MAA and which will begin in 1989; and the panel the committee sponsors at the winter Joint Mathematical Meetings. The Council seemed to agree that regular reports of this kind were very informative and would help to strengthen ties between the Council and the Science Policy Committee.

Council member Carol Wood reported on the annual International Science Fair, in which the AMS participated for the first time last May. Seven prizes totaling $3000 were given for outstanding mathematical projects by high school students. She said that recommendations for further AMS involvement would be in an upcoming report, and she encouraged the Council members to become involved in such activities at the regional level. Wood also acknowledged the assistance and support of Council member William P. Thurston.

The Council also heard a report on a recent survey conducted by associate executive director James A. Voytuk at the request of a committee headed by Thurston. The survey, which sought opinions on AMS election procedures, was sent to 150-175 people, including officers and ex-officers of the AMS. Voytuk reported that about 40 responses were received, and the results would be compiled in a report. One of the main purposes of the survey was to investigate attitudes about contested elections, and it was noted that the survey found that few other societies have uncontested elections as the AMS does.

Other Business

In addition to these matters, the Council discussed a letter from Saunders Mac Lane that made several suggestions of actions the Council could take and considered ways to strengthen connections between the AMS and the American Association for the Advancement of Science.

Allyn Jackson
Staff Writer

Computers and Mathematics

Edited by Jon Barwise

Editorial Notes

Doing Mathematics on a Computer

The computer is having a large impact on mathematics. Many aspects of this impact are shared with other disciplines, like physics, biology or economics. In all these fields it is changing the way people do simulations and experiments, write, teach, and communicate with one another. But there are some ways in which mathematics is destined to have a special relationship to computers. One of these has to do with the use pervasive of mathematics in computation.

There are two sides to this use of mathematics in computation. There is a sense in which whenever one wants to program a computer to do anything, one has to first come up with an algorithm, the algorithm that the computer program is going to embody. But of course algorithms are mathematical objects, defined over other mathematical objects. They presuppose that whatever real-world task one is after has been modeled by mathematical objects of some sort, objects over which the algorithm in question is defined.

Do you have mathematical software that you are willing to share with the mathematical community, either as freeware or shareware? If so, send a brief description to Jon Barwise. His address is on the next page of the Editorial Notes.

This makes computer programming a kind of applied mathematics. Every programmer is in the business of designing and implementing mathematical algorithms. So good computer programmers have to be good applied mathematicians in ways that they do not have to be applied physicists or applied biologists, or whatever.

However, the main focus of this month's column is on the converse side of the mathematics/computation relationship. It is about computer programs whose task is to allow the user "to do mathematics" explicitly. Here we have one of the grand ironies of mathematical history. For research aimed at showing the *impossibility* of making the doing of mathematics an algorithmic business, indeed research that succeeded in showing just that, in fact led to the modern digital computer.

David Hilbert formulated the research program of showing that all of mathematics could, in principal, be made algorithmic. His idea was that by turning attention from the traditional domain of mathematical objects (numbers, functions, sets, ...) to the domain of the symbols we use in doing calculations and giving proofs, we could make the whole business finite, concrete, and algorithmic, and so escape from the foundational problems that were troubling mathematicians of the time.

The results of Gödel, Church, Kleene and Turing show that Hilbert's program is impossible. The irony rests in the fact that this work, while showing the limitations of algorithms in the domain of symbols, and so of Hilbert's idea, also showed the tremendous power of that very idea, by way of the notion of Turing machine. Symbol manipulating machines, which is what digital computers are, will never be able to replace humans in doing mathematics, but they can do one heck of a lot of mathematics, and so, through mathematical modeling, one heck of a lot besides, which is what makes them so important in today's world.*

Given this history, it is only fitting that computers return to their origin and give mathematicians tools for doing mathematics. Not all mathematics, of course. We know their theoretical limitations. But they should provide us

* This is surely one of the greatest examples of unexpected consequences of pure research in mathematics. Who could have dreamt of the profound practical consequences of the efforts of Hilbert, Gödel, and Turing? It is amusing to imagine them applying to NSF for money and the kind of response their application would have gotten, especially as regards its role in overall structure of science and industry.

with useful tools for doing the routine computational parts of mathematics in a much more efficient way.

There are many programs on the market that aim at letting the user do mathematics on personal computers. Six of the most popular (EUREKA, TKSOLVER PLUS, MATHCAD 2.0, POINT FIVE, PC-MATLAB and GAUSS) are reviewed this month by Barry Simon and Robert Wilson in their article "Supercalculators on the PC."

But Simon and Wilson do more than just review and compare these six existing programs. They also formulate a list of features they think should be part of any program for doing mathematics by computer. In this way they not only help the would be user of existing programs, they also initiate a dialog with developers of future programs. If you have other features that you think should be added to the list, write a letter to the column.

Since I happen to be a Macintosh user, I want to mention that while their article is called "Supercalculators on the PC," the programs reviewed are also available for machines other than the PC. Just which machines a given program is available for is indicated in the review of the particular program.

In June, a powerful new program, *Mathematica*, was released by Wolfram Research. This program is available for the Macintosh and various SUN workstations, but not for the IBM PC. IBM has plans to release this program for the AIX/RT in the not too distant future. This program is billed as "A system for doing mathematics by computer." It will be reviewed in this column in a few months.

Next month we will have a review of the group theory program CAYLEY. As other programs come out, we intend to have them reviewed here as well. Please send suggestions for programs that should be reviewed, or potential reviews, or other contributions, to me.

Reviewers Needed

The column has already started receiving mathematical software for review. If you would be interested in doing such a review, please write and tell me your areas of expertise, and what equipment you have available. Be as specific as possible about the latter. And if you know of a program that you would like to see reviewed, write to the owner suggesting that a copy be sent to this column.

Professor Jon Barwise
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Ventura Hall
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A Letter to the Column

The following letter was received in response to the article by Ed Zalta about the patenting of algorithms in the previous issue.

Dear AMS:

The situation surrounding the grant to R. N. Bracewell of a patent for a "special purpose computer" to perform "the Discrete Bracewell Transform" is even more interesting than you might surmise from "Are Algorithms Patentable?," pp. 796-799 in the July/August *Notices*.

The continuous version of the transform was published by R. V. L. Hartley ("A More Symmetrical Fourier Analysis Applied to Transmission Problems," Proc. Inst. Radio Engrs., Vol 30, 1942, pp. 144-150). This citation is found in Dr. Bracewell's textbook, *The Fourier Transform and Its Application*, Second Edition, on the first page of Chapter 19, "The Discrete Hartley Transform". The transform discussed there is identical to the patented discrete Bracewell Transform.

Sincerely,

James W. Fox
Houston, Texas

Editors Comment:

There are very interesting issues as to when two algorithms are really different, just as there are questions as to when the proofs are really different. We all know that there can be many different algorithms for computing the same function. And there can be many different programs that implement a given algorithm. So neither easy answer is right. While there are beginnings toward a theory of algorithms that might answer such questions (e.g. by Y. Moschovakis at U.C.L.A.), there certainly is no widely accepted theory today. So how the patent office is going to decide the matter in particular cases, heaven only knows.

However, it seems that no such interesting issues are at stake in the case of Bracewell's patent. Rather, it is simply a matter of historical priority. As I understand it from Zalta, the facts are as follows. The Discrete Hartley Transform was, in fact, discovered by Bracewell. As often happens in mathematics, Bracewell modestly named it after someone whose work in the continuous case was suggestive in his own discovery—namely after Hartley. (Apparently the lawyer who drew up the patent switched the name to "Discrete Bracewell

Transform.") So, though the Discrete Hartley transform is the Discrete Bracewell Transform, it was in fact discovered by Bracewell. To further confuse matters, the *Fast* Bracewell Transform is distinct from the *Fast* Hartley Transform, but both of these were defined by Bracewell as well.

I would be interested in letters that address the question as to whether algorithms *should* be patentable at all. If you write a letter commenting on a previous column, please indicate whether you are willing to have some portion of your letter published in the column.

Supercalculators on the PC

Barry Simon and Richard M. Wilson
California Institute of Technology

Introduction

Hand held supercalculators such as the HP28S are wondrous beasts. But their system resources can't compare to a microcomputer like the IBM-PC. In this review we want to survey the software available for IBM compatible PC's in the supercalculator category. For inclusion, we required programs to not only calculate and graph simple functions but to have some kind of built in variables and "real programmability". We did not look at symbolic manipulation programs of which there are now a few available on the PC (we expect that the additional resources available under OS/2 will have a considerable effect on symbolic manipulation) nor do we report on two programs which were more sophisticated than four function calculators but which didn't meet our criteria: Dalin Software's SCIENTIFIC WHEEL and Structured Scientific Software's SOLVEIT. We examined six commercial programs that meet our perquisites: Borland's EUREKA, Universal Technical System's TKSOLVER PLUS, Mathsoft's MATHCAD 2.0, Pacific Crest Software's POINT FIVE, The Math Works' PC-MATLAT (the 'Mat' is short for matrix, not mathematics) and Aptech System's GAUSS.

To some extent, any interpreted language with mathematical functions, e.g. BASIC, could be used as a kind of supercalculator, but the most suitable such possibility might well be APL which is structured in a way most congenial for mathematical manipulation. In a real sense, APL is different from the other programs reviewed here in that you have to program to do things that are built into the alternatives although STSC has included enough workspaces with their version of APL that it has many of the aspects of a supercalculator. But invariably, APL can handle larger problems without choking than any of the other packages so for comparison purposes, we felt it appropriate to add an APL package. The standard for APL on the PC is clearly STSC's APL*PLUS and we used Version 7.0 for this comparison (which we'll henceforth shorten to "APL"). And to really show the cost in time for any interpreter, we include for one of our benchmarks, a comparison with a compiled Turbo Pascal program.

In understanding which of these programs might be right for you, you must bear in mind that comparing certain of them is like comparing apples and oranges. MATHCAD 1.0 and EUREKA had essentially no overlap of functionality. While that has changed with MATHCAD 2.0, it is still true that they are basically intended to meet different needs. For that reason, we'll begin the article with a quick once over trying to highlight the distinctions. Next we'll discuss some comparative issues like editing matrices. Then we'll write about each program separately. Next we'll present the results of a standard set of "benchmarks" and then we'll try to give the flavor of some of the packages by describing how each can be used to illustrate the Gibbs' phenomenon. We end with a section on what's missing and the reader may want to skip there to get some flavor of the state of the art. Information on prices and publishers is at the end of the article.

In a very rough sense, one can divide the programs into two groups: TKSOLVER, POINT FIVE, MATLAB, GAUSS and APL are all basically mathematical programming languages. In the other group are EUREKA, TKSOLVER and MATHCAD. These programs allow you to do things off the shelf without learning a new programming language. This is not to say that there aren't rules of syntax to learn or that the other packages don't come with a number of sample programs doing basic functions but rather that to get very much out of the package, you really need to learn at least the basics of their language. You'll note that TKSOLVER is on both lists. You can use it to solve simultaneous equations without accessing its extensive programming language which is there if you need more.

There is a second way of classifying these programs. Those who insist on something relatively easy to use should incline towards EUREKA, MATHCAD or POINT FIVE depending on whether they are interested in equation solving, calculations/reports or matrices/spreadsheets.

We should mention that Simon is a member of Borland's "executive advisory board" but since this is a non-paid position, we feel there is no conflict in our reporting on a Borland product.

Once over lightly

EUREKA, in most ways the most limited of the programs under discussion, is the easiest to describe. It is an equation solver allowing several simultaneous equations. Some of the "equations" can be inequalities and it understands max/min. If you have ever used one of Borland's compilers, you'll feel right at home with EUREKA: you prepare a source file in a built in editor following certain rules of syntax and choose the Solve command from the menu. If there is a syntax error, you are thrown into the editor at the place the error was noticed. Once you've solved the first time, many options are available. EUREKA recasts the set of equations as a minimization problem and uses a method of steepest descent algorithm.

TKSOLVER PLUS is also an equation solver but more versatile and powerful than EUREKA. It allows solution by direct substitution if possible as well as using Newton's method. You can input and deal directly with matrices and vectors, something that can only be done in EUREKA and in an ad hoc manner. And, unlike EUREKA, it has a rather complete programming language built in and illustrated in a large library of functions and examples supplied with the program. Indeed its programming language is in the same league as that of MATLAB and GAUSS. The greater power comes at the cost of a more complicated user interface and of a much greater effort required to learn the program. For simple occasional use, and probably for classroom use, EUREKA is to be perferred but for "serious" use, TKSOLVER is better. Another alternative for classroom use is the free MiniTK program provided by the publishers of TKSOLVER. If you mainly want the mathematical programming language you may well prefer one of the other programming environments.

MATHCAD's strong point is visual and typographical presentation. It runs in graphics mode with the virtues and vices inherent in that, you need more expensive hardware to begin with and actions like scrolling a page are much slower than in text mode programs like EUREKA. While all the other programs have graphics available, it runs separately from their main screens—MATHCAD lets you integrate graphs and text. With one of the other programs, you'll need some non-standard notation for sum since a large greek sigma with indices as displayed by MATHCAD can't really be made in text mode. While MATHCAD is not a replacement for a technical word processor for long papers, it is usable as a kind of technical word processor with "live" formulae when writing brief reports and is unique among the programs in this regard.

The remaining packages are all basically programming environments (as is a part of TKSOLVER). APL is an interpreter for a language which is especially tuned to arrays. It is unfortunate that its conditional and loop structures are so primitive. As a language, you can do almost anything in it. While we'd hate to write a word processor with it, that could be done. While it is possible to write both good or bad code in any language, APL has a deserved reputation for making cryptic code possible. It also has its own character set which its users tend to love and dabblers tend to dislike. STSC APL is missing a lot of useful tools present in some of the other packages. Its numeric matrix editor is limited, although you can write a better one; indeed some students at Caltech did write one for use in our linear algebra course. You could write your own Newton's method routines but they are not built in. As a general purpose programming language, there are third party books on the language some of which provide canned workspaces, for example the book *Abstract Algebra: A Computational Approach* by Charles Simms. STSC includes over 25 workspaces with the basic package and sells an additional 30 workspaces as part of separate packages.

POINT FIVE can be thought of as APL with simplicity and built in conveniences at a trade off of much less raw power. You'll never be able to do in a single line of

POINT FIVE code what you can do with APL. Like APL, it is an interpreter but the lines you type in and the output in response to those lines are kept in separate windows. There is a full fledged array editor built in. MATHCAD 2.0 is a rather recent upgrade which made it a more serious competitor to the other programs under consideration. POINT FIVE 2.0 which is under development will be out soon with additional features that may make it more competitive.

MATLAB is a set of matrix handling routines. It has any kind of matrix handling you could imagine and some you can't. While it is a matrix based language, it has support for many non-linear functions. It has a long, illustrious history and, as a result, there versions running on many other machines including Macintoshes, VAXes and Suns. Its graphic routines, including 3D graphs are especially impressive. It can be run as an interpreter in interactive mode, or you can use an editor (not supplied—you'll need your own) to write functions and routines that are called from disk and compiled the first time that you use them during a secession.

GAUSS has some similarities to MATLAB in that it is a powerful programming language built around manipulation of mathematical objects with an interpretative and a compiled mode. It has more programmability than MATLAB, especially more hooks to the computer. It was consistently among the spediest programs in our tests and with its large number of built in modules, it seemed to us the most "extensive" of the stand alone packages. But its user interface is rather clunky by the standards we have become used to on the PC.

The five programming environments—POINT FIVE, TKSOLVER, MATLAB, GAUSS and APL—are linearly ordered in terms of the pure programming power: for example APL gives you direct access to memory addresses and interrupts and you could only hope to write a word processoring program in GAUSS or APL. They are ordered in roughly the opposite way on the issue of ease of use: the language component of TKSOLVER isn't any easier than in MATLAB or GAUSS but you have direct access to its solver module. In terms of supplied routines though, the structure is trapezoidal with TKSOLVER, MATLAB and GAUSS providing much more in the way of built in mathematical routines than the other two programs.

If you are interested primarily in one of these packages as a programming environment, you will have to decide if it might not make more sense for you to use a more conventional computer language like FORTRAN, C or PASCAL with a library of mathematical routines. The IMSL library, Borland's TURBO PASCAL NUMERICAL METHODS TOOLBOX and Quinn-Curtis' SCIENCE AND ENGINEERING TOOLS with versions of Pascal, Modula and C are among the choices. Generally, the packages considered in this article are "higher order" languages—you are spared from issues like worrying about how the machine stores your data and the heap management that you often get into dealing with large structures under PASCAL—but there is no free lunch; invariably, compiled languages are faster and able to cope with larger structures.

Once over lightly on matrices and editing

You'd think that the one thing that these programs would get right is matrices and, in particular, editing matrices. As far as editing matrices, POINT FIVE is a model but alas while it will invert matrices and find determinants, it won't even find eigenvalues directly. MATHCAD's editor in general feels awkward to us but it is no worse for matrices than anything else and at least edits matrices in a fairly natural way. It goes down hill from there. EUREKA has no matrix support and TKSOLVER treats a matrix as a vector of vectors. APL comes with a workspace that allows some matrix editing but it is hardly a model of what one would like. We find it remarkable that MATLAB and GAUSS which are programming powerhouses fail to provide any serious matrix editing facilities: GAUSS' editor is amateurish and doesn't let you see the matrix structure while editing; MATLAB doesn't have an editor—while you can import a matrix prepared in your personal editor, such editors do not have any special facilities for handling the special structure of matrices.

On editing facilities in general, these programs show a wide variability. APL's full screen editor which will save pages of previous output and allow you to reissue commands in interactive mode is a pleasure to use although its program editor is only adequate. EUREKA's editor is the standard one in Borland compilers and is easy to use. POINT FIVE and TKSOLVER are line oriented programs and their editors are similar—adequate but not much better. MATHCAD's editor is unique to take advantage of its graphics mode and we found it rather difficult to use under various circumstances. For example, if you get an error message, (Backspace) will no longer remove the offending material! MATLAB has no real editor although it keeps a stack of previously issued commands which you can edit. Its philosophy is that you are best served by your own editor. Since you can invoke your editor from within MATLAB rather easily (if you have sufficient memory), this is a viable point of view. GAUSS' editor is its weakest element. In interactive mode, you are limited to two screens with a fair amount of clutter. In edit mode, file size isn't limited but the editor seems to be missing basic amenities like inserting an external file or moving a set of lines. This editor will be improved in version 2.0 of GAUSS due out by the time this article appears.

While on the issue of matrices and arrays, we should focus on GAUSS, MATLAB and APL in which arrays play a fundamental role. To a mathematician, arrays in APL are much more logically thought out than in MATLAB which has a number of plain inconsistencies which require specific testing for special situations. For example the function sum (array) gives the column sums of the array, unless the array is a 1 by *n* matrix in which case it gives the row sum. While GAUSS isn't inconsistent, we find it unnatural that the basic function in GAUSS which sums up the columns of a matrix returns a column vector rather than a row vector. APL supports arrays of any dimension so that in APL a vector is a one dimensional object while in MATLAB it is a two dimensional object which just happens to be one element wide in one dimension. And no other language has the lovely manipulative operations of "+.*x*" and "jot-dot".

Once over lightly on large data structures

When PCMATLAB, GAUSS, and POINT FIVE, are asked to display a large amount of data, the screen scrolls and that which has scrolled off the screen cannot be recovered (so you need to ask the program to display a smaller amount). By default, APL will save 75 lines other than the 25 on the screen (and you can reconfigure it to save more); moving with the arrow keys will allow one to see what has scrolled off. GAUSS lets you recall your one previous screen before you ran the command whose display scrolled off the screen. MATHCAD keeps a record of all that has happened since the program was loaded but as mentioned elsewhere, scrolling is very slow. The object editor in POINT FIVE will allow you to peruse a large matrix in a way where scrolling is possible and exceeds the other programs in convenience in this regard.

All the programs here other than APL respond to the 64K segment architecture of the Intel 80xx family by limiting objects to ones that fit 64K. Since reals typically take 8 bytes storage, that limits arrays to 8192 elements which will accommodate no larger than a 90 by 90 square matrix. With APL, array size is limited only by available RAM and we have used 205 by 205 matrices there. With the right add-on tools, one can deal with even larger objects in compiled languages. For example, TURBO PROFESSIONAL from Turbo Power Software will allow Turbo Pascal programs to access arrays limited only by available disk space, EMS memory or AT Extended memory. Because the segment size on an 80386 is a whopping 4 Gigabytes, 80386 specific versions of these programs (as already available from MATLAB and announced by STSC for their APL*PLUS and by GAUSS) will be able to handle very large arrays.

Once over lightly on graphing

You'll want to be able to graph functions and perhaps surfaces. There are several issues that you care about here. First, what kind of monitors are supported. Next, what kind of printer support there is and finally, exactly what you can graph.

On monitor support, all work on the CGA and the original Hercules monographics monitors. POINT FIVE shows graphs on the EGA in CGA resolution (640 × 200) only. The other programs all support the 640 × 350 EGA high resolution mode. MATHCAD and APL even have VGA support at this time.

Printer support for graphs is varied. POINT FIVE and TKSOLVER have no special support and printing is limited to shift PrtSc if you have a suitable driver for your monitor/printer combination such as the GRAPHICS program that comes with DOS and supports the CGA with the IBM Graphics Printer. The makers of TKSOLVER told us that they plan on introducing printer drivers soon. Among the others, APL, MATHCAD and MATLAB have especially good printer support.

As to what you can graph, TKSOLVER, MATLAB and GAUSS all support three dimensional plots. MATHCAD is unique in allowing mixing of the graphs in the middle of text.

Capsule Reviews

In our individual capsule reviews, we want to list the functions that each program supports. There is a "standard set" we'll just abbreviate that comprises:

standard set: four functions, power, exponential, ln, sin, cos, tan, cot, hyperbolic versions of the four trig, inverse of trig and hyp, factorial (integer only)

We will also use the following abbreviations:

stat means mean, standard deviation, variance

gamma means the full Euler gamma function

Bessel means at least some subset of J and Y functions

FFT refers to the fast Fourier transform (discrete FT on 2^n points)

RAM required indicates the amount of memory you need free to load the program (to within about 5K). You'll at least need the memory taken for the operating system in addition. In addition all use available of memory to store so you'll typically need 50-100K more than the minimum to do much work.

Equation solving refers to the ability to solve simultaneous nonlinear equations in several unknowns (more than one or two and more than linear equations which are discussed under matrix support).

Complex numbers refer to the ability to use complex numbers freely as arguments, for example to write sin(i). By "full"-support, we mean the ability to effortlessly enter a number like

$$x = 1 + 3 * i$$

and to multiply complex quantities with the same symbols used to multiply reals. It may be necessary (as it is in MATHCAD or EUREKA) to one time configure the program to understand what "i" means. If there is at least the ability to define complex polynomials and multiply complex matrices, but special treatment of complex quantities is required, we'll use the word "limited".

Save Warning? indicates whether the program warns you if you try to exit without saving your work. It is, of course, inexcusable for a program NOT to do that. A general request for confirmation of your intention to exit without telling you that you have unsavedwork is not sufficient in our opinions so we have indicated that situation with the answer "No (Exit confirmation only)."

Shell to DOS? This deals with whether one can run a new shell of command.com ("shell only"), run programs ("yes") including a shell of DOS or do neither ("no").

EUREKA

RAM required: 260K

Graph types: Line only of a single variable

Log scales in graphs: No

Graphics device support: CGA, Hercules, EGA, even primitive graphs in text mode

Printer support: IBM graphics printer compatible only

Math coprocessor: Used but not required, automatically detected if present

Functions: Standard set, numerical integration and differentiation, simple financial like future value

Matrix support: None

Equation solving: Yes

Complex numbers: Full but flawed

Branching: No

Users defined functions: Yes

External language support: No

Save Warning?: Yes

Shell to DOS?: Shell only

EUREKA is intended to solve up to 20 equations in multiple unknowns (it is limited to 6 equations if you have complex variables and round off errors become significant after about 10 equations). It does this very well but otherwise it is limited. No matrices, no gamma or Bessel functions, no log plots. And it seems to choke on certain types of complex equation solving as we'll explain when describing benchmarks.

EUREKA's strength is clearly its user interface. With MATHCAD's equation solver, you'll need to type in all the equations after solving to verify the extent to which the equations actually hold for the hypothetical solution. With EUREKA, a single key provides this information. Another key will graph the current function and one can put all this output easily into a report. If you want, several of these separate modules can appear in separate windows on the screen. Especially given the fact that it is available at discount from mail order software houses, it is by far the least expensive of these programs for individual purchase.

But as our benchmarks also show, it consistently quits working with the smallest numbers of variables and had problems with complex polynomials. As we remarked already, this program could be useful for classroom use and its easy interface makes it suited for very occasional use, but otherwise, we'd place it at the bottom of our list.

There is a version of EUREKA for the Macintosh.

TKSOLVER PLUS

RAM required: 290K

Graph types: Line, bar, pie built in, contour graphs via work sheet

Log scales in graphs: Yes

Graphics device support: EGA, CGA, Hercules

Print Supporter: only via PrtSc and the DOS graphics command

Math coprocessor: Used but not required; authomatically detected, if present

Functions: Standard set, net present value, gamma, Bessel; in addition many functions provided via work sheets including Simpson's rule integration and numeric differentiation, fast Fourier transform

Matrix support: Via separately loaded modules: multiplication, inverse, determinant, eigenvalues

Equation solving: Yes, both by substitution and Newton's method

Complex numbers: Limited (fairly complete but special notation is needed to handle complex quantities)

Branching: Yes, extensive options

User defined funtions: Yes

External language support: No

Save Warning?: No (exit confirmation only)

Shell to DOS?: No

This is the most powerful by far of the general purpose packages (EUREKA, it and MATHCAD). Compared to it, they seem rather limited. In addition to its basic built-in equation solving via either direct substitution or Newton's method, it has an extensive language and comes with a wide library of worksheets with functions that you can use for many purposes: a fast Fourier transform, numerical differentiation, symbolic differentiation, for a very restricted class of functions, even a Runge Kutta differential equation solver!

TKSOLVER uses the windowed worksheet as its main meta- phor. There are nine main windows but each can have subsheets. Two are most important: the rule sheet and the variable sheet. If you type in an equation that you want to be one of the rules, it automatically adds the variables in the equation to the variable sheet. Keeping the variables separate and ready for instant viewing is a nice touch. The definitions of procedures and functions are kept in a separate sheet as is a list sheet for things like tables and matrices. You can have up to two windows on a screen at a time and hitting "=" when at command mode brings up a list of windows. This separation is useful but it does add considerable complexity to the program. Indeed, we consistently found it difficult to use TKSOLVER without frequent recourse to the manual. TKSOLVER has excellent context sensitive help but while learning the program, we found that we needed to look in the manual to get some idea how to attack problems. We suspect that once one masters the program, the online help would be enough. TKSOLVER has a toll free number for questions.

TKSOLVER handles syntax and equation inconsistency errors quite well. Equations with a problem have a > placed in the margin and moving the cursor to that > displays an error message about the problem.

While this program is very powerful, some of that power may be overkill: it's clearly nice to be able to burst into your neighbor's office and boast that your supercalculator does Runge Kutta but we suspect that if you really need RK, you'd be best served to write a compiled program to number crunch rather than to use an interpretive language like TKSOLVER. The other downside of the power involves a more complex user interface (although if you've been turned off by an earlier version of TKSOLVER, the precursor of TKSOLVER PLUS, the interface has improved considerably from those earlier versions) and some considerable effort to set up the program so that the functions you really want are easily available. With EUREKA or MATHCAD, numerical differentiation is built in; with TKSOLVER, you'll need to transfer it from the library into your regular toolbox "model" if you want to use it regularly. The bottom line is that if you have need of this kind of program (i.e. equation solving) on a daily basis, it is probably well worth the effort to master this program and we feel, barring some special circumstances, this is the program of choice for you. If your needs are likely to be occasional, one of the other programs, probably MATHCAD would be a better choice.

While we admire TKSOLVER, we found it the most difficult program "to get into". We spent as much time with the program as with any other but felt the least secure in using it. Indeed, most of the methods we used in the first draft of our benchmarks were awkward and were replaced by superior suggestions made by the TKSOLVER staff.

TKSOLVER has the unique feature of combining its equation solving with its other modules. If you wanted to graph a parametric equation where the relations of the graphed variables to the parameter were only implicit, TKSOLVER would do it rather easily and all of the other programs would do it only with difficulty, if at all. The cost for this power is that it becomes a more involved process to set up parametric equations with only explicit equations than in any of the other programs.

There are two limited versions of TKSOLVER availabe. McGraw-Hill sells a student edition for \$44.95—this is the same as the main program but without the extensive libraries of functions (which provide differential equation solving, numeric integration and other basic features), with only one of the three manuals and without support. There is also a free demo program available upon request which allows solutions of up to 24 scalar equations in up to 32 variables limited to the built in functions without the programmability or the array handling. There are versions of TKSOLVER for the Macintosh, Apple IIe, TRS-80 and several non-compatible MS DOS machines like the DEC Rainbow.

MATHCAD

RAM required: 340K

Graph types: Line, dot, bar

Log scales in graphs: Yes

Graphics device support: REQUIRES graphics monitor—CGA, EGA high res, Hercules

Printer support: Together with MATLAB and APL*PLUS, the best of all these programs includes standard dot matrix, HP laser and plotters (but not PostScript support)

Math coprocessor: Not required but supported and recommended; automatically detected if present

Functions: Standard set, stat, Bessel, fft, linear regression, linear interpolation, cubic spline, gamma, erf, numerical integration and differentiation

Matrix support: Yes, products, inverses and determinants

Equation solving: Yes

Complex numbers: Full

Branching: VERY limited (two functions only "if (cond, $v1, v2$)" which returns $v1$, resp $v2$, if cond is true, resp false and until (exp 1, exp 2) which iterates exp 2 until exp 1 is negative)

User defined functions: Yes

External language support: No

Save Warning?: Yes

Shell to DOS?: Yes

If it weren't for the issue of speed, MATHCAD would be close to an ideal supercalculator. Not that we haven't complaints but except for symbolic manipulation, it has all the functions that you'd want: not only the standard ones including statistics, but even linear correlations and cubic splines. It has a Newton's method solver and FFT. It will integrate (using Simpson's rule) and do a numerical differentiation. And it will allow reports with real cap sigmas for sums! Moreover, it does simple calculations with the least amount of thinking and reading of manuals.

Its Achilles' heel is the issue of speed. There are two different aspects of this. As our tests show, it is relatively slow in its calculational ability. In addition, by default it computes the formulae scrolling into view as you scroll so you'll often have to sit there while WAIT flashes on the screen. On a 16 MHz '386, this wasn't too bad but it was unpleasant on an 8 MHz Toshiba 1100+—we suspect we'd find it unacceptable on an original PC or XT. You can turn off automatic calculation but scrolling is still slow because of the graphics mode and you need to remember to hit the Calc key regularly. Even worse, you need to remember that the Calc key isn't enough when you do a printout. You must instead call a special command to recalc the entire document.

Another weakness is the limited language capability but by careful use of vector valued functions you can go quite far: we figured out how to compute greatest common divisors in spite of the fact that their tech support said that it couldn't be done!

Except for the speed issue, there is a lot to like about MATHCAD. You can issue commands through function keys, through menu or from a command line. While its initial RAM requirements are high, it supports EMS for its workspaces. And it has a toll free support number.

MATHCAD understands complex numbers very well—you can ask it to compute $\sin(2i)$ if you want.

We did have a few gripes: the editor is idiosyncratic—because of the structure of its equations, one has to expect some compromises but we found this the most disconcerting part of the program: Del and Backspace mean the same thing and Ins toggles between two insert modes(!)—there really isn't an overtype mode at all. It was annoying that you couldn't configure the program to use the keys you wanted: [means subscript—too bad if you'd find something else more natural. And we never did fully comprehend where the cursor needed to be placed for certain operations. If you want to define a variable "n" to be equal to 2, you must have

$$n := 2$$

on the screen which you put in by typing "n : 2". If you start typing "n =" you immediately get an "undefined variable" error. We never did figure out where to place the cursor to remove the = without also removing the n! In particular, after an error message, backspace does not undo the last keystroke.

For some reason, MATHCAD indexes vectors and matrices starting at zero; that is, a vector of length n has coordinates labeled by $0, 1, \ldots, n-1$ instead of $1, 2, \ldots, n$. We understand why this is done in assembly language and the C language (where indices represent "offsets") and is an option in APL. Despite the fact that it can be changed, we find this an awkward and strange default in a package that otherwise makes a point to closely approximate the most standard mathematical notation.

The online help isn't bad but it is not context sensitive and it isn't available when you really need it. If you want to change the formatting of an equation—you choose format from a menu and get a cryptic list of the current values of the formatting parameters. You'd think that it would be natural to call up help at that point and to see what the parameters mean but help isn't available then! If you need to check what the parameters mean, you must accept the old formatting values, call up help and then recall Format from the menu. One of the strengths of this program is the ability to provide screen and printer output with characters which aren't in the text mode set. Then why limit me to only 17 Greek letters: what if I happen to want a lower case gamma or a chi? And why not give me access to italics and boldface—even an additional font for section headings? While most uses of a supercalculator don't require serious programming constructs, their lack really limits this program to supercalculator functionality.

But these complaints are minor. If your machine is fast enough or you are patient enough, this is the program for you!

One final remark. Addison-Wesley sells a student edition of MATHCAD for not much more than 10% of the price of the regular program. This program is not only limited in the size of documents allowed but is a limited edition of version 1.1 of MATHCAD rather than the version 2.0 that we are reviewing (MATHCAD version 1.1 is missing the matrix support and the ability to solve sets of simultaneous equations). We have been told that a student edition of MATHCAD 2.0 is planned.

POINT FIVE

RAM required: 215K (8087 version)

Graph types: Dot, line, bar, stacked bar

Log scales in graphs: No

Graphics device support: CGA, EGA in CGA emulation only, Hercules

Printer support: For graphs via PrtSc command only

Math coprocessor: Separate 8087 and non-8087 versions

Functions: Standard set (except hyperbolic), stat plus many additional statistical functions including chi squared and *t* test, many financial functions

Matrix support: Yes, products, inverses and determinants

Equation solving: Linear only via matrix inverse

Complex numbers: No

Branching: For loops, if-then-else allowing multiple statements after then or else but no gotos and no subroutines

User defined functions: No

External language support: No

Save Warning?: Yes

Shell to DOS?: No

POINT FIVE is a broader program in what it can do than the others under review in that it has many spreadsheet like properties and this will become more pronounced when version 2.0 is available. In this sense, it is addressed to a broader market than the other programs under review including social scientists. But its mathematical ability is more limited than any other program under review except perhaps for EUREKA. For pure supercalculator purposes, it has many lacks: no user defined functions, no equation solving, no integration or differentiation and no complex numbers. But it has a wide array of other functions that may make it attractive as a multi-purpose program that has some supercalculator features. It has among the most complete statistical analysis functions of the programs under discussion and it has various built in routines for computing interest payments and future values.

POINT FIVE has some of the feel of APL from which it borrows the idea of workspace. It is a friendlier environment than APL with the lovely idea of separating output from input. POINT FIVE's strength involves its ability to deal with data structures. It has a built in array editor which is a pleasure to use. Its ability to manipulate these arrays makes it a tool that could reasonably replace a spreadsheet in many places that one might want to use one.

POINT FIVE admits a data type called "tables". A table is a matrix whose rows and columns can be labeled—and the column and row vectors can then be referred to by name. If your calculus class grades are kept in a table, you can ask POINT FIVE to calculate sum(johndoe) or sd(exam2)—the latter computes the standard deviation.

The program has a number of annoying features, most of which we've been told will be addressed in version 2.0: if you want to multiply matrices you must type out in full the keyword MATRIXMULT (and similarly for other functions); its support for printing graphs is limited to hitting PrtSc and it doesn't support high resolution on the EGA.

Version 1.0 of this program is an interesting first step but it is rather limited. We are excited by what we've told will be in Version 2.0 but in a world with vaporware, one should exercise restraint in purchasing programs on the basis of promised future versions. Given its rather aggressive sitewide licensing program though and the functionality already built in, this is worth your consideration.

PC-MATLAB

RAM required: 270K (will run with less but graphics not available)

Graph types: Line, bar, polar, 3-d surface, 3-d contour

Log scales in graphs: Yes

Graphics device support: CGA, EGA, Hercules

Printer support: Together with MATHCAD and APL*PLUS, the best printer support: Epson printer, Postscript, HP LaserJet, various plotters, other devices with CGI support; the major lack is no support for the Toshiba 24 pin dot matrix printers

Math coprocessor: Required

Functions: Standard set, gamma, stat, fft, poly fit, many electrical filtering functions, splines

Matrix support: Very extensive, including det, eigenvalues and eigenvectors, qr and Schur decompositions, others

Equation solving: Yes

Complex numbers: Yes

Branching: If, for, while, subroutines, pause for keystroke

User defined functions: Yes

External language support: Microsoft C, Borland's Turbo C and Microsoft Fortran

Save Warning?: No

Shell to DOS?: Yes

MATLAB is included here because it has functionality as a supercalculator but that isn't its real purpose. It is intended as a serious language for any kind of linear mathematics and is used for real number crunching. As discussed earlier, it has support for other computer systems (Macintosh, VAX, Suns) and is one of the first programs available with support for 80386 based machines and Weitek coprocessors. You manipulate data either in immediate mode or more often by writing scripts. Most of the functions that the program comes with are precisely in the form of these external script files called M-files. It does not come with its own editor so to write M-files you'll need your own ASCII editor which you can call directly from the program. MATLAB will load the functions into memory the first time in a session it is called. For better or worse, you may not define more than one function in a file, so our disk drive soon was full of dozens of these M-files

The script files can call a vast array of matrix and vector functions—not merely the standard ones but functions like Cholesky factorization. The routines used are based on the LINPACK and EISPACK projects. There are also logical functions and many program control functions.

MATLAB understands complex numbers very well—you can ask it to compute $\sin(2i)$ if you want.

If you use ANSI.SYS to set colors at the DOS prompt, MATLAB's text screens will be a mixture of black and the ANSI colors for a rather awkward appearance.

Most impressive are MATLAB's graphics capabilities including some 3-d graphing. It has excellent printer support; you need to save the graphs in a special file then exit the basic MATLAB program to run another program to print, but the graphs on a LaserJet are really impressive. Unlike the version of GAUSS current at this writing, MATLAB supports the LaserJet at a full 300 dpi if your printer has sufficient memory.

We found MATLAB relatively easy to learn and use. We think it would be quite practical to use in, say, a linear algebra class. A few examples provided by the instructor would enable those with some programming experience to catch on immediately. And once M-files are understood, matrices for analysis, or subroutines to be incorporated into student work, can be distributed easily on floppy disks or electronically. (The only problem for some students might be the need for an external editor.)

If matrices are your stock-in-trade or you need the portability to minicomputers, 386 or Weitek support, then this is a serious program to consider. If not, GAUSS' more powerful programming environment may be a more sensible choice although it is harder to use.

GAUSS

RAM required: 170K (graphics requires much more; over 400K free)

Graph types: Line, bar, polar, 3-d surface, 3-d contour

Log scales in graphs: Yes

Graphics device support: CGA, EGA, Hercules (VGA support promised in Version 2.0 which may be out by the time this article is published)

Printer support: Various dot matrix, HP LaserJet but only at 150 dots/in resolution (300 dpi and postscript support promised in Version 2.0 which may be out by the time this article is published)

Math coprocessor: Required

Functions: Standard, stat, Gamma function, non-parametric statistics, FFT, time series functions (but no Bessel functions)

Matrix support: Determinants, products, eigenvalues

Equation solving: Nonlinear systems with up to 90 equations claimed by a direct method with several alternates, nonlinear maximization also

Complex numbers: (Special program files and symbols required)

Branching: Do while, do until, if ... then ... else

User defined functions: Extensive including local variables

External language support: Microsoft C and Fortran, RM Fortran, C86 (but not Turbo or Quick C)

Save Warning?: No (Exit confirm only)

Shell to DOS?: Yes

In terms of what it can do, this is an impressive product. It comes with over 500 pages of documentation and 10 disks, mainly with extra modules allowing solutions of non-linear equations and sophisticated statistical analysis. It is consistently among the faster programs in our benchmarks and the most powerful programming language of any of the programs under discussion except APL. Its only serious weak point from a mathematical point of view is that its support of complex numbers is limited. It doesn't directly understand things like $\sin(i)$ although you could easily develop your own library of such functions if you wanted. It has a number of functions to handle complex matrices but you must always enter the complex matrix as a pair of matrices representing the real and imaginary part.

Its graphic support is also extensive and quite well done although it is unfortunate that even on a LASER JET with sufficient memory it can only handle graphs at half density, a lack which is supposed to be corrected in Version 2.0.

In spite of all this, the interface to the program (in the version current at the time we wrote this review) is extremely clunky. It has a direct mode where you can just type in an arithmetic string but you must end each line with ⟨F4⟩ ⟨F2⟩ to execute. Moreover, it insists on telling you that the current directory on a separate line each time that you make an execution so the screen quickly fills up. Since you can only type on the current screen and access one saved screen of commands, this is most unfortunate. And like MATLAB, with ANSI installed, your screen will be an awkward looking mixture of black and color. In addition, since GAUSS uses DOS to get keyboard input, if you've redefined keys with ANSI.SYS, you'll have to undefine them before entering GAUSS. Just as we were finishing this review, we received a beta test copy of Version 2.0 which is expected to be released before this review is printed. At least some of our complaints about the interface have been answered although a quick look suggests it still has some serious lacks such as a decent matrix editor.

There is a possibility with GAUSS, you may no longer have any need of Fortran, Pascal, C or whatever other programming languages you may be using for computations. (Even though APL is also powerful and used constantly by one of us, there are tasks for which we find it awkward and slow. And MATLAB and the others that have programming languages don't have quite enough control statements or access to the system to satisfy us.)

The basic data type in GAUSS is the matrix and there are hundreds of functions built into GAUSS for dealing with matrices. For example, given a matrix x, MININDC(x) will return a column vector containing the index (i.e. row number) of the smallest element in each column of x. We didn't come close to learning them all; the Command Reference section of the manual runs 300 pages. GAUSS also has sophisticated ways for dealing with missing or non-number entries in matrices.

Aptech Systems, the publishers of GAUSS have announced GAUSS 2.0 which they expect to ship before this article is published. A version of GAUSS for 386 machines is also expected out soon.

APL*PLUS PC

RAM required: 180K (with graphics)

Graph types: Line and pie graphs

Log scales in graphs: No unless you program them yourself

Graphics device support: With VDI, support for CGA, Hercules, EGA, VGA

Printer support: With VDI, very complete including Epson, Toshiba and HP printers/plotters but not postscript

Math coprocessor: Recommended but not required; automatically detected if present

Functions: Standard set, stat built in—many others in workspaces

Matrix support: Basic operations including inverses built in. Determinant, eigenvalue and eigenvector workspace available

Equation solving: Only possible by programming it yourself (but a workspace which solves a single complex equation of a single complex variable is provided)

Complex numbers: Limited (special complex workspace with special functions needed)

Branching: Yes

User defined functions: Yes

External language support: Assembly

Save Warning?: No

Shell to DOS?: Yes

A note on graphs: Traditionally, APL graphics relied on a set of routines called ⎕G functions and they were far from transparent to the user. With the current version 7.0, VDI support from GSS has been included with drivers for a wide array of printers and monitors. With maximum buffering for bitmaps, and an EGA/LASERJET combination, these drivers reduce the memory available to APL by about 130K.

While MATHCAD does have some very limited programmability, its basic philosophy is to provide you with canned routines that are relatively easy to use. A program like MATLAB is basically a programming language limited to mathematical manipulation with lots of canned routines that you can invoke or modify by changing the source code provided. APL is on the opposite end of the spectrum from MATHCAD—it is a full fledged programming environment with a limited number of canned routines included with the basic package.

One could argue that we could just as well discuss BASIC as APL, but in fact APL was developed by a mathematician as a compact language for mathematical expression and so stands out among programming languages that a mathematician might want to use and as time goes on, STSC includes more and more canned routines with their basic package. It seems to us that the language is especially well suited to problems in algebra and discrete mathematics. It takes a little getting used to but once you do, it becomes quite natural to write something like

$$+/\iota\ 100$$

to sum the numbers from 1 to 100 (ι 100 forms a vector with a 100 entries and +/ sums the vector). Other aspects of the language take more getting used to. It has its own symbol set so you'll need to replace a character ROM on a monochrome monitor or CGA (there are soft character fonts for the CGA but they are far from ideal and one losses considerable functionality in the user interface) or downloadable fonts on the EGA or VGA. Moreover, by default APL uses its own keyboard driver. If you use this driver, macro programs, cut and paste utilities and other resident programs are not available. You can choose to not use the APL driver and have a keyboard macro program present but then you are forced into a strange keyboard remapping where, for example a ")" is not entered with the key that has a ")" on it but the one with a quote on it! So while a macro program will record keystrokes properly for playback, they will not appear in the macro editor as they appear to APL! Another unfortunate consequence of the special character set is the impossibility of using one's favorite editor to write programs. The full screen editor in STSC's implementation of APL is limited but APL programs require special characters not available in other editors.

Among APL's strengths are its many array primitives. When we said it didn't have many "canned routines", we meant things like LU-decomposition of matrices. But you can quickly reverse a vector V with ϕV, drop the first five coordinates with $5 \downarrow V$, order its elements with $V[⍋V]$, find the value of the largest coordinate with $\lceil/V$, decide whether some coordinate is 7 with $7 \in V$, extract the positive coordinates with $(V > 0)/V$, and find the first nonzero coordinate position with $(V = 0)\iota 1$. If M is a matrix, then $M[⍋M;]$ reorders the rows lexicographically. With a few keystrokes and no programming, you can rotate the ith row of M i coordinates to the right, add a column of zeros, delete the rows of all zeros, etc.

An important aspect of APL is the idea of "workspace", which has been borrowed by many other programs. Every function or variable created (and not erased) during a session is saved in a single file by the command

)SAVE wsname.

When the workspace is loaded at a later session, all functions and variables can be freely used.

STSC has announced APL* PLUS II/386, a version that runs on 80386 computers making use of the large address space of those computers. It allows nested arrays and we are told that its handling of editing matrices and many of the other issues we discuss is much improved.

Benchmarks: Overview

There are perhaps two types of problems one might use as tests or "benchmarks" for these programs. First, there are those problems which are relatively simple and to which one just wants a quick answer with no fuss. Then there are those problems which one might wish to more intensely investigate or research. For the latter, one should be willing to spend hours reading the manuals and learning the programs.

We don't claim to have done any research level problems, but we did choose the Gibbs Phenomenon as a topic to investigate in depth with several of the programs. In the other samples, we limited the effort spent on our approach to the problem to what we consider a reasonable amount so that we didn't do certain problems which would be possible if we wrote a little program.

The sample problems were done on an 8MH IBM PC-AT with 640K of memory (505888 bytes free after the operating system and user's TSR's were loaded), an 80827 mathematics coprocessor, and an EGA (enhanced graphics adapter). The time required for execution on other machines will be different. For example, a 4.77MH 8088-based IBM PC or compatible without an 8087 coprocessor will require perhaps five times as long.

Our list and a brief description of the sample problems follows. In describing the code we used to solve the problems, we have chosen to save space by putting several statements on one line. The statements are separated by the program's statement separators.

GCD: Compute the greatest common divisor of two 15 digit integers.

Lissajou: Graph $x = \sin(2t + 0.6)$, $y = \sin(5t)$ as t ranges over $[0, 2\pi]$.

Roots: Find the roots of $x^3 - x^2 - x - 1$.

Hilbert: What is the largest Hilbert matrix $H_n = (1/(i+j))_{i,j=1}^n$ which can be successfully inverted? Hilbert matrices are chosen because they are very close to being singular.

Inverse Squares: Evaluate $\sum_{k=1}^{8000} 1/k^2$. (How long does this take?)

Simultaneous Equations: Solve the (admittedly ridiculous) system

$$\begin{cases} \sin(x) + y^2 + \ln(z) = 7 \\ 3x + 2^y - z^3 = -1 \\ x + y + z = 5 \end{cases}$$

The benchmarks suffer the usual complaints that benchmarks are subject to: to make them quick and self-contained, they are simple and rather trivial and so it can be claimed that they don't really test these programs. This is correct: they are not so much intended to "test" these programs as to illustrate how they work.

Benchmarks: GCD

We first tried to define a function GCD which could be used freely in subsequent work; only in APL, PCMATLAB, TKSOLVER and GAUSS were we able to do this. But all programs except EUREKA did solve our isolated example.

POINT FIVE: We typed in the four lines

```
001  a = 156562431911123
002  b = 442677773754356
003  for i = 1 to 50 do if b eq 0
     then i = 51 else temp = b,
     b = mod(a, b), a = temp
004  a
```

It took about 1.5 seconds to supply 7 as an answer.

PCMATLAB: We created an *M*-file:

```
function b = gcd(a, b)
if a = 0, return, end
b = gcd(rem(b, a), a);
```

(One of us is very fond of recursive programs.) Then we asked PCMATLAB to compute

gcd(156562431911123, 442677773754356)

and got the message

error 2000 : Stack overflow

and found ourselves at the DOS command line. But

gcd(15656243, 44267777)

was found to be 1 in about a second. We rewrote the *M*-file as an iterative program and the former gcd was done correctly in a second.

APL: We wrote a short recursive function:

```
[0]  A ← A GCD B
[1]  → (B = 0)ρ0
[2]  A ← B GCD B|A
```

It took about 1/4 second to execute

156562431911123 GCD 442677773754356.

GAUSS: We typed

```
≫ proc gcd(a, b);
if b = 0; retp(a); endif;
rept(gcd(b, a%b)); endp ≪
```

and then pressed ⟨F2⟩ to define gcd. In an instant, we had

gcd(156562431911123, 442677773754356).

EUREKA: Can't do it.

MATHCAD: It is not easy to calculate GCDs in MATHCAD, but we did it. Here is an approximation of what our screen looked like after we finished:

$$v^{\langle 0\rangle} := \begin{bmatrix} 156562431911123 \\ 442677773754356 \end{bmatrix}$$

$$f(x) := \begin{bmatrix} x_1 \\ \mathrm{mod}[x_0, x_1] \end{bmatrix}$$

$$i := 0..100$$

$$v^{\langle i+1\rangle} := \mathrm{until}\left[v^{\langle i\rangle}{}_1 - 1, f[x^{\langle i\rangle}]\right]$$

$$\mathrm{cols}(v) = 30$$

$$v^{\langle 29\rangle} = \begin{bmatrix} 7 \\ 0 \end{bmatrix}$$

TKSOLVER: The TK manual emphasizes using the provided procedures rather than writing your own and indeed GCD is in a model. One has to know where to find it but then one hits/SL (which calls up the main menu with /, chooses Storage from that and then Load from the storage submenu). Then ⟨Enter⟩ brings up a file listing with a cursor one can manipulate to choose the file. Once loaded, one has the GCD function available. If one has just followed the tutorial, it would be tempting to set up a rule $x = \text{GCD}(a, b)$ and then go to the variable sheet and put in the values of a and b but TK has an immediate evaluate command */EE* (Evaluate Expression) after which typing in

GCD(156562431911123,
442677773754356)

provided the value 7 immediately.

Trying to roll our own, it took us a while to figure out how to write procedures in TKSOLVER (the manual is not very good on this; it emphasizes using the provided applications rather than writing your own), but in the end it was simple. We created a procedure GCD which had a and b as input variables and d as the output variable, and which was defined by

```
top: if b = 0 then goto done
call mod(a, b; rem)
a := b
b := rem
goto top
done: d := a
```

Then we typed

/ee GCD(156562431911123,
442677773754356)

found the answer 7 immediately.

We also tried a recursive function following a suggestion from the makers of TKSOLVER. One makes a, b the input and d the output as above but lets the function GCD be defined by the single statement

```
if b > 0
then d := GCD(b, mod(a, b))
else d := a
```

Typing

/ee GCD(156562431911123,
442677773754356)

caused an error message "Functions nested too deep". While this is better than MATLAB's dump to DOS, it doesn't seem much BETTER but in fact one can recover completely. The values of a and b at the time the nesting became too deep are stored in the variables a and b, so that entering /ee $\text{GCD}(a, b)$ will complete the recursion yielding 7.

Benchmarks: Lissajou

MATHCAD: We typed in

```
f(x) := sin(2 * x + .6)
g(x) := sin(5 * x)
t := 0, .05 .. 6.3
```

Then hit @ for a plot and graphed $f(t)$ against $g(t)$ with appropriate limits. Success.

POINT FIVE: We typed in

```
t = index(120) * pi/60
x = sin(2 * t + .6)
y = sin(5 * t)
linegraph(y, x)
```

Success. The graphing is done in CGA resolution, so was not as nice as in MATHCAD. POINT FIVE chooses the limits of the axes for you, which was appreciated.

EUREKA: EUREKA can only graph functions of a single variable; it cannot graph parametrically.

APL: APL as a programming language has quite decent graphing primitives. But it is not for casual use as a graphing program.

Nevertheless, STSC has provided a graphics support workspace which makes possible what might be called semi-casual graphing. It is more involved than the previous programs to set up; we first had to edit DOS's CONFIG.SYS file to include (to support an ega; a third file would have been needed if we'd wanted to use VDI graphics on a supported printer) the lines

```
device= c : \apl\ibmega.sys
device= c : \apl\gsscgi.sys
```

and install an interrupt handler (APLCG12.EXE in our case), call up APL and load the VDI.AWS workspace. Then the procedure is similar to the other programs:

```
T ← ∘0, (⍳200) ÷ 100
X ← 1 ∘ .6 + 2 × T
Y ← 1 ∘ 5 × T
DISPLAY '0 0 640 350
XYPLOT X, [1.5]Y'
```

The graph displayed the 101 plotted points (as dots) joined by line segments in EGA resolution with a pair of axis (but without labelling or graduations).

One of the obscurities of APL is apparent; instead of $\text{SIN}(X)$, one must write $1 \circ X$. If you complain to an APL person about this, he will respond that you can easily *define* SIN X in your workspace to be 1 "circle" X. Nevertheless, this (remembering the meaning of the symbols, not to mention where to find them on the keyboard) is a big problem for beginners—and if you are a casual user and don't use APL for a month, you will surely forget. Similarly, the ",[1.5]" indicates one of a large number of different ways of concatinating matrices.

PCMATLAB: We typed in

```
t = 0 : .05 : 6.3;
x = sin(2 * t + .6);
y = sin(5 * t);
plot(x, y)
```

and PCMATLAB choose the limits of the axes and numbered them for us. The program recognized our EGA and gave us a red graph with white axes.

TKSOLVER: We went to the Variable sheet and with a few keystrokes specified t as an input list and x, y as output lists. Then we had to highlight t and hit ">" twice to "dive" into the subsheet for t. Then hitting "!" brought up a dialog to define t as a list from 0 to 6.3 in units of 0.05. Next we had to go to the Rule sheet to type in the parametric equations and then hit ⟨F10⟩ to evaluate the output lists. By default the program insists on flashing answers as it computes, so we had to wait a noticeable amount of time for what was only about 200 simple calculations (we later learned of a way of modifying this default which sped up the calculations considerably). Then we had to go to the plot sheet and specify that we wanted a line plot with x and y as the variables on the x and y axes. Finally ⟨F7⟩ drew the graph.

TKSOLVER recognized our EGA and choose the axes for us. The graph quality was good but the number of keystrokes needed and the involved interrelationships which one had to juggle made this far from the effortless task it was in POINTFIVE, MATHCAD, MATLAB or GAUSS.

We should report here the comment that the product manager for TKSOLVER made to this complaint: for a simple contrived problem like this, TKSOLVER is more complicated than need be but the complication is there to accommodate more complex situations where x and t might obey some involved implicit equation rather than an explicit one. There is some merit to this remark: while MATHCAD shines in the trial problem, if x and t were given implicitly, one would be hard pressed to graph the function with MATHCAD. In TKSOLVER, the structure is such that setting up the problem would be no harder than the simple parametric equation that we discuss.

GAUSS: First one types in

$$\gg \text{run graph2d.get} \ll$$

followed by ⟨F2⟩ ⟨F4⟩. The double chevrons are not typed in (they are the GAUSS program delimiters). ⟨F2⟩ ends the program and ⟨F4⟩ executes it and in this case 2 dimensional graphing routines are loaded into memory. Like so many other features, graphics must be loaded as an external program. Then one need only type in

$$\gg t = \text{seqa}(0, 0.05, 126);$$
$$px = \sin(2 * t + .6);$$
$$py = \sin(5 * t);$$
$$\text{call graph2d;}$$

to get a graph with default axes properly choosen. Before running GAUSS, you run a configuration program to pick colors and to tell GAUSS that you have an EGA. Default axes, colors etc. can all be adjusted by setting certain global variables to the desired values.

Benchmarks: Roots

APL: STSC's APL*PLUS comes with a workspace COMPLEX which contains, in particular, a routine CXROOTS which will attempt to find the complex zeros of any function you can define in APL. Like all the provided workspaces, you are not presented with what we would call a polished user interface (use EUREKA if you want that). Also, as is typical, the written documentation (a paragraph) is limited and you are referred to the workspace itself for additional documentation, but this was sufficient *if* you know some APL and, in the end, we liked the way it worked. However, we remark that CXROOTS compared poorly to some of the more specialized equation solvers when asked to find roots of the more complicated functions that we tried.

Here is what one must do after loading the workspace: We defined a function CXfn (you *must* use that name) by the single line

$$Y \leftarrow (X\, ZSTAR\, 3)$$
$$-((X\, ZSTAR\, 2) + X + 10)$$

Here ZSTAR is one of the function sprovided in COMPLEX. Note that the workspace uses a vector of length two to represent a complex number (so that i is represented by 0 1) and a 2 by n matrix to represent a complex vector, etc. This means that the usual + and − work as you would like with complex arrays but you must use other provided functions for multiplication, etc.

Then we executed

CXROOTS 1 2 3 4 5 6

and were rewarded with the display

¯0.4196433776	¯0.4196433776
0.6062907292	¯0.6062907292
1.839286755	
¯2.90300813E¯28	

the columns of which represent the three roots. This took 13.7 seconds when we supressed the display of the intermediate iterations and a couple seconds more if we did not.

The numbers following CXROOTS are "guesses" which you provide to the function (and which are interpreted as half as many complex numbers). You must provide at least as many pairs as you want roots (although for some reason, you may not provide just one pair). The function CXROOTS is pretty clever in what it does with the guesses; it never finds a root more than once and often *any* guesses sees to work. For example,

CXROOTS 100 101 102 103
104 105 106 107

produces as output

*No convergence for root number 4; value returned for that root is the computation after 6 iterations

⁻0.4196433776 ⁻0.4196433776
0.6062907292 ⁻0.6062907292
1.839286755
6.058451752E⁻27
4.29896533E18
⁻3.732554945E17

MATHCAD: We set the number of digits displayed to 8 and typed in (the initial value of x is the starting value of x)

$x : 0$
$y : \text{root}(x\hat{}3 - x\hat{}2 - x - 1, x)$

which displayed as

$x := 0$
$y := \text{root}[x^3 - x^2 - x - 1, x]$

When we typed in $y =$, MATHCAD replied 1.83930348. If we went back up to $x := 0$ and entered $x : 1i$, since MATHCAD understands complex numbers, it replied

$-0.41969715 + 0.60633699i$

The observant reader may have noticed, as we did, that these are not correct after the 3 digit! After consulting the manual, we learned of a built-in variable called TOL which specifies the allowed error and which defaults to 0.001 so these answers are correct within the allowed error set up initially. We went back to the initial value $x = 0$ tried setting TOL to 0.0001 and were greeted with the message "Does not converge" so we tried $x = 1.83$ and got the same message BUT when we tried an initial guess of 1.9, we were rewarded with 1.83928676 and the complex root was obtained accurately when we took an initial value of i. The moral is that MATHCAD at least seems quite sensitive to the initial guess.

POINT FIVE: POINT FIVE can not solve equations (even polynomials) primitively. We could have failed it on this problem, but we were a little more patient and taught it Newton's Method

$$x_{i+1} = x_i - \frac{f(x_i)}{f'(x_i)}$$

for our particular polynomial. This may be more than many users wish to do in order to find roots.

We typed in the lines

$x = 2$
$x = x - (x * x * x - x * x - 1)/$
$(3 * x * x - 2 * x - 1), x$

and executing the second line until the value of x no longer changed. Thus we found the real root only.

PCMATLAB: This program has a built in polynomial root finder. All we needed to type in was

≫$p = [1 - 1 - 1 - 1]$
≫format long
≫roots(p)

to which it responded

1.83928675521416
−0.41964337760708
+0.60629072920720i
−0.41964337760708
−0.60629072920720i

GAUSS: One of the furnished "external functions" provided with GAUSS is a polynomial root finder. It worked quite well; here's what we had to do to get the answer:

≫ run eig.arc ≪
≫ run poly.set ≪
≫ LET $c = 1 - 1 - 1 - 1$;
polyroot(c) ≪

[Answer:]

1.83928676	0.00000000
−0.41964338	0.60629073
−0.41964338	− 0.60629073

This procedure actually works by setting up a matrix whose characteristic equation is the given polynomial and finding the eigenvalues!

EUREKA: We typed $x\hat{}3 - x\hat{}2 - x - 1 = 0$ into the Edit window and EUREKA solved (for the real root) correctly in less than a second. This was very easy. We then choose Options from the main menu, settings from the submenu, and changed Complex to YES. We added $x := i$ to the Edit window to tell EUREKA to start at that value and in an instant it had a wrong answer:

Solution:

Variables		Values
re x	=	.45791313
im x	=	−.63752431
Maximum error is		.11698753

Well, perhaps it is not wrong since it *is* within the maximum error. When we changed the equation in the Edit window to $x*x*x - x*x - x - 1$, the complex root was found accurately, so the bug is in complex exponentiation. In addition, EUREKA has an explicit "poly" function for finding all the roots of a polynomial. If one types in $f(x) := \text{poly}(x, 1, -1, -1, -1)$ and hits the Solve key, in an instant one is greeted with

Roots to the polynomial f

Real part	Imaginary part
−.41964338	0.60629073
−.41964338	.60629073
1.8392868	.00000000

This was nicely done but only partly makes up for the fact that doing it the way most users will try (if they haven't absorbed the manual) doesn't work.

TKSOLVER: We typed x^3 − x^2 − x − 1 = 0 into the Rule Sheet, went to the Variable Sheet and entered 2 as a "guess" for x and "G" in the status column which tells TKSOLVER that 2 is a guess and pressed ⟨F9⟩ to solve. Less than a second was required for the real root as 1.8392868. You enter complex numbers as pairs (x, y). It does not understand (x, y)^3 but it does understand POWER((x, y), 3) so we entered

```
POWER((X, Y), 3)
−POWER((x, y), 2)
−(x, y) − (1, 0) = (0, 0)
```

and made guesses for both x and y. It found the root −.4196434 + .60629073i. TKSOLVER also has an explicit model dealing with cubic equations which we could have used.

Benchmarks: Hilbert

We attempted to calculate the inverse, H^{-1}, of the Hilbert matrices of orders n for $n = 8, 9, 10, \ldots$. We defined ERR(n) to be the maximum of the absolute values of the union of the elements of $I - HH^{-1}$ and $I - H^{-1}H$ (as computed by the programs). The methods we had to use to construct the Hilbert matrices and to calculate ERR(n) will also be of interest to the reader as they give some idea of how to use the programs. The inverting of the Hilbert matrix for n about 10 takes a noticable amount of time, a second or two, in all these programs. The double loop to form the Hilbert matrix can take almost 10 seconds (although it was instantaneous in APL because of the built-in jot-dot operator).

In PCMATLAB, GAUSS, and APL, we had a choice of defining functions (writing small programs) to compute the Hilbert matrix given n, or to compute ERR(n) from n, or doing everything from the command line.

APL: A "DOMAIN ERROR" was given when we attempted to invert the Hilbert matrix when $N \geq 12$. The code used follows.

```
N ← 10 ⋄ H ← ÷¯1
 + (⍳N)∘. + (⍳N)
H INV ← ⌹ H
ID ← (⍳N)∘. = (⍳N)
 + ERR ← ⌈/, (ID − H + .
                × H INV),
(ID − H INV + . × H)
```

Here are the results:

$N = 8$	0.00000018348
$N = 9$	0.00000898586
$N = 10$	0.00028113640
$N = 11$	0.00697469388

POINT FIVE: POINT FIVE and MATHCAD seemed not to mind being asked to invert near singular matrices; they just did their best (and gave no warnings). Here is the code and the results with the former:

```
n = 10, h = shape(fill(0, n * n), n, n)
for i = 1 to n do for j = 1 to n
 do h[i, j] = 1/(1 + j − 1)
h inv = matrixinv(h)
id = shape(fill(0, n * n), n, n),
 for i = 1 to n do id[i, i] = 1
a = max(abs(id−
      matrixmult(h, h inv)))
b = max(abs(id−
      matrixmult(h inv, h)))
max(concat(transpose(a),
          transpose(b)))
```

$n = 8$	0.00000025331
$n = 9$	0.00000739097
$n = 10$	0.00016784667
$n = 11$	0.01135253906
$n = 12$	0.13476562500
$n = 13$	1.18750000000
$n = 14$	360.00000000000
$n = 15$	4.12500000000

PCMATLAB: For order 12, we got the message.

Warning: Matrix is close to singular or badly scaled. Results may be inaccurate.

$RCOND = 3.572248e-017$

and indeed this seems to be the case. Here is the code and the results.

We created an M-file HILB.M (MATLAB comes with a very similar M-file of the same name) containing the lines

```
function h = hilb(m)
for i = 1 : m
  for j = 1 : m
    h(i, j) = 1/(i + j − 1);
  end
end
```

Then we entered

```
n = 10;  x = hilb(n);
a = x * inv(x) − eye(n);
b = inv(x) * x − eye(n);
max(max(abs([a, b])))
```

at the command line. The answers:

$n = 8$	0.00000069771
$n = 9$	0.00004452642
$n = 10$	0.00166572630
$n = 11$	0.03627222776
$n = 12$	1.68031120300

MATHCAD: It was easy to form and invert the Hilbert matrix, but it was a challenge to compute ERR(n)—we got tired and did it by eye. One types in (recall that the origin of vectors and matrices in MATHCAD is 0)

$$n := 9 \qquad i := 0..n \qquad j := 0..n$$

$$M_{i,j} := 1/(i + j + 1)$$

and displays

$$M^{-1} \cdot M - \text{identity}(n + 1) \text{ and}$$
$$M \cdot M^{-1} - \text{identity}(n + 1)$$

and by eye looks for the entry of maximum absolute value (despite what the manual says, the max function seems to only work on vectors, not matrices). For 10×10 matrices this maximum was about 0.0005, about 2.0 for 12×12, and 188 for 14×14.

GAUSS: We typed in

```
≫proc hilb(n);
  local i, j, h;  h = zeros(n, n);
  i = 1;
  do while i <= n;      j = 1;
  do while j <= n;      h[i, j]
   = 1/(i + j − 1);     j = j + 1;
  endo;     i = i + 1;     endo;
  retp(h);     endp ≪
```

and pressed ⟨F2⟩ to define the function hilb(n). Then,

```
n = 10;     h = hilb(n);
max c(maxc(abs(h * inv(h)
  −eye(n)))); maxc(maxc
  (abs(inv(h) * h − eye(n))));
```

was executed (with various values of n) to find ERR(n) as

$n = 8$	0.00000017
$n = 9$	0.00000481
$n = 10$	0.00021564
$n = 11$	0.01033556

For $n = 12$, we got the message "matrix singular".

TKSOLVER: To TKSOLVER, a matrix is a list of lists (the rows). We loaded the model INVERT.TK. (The documentation is provided only as comments in the model.) We defined a "Procedure Function", Hilbert in the Function Sheet as follows

```
for i = 1 to n
  for j = 1 to n
    'a0[i][j] := 1/(i + j − 1)
  next j
next i
```

and a function worst defined by

```
W := 0
for i = 1 to n
  'w[i][i] := 0
  W := max(W, max('w[i]),
              − min('w[i]))
next i
```

and finally the rule sheet

```
call Mblank('a0, n);
initialization
call Mblank('A, n)
call Mdelete('a)
call Hilbert(n);
the above procedure
call LUDMIN
(n, 'a0, 'a, 'A);
built in matrix inversion
call Mproduct('a0, 'A, 'w)
W1 = worst(n)
call Mproduct('A, 'a0, 'w)
W2 = worst(n)
ERR = max(W1, W2)
```

The results were

$n = 8$	0.000000512
$n = 9$	0.000025083
$n = 10$	0.001103396
$n = 11$	0.036533826
$n = 12$	4.563780308

roughly comparable to MATLAB but not quite as good as GAUSS.

EUREKA: Since EUREKA only deals with equations, we asked it to solve the eight systems of eight linear equations equivalent to $H_8\underline{x} = \underline{e}$ where H_8 is the order 8 Hilbert matrix and $\underline{e}$ ranged over the eight unit vectors. Each system took between 5 and 47 seconds to solve (for some reason, the same system varied in the time required when we tried to solve it again, and very slightly different solutions were found). The maximum error according to EUREKA varied from .00057587813 when $\underline{e} = (1,0,0,0,0,0,0,0)^t$ to .61053876 which occurred when $\underline{e} = (0,0,0,0,0,0,1,0)^t$. We were tired of typing in the equations by hand and did not carry this test further.

Benchmarks: Inverse Squares

The effective use of arrays in the programs that have them (memory permitting) allows those programs, interpretive as they are, to approach the speed of compiled languages. Nevertheless, TURBO PASCAL was faster in actual execution time compared to the fastest (GAUSS) of our array processing supercalculators. Loops in these interpreters are terribly slow as our tests show below.

All programs used the math coprocessor and all those which did our problem gave the answer: 1.644809075.

APL: We entered "+/÷(ι8000) × (ι8000)" and got the answer in 5.6, 4.8, and 4.8 seconds, respectively, on three successive trials.

One and a half minutes were required for the following program to execute:

```
[1]  S ← 0⋄I ← 1
[2]  LOOP : S ← S + ÷I × I
[3]  → (8000 ≥ I ← I + 1)/LOOP
```

PCMATLAB: We typed in $x = 1:8000; \mathrm{sum}((1)./(x.*x))$ and 4 seconds later, we got

ans =
1.64480907466040

Programming an explicit loop with

$s = 0;\quad \mathrm{for}\ i = 1:8000$
$s = s + 1/(i*i);\quad \mathrm{end};$

s took 2 minutes, 14 seconds.

POINT FIVE: We entered "sum

(1/(index(8000) * index(8000)))".

The answer was the same as APL's and PCMATLAB's, but took 17 seconds. Five minutes, 15 seconds were required for the statement "for $i = 1$ to 8000 do $s = s + 1/(i * i)$;" to execute.

MATHCAD: We entered

$$i := 1..8000 \qquad \sum_i \frac{1}{i*i} =$$

and got our answer in 24 seconds.

EUREKA: EUREKA accepted "$x = \mathrm{sum}(1/(n*n), n, 1, 101)$" when asked to Solve and gave the correct answer. When 101 was replaced by 102 (or 8000), the error message "sum is too large" was displayed.

TKSOLVER: We went to the function sheet by typing "$= F$", filled in the blanks to say we wanted to define a procedure called isqr and used ">" to dive into the program subsheet. On that sheet, we filled in blanks to indicate that n was an input variable and z an output variable and then typed in the program

```
z := 0
for i = 1 to n
  z := z + 1/i^2
next i
```

Then we typed /ee isqr (8000) and after 16 seconds we got the answer 1.644809074660402.

GAUSS: We entered

$$x = \mathrm{seqa}(1, 1, 8000);$$
$$\mathrm{sumc}(1./(x.*x))$$

and received the answer in 1.92 seconds; this was the fastest of all our review programs. Even an explicit loop

```
i = 1;   s = 0;
do while i <= 8000;
s = s + 1/(i * i);
i = i + 1;   endo;   s
```

took only 26 seconds.

TURBO PASCAL: 1.26 seconds with the 80287 coprocessor; 3.90 seconds with Turbo's six byte reals and no coprocessor. We were surprised that GAUSS did as well as it did relative to Turbo.

Benchmarks: Simultaneous Equations

EUREKA: We typed the equations in the Edit Window, then pressed ⟨Esc⟩ and ⟨S⟩ to solve. In a little over a second, we had an answer:

Solution:

Variables		Values
x	=	.59905376
y	=	2.3959314
z	=	2.0050148

Maximum error is

$$1.7763568e - 15$$

TKSOLVER: We typed the three equations into the Rule Sheet. Then we pressed ";" to get to the Variable Sheet and put G's (for "guess") in the Status columns for all three variables; then ⟨F9⟩ to solve. Within a second or so we got the answer

Name	Output
x	.59905376
y	2.3959314
z	2.0050148

One unique feature of TKSOLVER is that it is not necessary to guess all three variables—it will mix direct substitution and its indirect method so that if you only guess two variables, it will use the third equation to find the third variable and then minimize the errors from the other two equations. In a simple problem like this, the time saving and potential increased accuracy in this change from three to two variables isn't important but it could be significant in larger problems. The fact that there are only two variables does give one access to various graphical methods and the TKSOLVER staff took this benchmark, used TK's contour graphing and located a second solution at

Name	Output
x	5.1004127
y	−2.6442372
z	2.54382442

MATHCAD: One begins by typing in the desired accuracy and digits displayed if you want more than the default 3 places. Then you put in guesses of the 3 numbers listed as equalities and follow that by the key word "Given". One then types in the equations using Alt− = to show equalities here. End with "Find(x, y, z) =" and the correct values are displayed within a second.

PCMATLAB: There is nothing advertised as an equation solver but in the readme file on disk is the description of a function added after the manual was printed:

"nelder.m Nonlinear optimization"

which minimizes a function of several variables. By setting up an explicit sum of squares and minimizing, one solves the equations. First you've got to make an M-file, call it xyz.m

```
function q = xyz(p)
x = p(1);   y = p(2);   z = p(3);
  q1 = sin(x) + y^2 + log(z) - 7
  q2 = 2*x + 2^y - z^3 + 1
  q3 = x + y + z - 5;
  q = sum([q1 q2 q3].^2);
```

Then, inside MATLAB, use the commands

```
format long
p0 = [1 1 1]
p = nelder('xyz', p0, 1e-8)
```

to obtain after 129 seconds (considerably slower than other programs!!):

0.59905375845510
2.39593140122909
2.00501484103321

GAUSS: This program comes with 12 external modules, one of which is a non-linear equation solver. After starting GAUSS, one issues the command

≫ run nlsys.set ≪

which loads the non-linear equation solver. Then one types in

```
≫ let p=1 1 1;
vf = zeros(rows(p), 1);
proc f(w);
local x, y, z;   x = w[1, 1];
y = w[2, 1];   z = w[3, 1];
vf[1, 1] = sin(x) + y^2
 + ln(z) - 7;   vf[2, 1] = 3 * x
 + 2^y - z^3 + 1;
vf[3, 1] = x + y + z - 5;
retp(vf);   endp;
x = nlsys(&f, p, 0, 1e - 6, 0, 1);
```

and within an instant, one gets the response

```
Final estimates for x are:
0.599054   2.395931   2.005015
```

In the above, the parameters for the function nlsys include $\&f$ which is a pointer to the function f, p which is the initial guess $1e-6$ which is the tolerance. The fact that one cannot deal directly with vectors but must discuss 3 by 1 matrices and the arcane syntax are typical of GAUSS.

The Gibbs Phenomenon

The Fourier series expansion for the square wave $s(x)$ defined by

$$s(x) = \begin{cases} \pi/4 & \text{if } 0 < x < \pi \\ -\pi/4 & \text{if } \pi < x < 2\pi \end{cases}$$

is

$$f(x) = \sum_{n=1}^{\infty} \frac{\sin((2m+1)x)}{2n+1}.$$

If we let $f_k(x)$, $k = 1, 2, 3, \ldots$ denote the kth partial sum of the above series, then $f_k(x) \to \pi/4$ as $k \to \infty$ for all $x \in (0, \pi)$. But there is an "overshoot" as discovered by J. Willard Gibbs, that is $\max(f_k(x))$ does not go to $\pi/4$ but to a universal quantity.

The goal of this benchmark is to study the Gibbs phenomenon graphically and analytically with special emphasis on f_{20}. We would hope, at a minimum, to be able to graph f_{20} on the interval $(0, 1.6)$, say, and calculate its maximum value in the interval. But we would also like to compare, say f_8, f_9, and f_{10}, perhaps by graphing all three on the same axes. In addition, we have tried to calculate the values of f_{500} and $f_{10000}(x)$ for $x = 1$ and 1.1. Another item was to compute the average of f_{20} on the interval $[1, 2]$, i.e.

$$(*) \qquad \int_1^2 f_{20}(x)\, dx.$$

This should be close to $\pi/4 = 0.7853981634$. It is readily evaluated exactly as a sum of cosines and has the value 0.7860233539 to ten places.

MATHCAD

To graph f_{20}, we had only to type in

$$i := 1, 3..39$$
$$f(x) := \sum_i \frac{\sin(i \cdot x)}{i}$$
$$x := 0, .01..1.6$$

Then, moving to a new area, type @ and fill in the limits. The plot took 15 seconds to appear. (The default plot size is tiny. We formatted the graph to be a reasonable size.)

The value of $f_{10000}(1)$ took 40 seconds. Less than 3 seconds were required to find the integral in $(*)$ to be 0.7860334038. (Slightly too large—see the calculations of the integral in the section on APL.) It was extremely easy to do this; just hit & to get the integral signal and fill in the limits, function, and variable.

Of all the programs we considered, MATHCAD did all this with the *least* manual reading.

APL

APL has no native graphing ability. But its ability to calculate values of the partial sums $f_k(x)$ greatly exceeds the abilities of the other programs.

An experienced APL programmer would define a function GIBBS something like what follows:

```
[0]  V ← K GIBBS X
[1]  ODDS ← ¯1 + 2 × ⍳K
[2]  V ← +/[1](1 ○ ODDS∘. × X)
      ÷ODDS∘. + 0 × X
```

If one were satisfied to calculate $f_k(x)$ only for scalars x, then one would use

```
+/(1 ○ X × ODDS) ÷ ODDS
```

as the line [2] of the definition. But the above definition has the advantage that it accepts vector valued arguments X. For example, to calculate $f_{20}(1)$, one enters

```
20 GIBBS 1
```

and the answer appears immediately below. To find $f_{500}(x)$ for $x = .001, .002, \ldots, .010$, one enters

```
500GIBBS.001.002.003.004
 .005.006.007.008.009.010
```

and is (after 9 seconds of computation) presented with

0.4730415603 0.8027066335
0.9243265233 0.8791017243
0.7749654244 0.7123432723
0.7272979221 0.7870935903
0.8325207556 0.829174451

To find the maximum of the 100 terms $f_{20}(x)$ for $x = .001, .002, \ldots, .100$ took 7 seconds (it was 0.9261319947); to do this, one enters

```
⌈/20 GIBBS (⍳100) ÷ 1000
```

because for any vector V, ⌈/V will return the maximum entry in V similar to the way +/V will return the sum of the entries in V. It took 17.7 and 21.5 seconds, respectively, to compute

$$f_{10000}(1) = 0.7853740028$$

$$f_{10000}(1.1) = 0.785421729$$

The trapezoid rule

```
( + /(20 GIBBS 1 2),
 (2 × 20 GIBBS 1 + (⍳99) ÷ 100))
   ÷ 200
```

gave 0.7860150883 as the integral (∗) in about 3.5 seconds. Simpson's rule

```
(+/(20 GIBBS 1 2),
  (2 × 20 GIBBS 1 + (⍳49) ÷ 50),
(4 × 20 GIBBS .99+
            (⍳50) ÷ 50)) ÷ 300
```

gives 0.7860234421 (and the true value is 0.7860233539).

For graphing, we used the VDI.AWS workspace (see the Lissajou benchmark). An acceptable plot was produced by the commands

```
VALUES ← 20 GIBBS (⍳100)
          ÷ 100 DISPLAY

'0 0 640 350 LINEPLOT VALUES'
```

TKSOLVER

First we needed to define a function Gibbs depending on a parameter, n. As usual we went to the function sheet with "= f", and said we wanted to define a procedure Gibbs. In the fill-in-the-blanks this time, we indicated n as a parameter variable, x as input and z as output and typed in the rules

```
z := 0
for k = 1 to 2 * n - 1 step 2
   z := z + sin(k * x)/k
 next k
```

Getting graphical output is a little tedious. One must go to a plot sheet (with "= p") and specify lists to be plotted. Normally, one must go to list subsheets to enter the lists but a recent TKSOLVER newsletter (both TKSOLVER and MATHCAD have informative newsletters with useful information for users) suggests setting up once and for all a function plot with input parameters fun $x1, x2, m$ and the definition

```
call blank('x)
call blank('y)
dx := (x2 - x1)/m
for i := 1 to m + 1
  'x[i] := x1
  'y[i] := apply(fun, x1)
  x1 := x1 + dx
next i
```

Here a leading ' refers to a list. The built in procedure "apply" allows one to treat a function name as a variable. One would define plot one time and add it to ones repetoire of functions. After defining Gibbs and plot, one must go to the list sheet and dive to a line plot subsheet specifying 'x as the x axis variable and 'y as the only y axis variable. Next use "= V" to go to the variable sheet and specify the value 20 for n. Then type "/ee call plot('Gibbs, 0, 1.6, 160)" which took 13 seconds to evaluate. ⟨F7⟩ then produces a plot instantly.

Graphing the three functions requires you to change the value of

n, use the same "/ee call plot('Gibbs, 0, 1.6, 160)" three times with the use of use "/ee call listcopy('y,'z?)" with ?= 1 and then 2 between calls to plot. In the plot sheet, indicate that the series should be y, $z1$ and $z2$. Given that there is no stack of /ee values, one must "type call plot('Gibbs, 0, 1.6, 160)" three times! Alternatively, one could write a single procedure based on plot which defined these three functions.

By setting the value of n in the variable sheet to 500 or 10000, it was easy to compute $f_{10000}(1)$ which took 31 seconds and the other values.

One pays the price for the vast array of functions that TK-SOLVER comes with that one has to locate the particular functions that one needs in the right on disk model. On advice from the TK-SOLVER staff, we used a minor modification of the Golden mean search section from OPTIM\ OPTIM1C.TK for the maximum problem and defint3 (using a Romberg approximation) from DIFFINT\ DEFINTEG.TK to evaluate. We then set up a Rule sheet saying:

$y = \text{Gibbs}(x)$
call Golden(.05, .15, 'Gibbs; x, y)
average = defint3('Gibbs, 1, 2)

set $n = 20$ in the Variable sheet and evaluated. The time to compute both the maximum value (.9261322) and the integral (.78602335) was 72 seconds. The built in Romberg integration procedure is exact to the number of decimal places shown.

POINT FIVE

As in APL, the Gibbs problem can be set up compactly. tr stands for transpose, not trace.

$x = \text{index}(160) * .01$
$n = \text{index}(20) * 2 - 1$
gibbs=acctotal(sin(matrixmult(n, tr(x)))/n)

at which point, one gets a single graph with

$x20 = \text{tr}(\text{gibbs}[20, \sharp])$
linegraph(x, $x20$)

and multiple graphs with

$x8 = \text{tr}(\text{gibbs}[8, \sharp])$
$x9 = \text{tr}(\text{gibbs}[9, \sharp])$
$x10 = \text{tr}(\text{gibbs}[10, \sharp])$
linegraph(x, $x8$, $x9$, $x10$)

The CGA resolution and lack of easy print formatting were the main disappointment in the single graph. The markers used to distinguish different graphs thoroughly mucked up the three function graph. The maximum of $x20$ is computed as max($x20$) and gives 0.925863837.

gibbs500 is evaluated fairly easily with

$n = 2 * \text{index}(500) - 1$
gibbs500=sum(sin(n)/n)
format(gibbs500, 20, 17)
gibbs500

and a similar formula for the value at $x = 1.1$. The answers are 0.78506368425933900 0.78489105914780900.

The integral is computed with the program

$x = \text{index}(101) * .01 + .99$
$n = \text{index}(20) * 2 - 1$
gibbs=acctotal
(sin(matrixmult(n, tr(x)))/n)
$x20 = \text{tr}(\text{gibbs}[20, \sharp])$
gibbsint=integrate($x20$, .01)
format(gibbsint, 14, 11)
gibbsint

yielding the answer 0.78601508833. Evidently, POINT FIVE uses the trapezoid rule rather than Simpson's rule to do its integrals.

Memory and time problems do not make the calculation of gibbs10000 practical.

EUREKA

Here is what we typed into the Edit window:

$y = \text{sum}(\sin(x * (2 * n + 1))/(2 * n + 1), n, 1, 20)$
$x > 0$
$x < .1$
\$ max(y)

After asking EUREKA to "SOLVE" we got the following in the Solution Window:

E:SOLUTION. Line 1
Solution:

Variables		Values
x	=	.0785398574
y	=	.92613220

Confidence level = 95.6%
All constraints satisfied.

To plot, we replaced y by $f(x)$ and asked EUREKA to "plot" f with endpoints 0 and 3.14. After viewing the cute dots for a second, we pressed F5 to "Zoom" into graphics mode. About 16 seconds. Very nice. EUREKA chooses the y-limits for you and *does not require you to specify the exact x values on which to evaluate the function.* Evidently, it simply chooses the values of x corresponding to horizontal pixels on our EGA monitor. *This is nice—all programs should do this or have it as an option.*

There is no way to calculate $f_{10000}(1)$. We got an error message "sum is too large" when we tried even $f_{102}(1)$, but $f_{101}(1)$ was calculated correctly.

PCMATLAB

As usual with MATLAB, to define a function, you call up your editor and define an M-file. We made a file gibbs.m with the lines

```
function y = gibbs(k, x)
y = zeros(x);
for i = 1 : 2 : (2 * k - 1)
  y = y + sin(i * x)/i;
end
```

Plotting F20 is easy; issue the commands:

```
>>x = 0 : .01 : 1.6;
>>y = gibbs(20, x);
>>plot(x, y)
```

There was noticable pause after the line defining y, but the plotting was instantaneous. Finding the maximum value was done with

```
>> max(y)
```

which returned the answer 0.92586. Comparing F8, F9 and F10 on one set of axes is done with

```
>> plot(x, gibbs(8, x), x,
      gibbs(9, x), x, gibbs(10, x))
```

while

```
>> y500 = gibbs(500, [1 1.1])
```

returns 0.78506368425934 and 0.78489105914781. Because MATLAB evaluates a sum by forming a vector (rather than by a direct do loop) and vectors are limited to 8092 elements, one cannot use gibbs.m to evaluate F10000 but it is easy to break the sum into two parts which one then sums together.

MATLAB has no built in integral function but it is easy to hand code Simpson's rule and it would be easy to define an M-function embodying it.

```
>>x = 1 : .01 : 2;
>>y = gibbs(20, x);
>>(y(1) + y(101) + 2 * sum
      (y(3 : 2 : 99)) + 4 * sum
      (y(2 : 2 : 100)))/300
```

Not surprisingly, the answer agreed with that found by APL.

GAUSS

One first defines a function gibbs (x, n) as follows

```
>>proc gibbs(x, n);
    local i, f;
      i = seqa(1, 2, n);
      f = (sumc((sin(i. * x')). /i));
    retp(f);
  endp <<
```

The "." before an operator indicates outer product when the objects are a row and column vector and element wise operations when both are column vectors (and column by column operations when one is a matrix and the other a vector). By default vectors are column vectors. The ' in the formula defining f is needed so that x can be a column vector as it must be to do graphing. Having run graph2d.get at the start of the session, one can graph f_{20} quickly by just using

```
>> px = seqa(0, .01, 160);
py = gibbs(px, 20); call graph2d <<
```

Graphing multiple functions isn't difficult but it is a little awkward; px and py must be matrices of the same shape so one uses the operator ~ which concatanates two matrices on the left-right basis. So, to graph f_8, f_9 and f_{10} at the same time, one uses

```
>> u = seqa(0, .01, 160);
px =~ u~u;
py = gibbs(u, 8)
~gibbs(u, 9)~
gibbs(u, 10); call graph2d <<
```

To find the maximum of f_{20}, one need only type in

```
>> y = seqa(0, .01, 160);
maxc(gibbs(y, 20)) <<
```

and in an instant, one gets the answer (0.92586384). Typing in "gibbs(seqa(1, .1, 2), 500)" resulted 6 seconds later in the answers

0.78506368 0.78489106

but trying gibbs(1, 10000) gave an error message presumably because a 10000 element sequence takes more than 64K, but, as in MATLAB, the sum could be evaluated by breaking it into two pieces.

To compute the Simpson's rule integral, one just types in

```
>> intsimp(&gibbs,
1, 2, 20, 1e - 8) <<
```

and gets the answer 0.78602335 which is particularly accurate and quick in comparison to the other programs.

What's missing

The short answer as to what's missing is "a lot". By taking the best from each of these programs one could get a very good supercalculator and some of the individual programs are certainly functional but we are struck by the fact that the most powerful of these programs have flawed user interfaces and the one with the slickest interface has so little power.

The first thing that our dream program has is a decent editor and, in particular a decent matrix editor. While it is true that programers are often best served by their own favorite personal editor, the fact that one needs to deal with specialized objects like matrices requires a separate editor. But, recognizing that users have to face too many editors, the math editor in this dream program is fully configurable (as only EUREKA's editor is). This is done in a configuration program which means that it takes no memory from the main program. POINT FIVE comes closest to a decent matrix editor and APL and EUREKA to decent editors but none of the programs pass here and some do very badly indeed.

Next it should have a wide array of basic mathematical functions including statistical functions. Financial functions aren't required although if it will sell copies outside the scientific community, there is no reason not to include it. Rich sets of functions take a lot of memory and thereby represent a problem. Our dream program will have two ways around this issue. First, it will support the Lotus-Intel-Microsoft Expanded Memory Specification (EMS). Users with an EMS board will be able to load all the functions into EMS memory. Other users will be able to choose the functions they want by making a simple ASCII list without having to cut and paste together their personalized workspace from a collection of parts of canned workspaces. None of the programs other than APL and MATHCAD support EMS although all have serious memory limitations. TKSOLVER, APL, and GAUSS all have large parts of their function library in separate files and manipulating them can be a nuisance. MATLAB probably handles the conflict between memory usage and the number of funtions best. If you call a function not in memory, it looks for an "M-file" on disk with that name and if it finds it, the file is compiled and stored in memory. The problem with this is that each function requires its own file; at a minimum file allocation size of 2K on most hard disks, this can be very costly in disk space.

The actual list of functions should include lots of matrix control—eigenvalues, eigenvectors and various decompositions. We'd like a wide array of statistical functions, including correlation and fitting procedures and functions for solving a series of non-linear equations. Numerical integration and differentiation, a wide array of mathematical functions (like Bessel, gamma, erf and maybe hypergeometric) and fast Fourier transforms should be included. As long as we are dreaming, we can ask for symbolic differentiation and other symbolic manipulation features. On this account of a wide variety of functions the programs fare pretty well. TKSOLVER, MATLAB and GAUSS all have a vast array of functions while MATHCAD has enough to keep it acceptable. EUREKA and POINT FIVE are rather limited on these points while APL depends on addons from STSC and/or third party programs for some of these things.

We'd like to have some real programmability built into this dream program with a coherent syntax. There should be all the standard control structures associated with PASCAL or C, perhaps even a syntax similar to theirs. If you try to run or compile a subprogram and there is an error, you should be thrown into the editor with the cursor at the offending place. TKSOLVER, MATLAB, GAUSS and POINT FIVE have adequate control structures and APL has real programmability without them. EUREKA and MATHCAD are just deficient in this regard. As for an intelligent compiler, only TKSOLVER and EUREKA have that.

We'd hope to see a snappy user interface with drop down menus, dialog boxes and mouse support. The possibility of separating the elements of the program into separate windows is a good one—we especially like the separation of input and output that is present in EUREKA, TKSOLVER and POINT FIVE. But separate windows/modules can be overdone; the seven separate windows in TKSOLVER are rather duanting. The best user interfaces are in EUREKA, MATHCAD and POINT FIVE which are also the least powerful packages. In our opinion, all but EUREKA need some snap added to their interface. On the issue of mouse support, we should mention that it is unfortunate that none is present in MATHCAD. A graphics mode program like MATHCAD has a problem with speed of just moving a cursor around the screen—in such circumstances, a mouse can be a valuable tool—it would be valuable with any program's graphics if functions like zoom are implemented.

Finally, there is the issue of graphics. Our dream program has separate graphing modules for two and three dimensions. The two dimensional module allows easy graphing of one or more functions with different functions drawn in different colors or, optionally, for monochrome setups in different symbols (e.g. dots vs continuous line). The program should make an intelligent guess of the axes to use but it should be easy to reset them. Up to this point, several of the programs, most notably MATHCAD do a good job. In addition, there should be a crosshair that can pop up and be moved to give you the coordinates of any point. This could be used to read off the intersection point of two graphs. And it should be possible to popup an adjustable window which can be moved and reshaped and then magnify what is in the window to full screen. None of these programs offer these features, although we have seen stand alone graphing programs, including an internal Caltech program, that do.

The dream program will allow graphing of surfaces and also contour maps of surfaces. TK-SOLVER, GAUSS and MATLAB all allow such three dimensional graphing but only MATLAB lets you easily rotate the perspective. Finally, the dream program has solid printer support. If you have ever seen the output that a business graphics program like Harvard Presentation Graphics can produce on even a 120 dots per inch 9 pin graphics printer, you'll know what high class, high resolution printer support can produce. Some of these programs, e.g. TK-SOLVER and POINT FIVE limit printer support to using Shift-PrtSc, an inexcusable way to brush off printer output. EUREKA, which limits the output to IBM Graphics compatible printers, isn't much better in the age of 24 pin dot matrix and laser printers. The others are somewhat better although GAUSS' limitation of laser support to half density mode is unfortunate.

Of course in discussing our dream program, one has to bear in mind that the market for such programs is much smaller and somewhat more price sensitive than for a genre like business presentation graphics. Our dream program would require a lot of development resources and may be a while in coming.

Price and Publishers

EUREKA: THE SOLVER is putlished Borland International, 4585 Scotts Valley Drive, Scotts Valley, CA 95066, (408)438-8400 and lists for $167. Borland offers special educational discounts on its entire product line. Contact Borland educational sales at (408)438-8400.

TKSOLVER PLUS is published by Universal Technical Systems, 1220 Rock St., Rockford, Ill., (800)435-7887 or (815)963-2220 and lists for $395. Sitewide licenses are not available but there is a 40% discount for academic institutions. There is a reduced cost/function student edition and a free demo with some functionality available. There are also additional "SolverPacks" available for $50–$70 each.

MATHCAD is published by MathSoft, Inc., 1 Kendall Square, Cambridge, MA 02139, (800)628-4223 or (617)577-1017 and lists for $349. Sitewide licenses are available. There is a reduced cost/function student edition available.

POINT FIVE is published by Pacific Crest Software, 887 NW Grant Ave., Corvallis, OR 97330, (503)754-1067. It lists for $295 ($195 for educational institutions). Special sitewide licenses for academic institutions are available for prices ranging from $500 to $5000 depending on size.

PC-MATLAB is published by The MathWorks, 20 N. Main St., Suite 250, Sherborn, MA 01770, (617)653-1415. It lists for $695 for the regular version. Versions are available that run in native mode on 386 machines with or without the Weitek coprocessor. There is a special price of $395 for universities and $200/each in units of 10 or more.

GAUSS is published by Aptech Systems, 1914 N. 34th St., Suite 201, Seattle, WA 98103, (206)547-1733 and costs $395 (the 386 version will cost $495). While the program itself comes with printed documentation, the extra module only comes with documentation on disk or printed documentation for an additional fee. Sitewide licenses are available and an educational discount by $100 off list price is available on single copy purchases.

The APL∗PLUS SYSTEM FOR THE PC is published by STSC, 2115 E. Jefferson St., Rockville, MD 20852, (301)984-5000 and lists for $695 for an individual copy. Academic discounts are available at about 50% off. Call (301)984-5123 for information on sitewide licenses.

News and Announcements

L. S. Pontryagin 1908–1988

Academician Lev Semenovich Pontryagin died May 3, 1988, in his eightieth year. He was born in Moscow, September 3, 1908.

Overcoming the handicap of blindness, suffered in an accident at the age of 14, Pontryagin entered Moscow University in 1925. He was influenced by P. S. Aleksandrov, and two years later his first results, on the Alexander duality theorem, were produced. For approximately the next quarter century his work was in topology and algebra or, as he expressed it, "problems where these two domains of mathematics come together." Then in 1952 he began to work exclusively on applied problems, in particular differential equations and control theory. He pursued this activity for the remainder of his life.

After graduating from Moscow University in 1929, Pontryagin became a member of the Mechanics-Mathematics Faculty there. Beginning in 1934, he was affiliated with the Steklov Institute, where he was head of the Differential Equations Department. In 1939 he was elected Corresponding Member of Academy of Sciences of the USSR; full membership came in 1959. In 1970, he was elected Vice-President of the International Mathematical Union.

Golub Receives Distinguished Service Award

Gene H. Golub, Professor of Computer Science at Stanford University, was honored with the SIAM Award for Distinguished Service to the Profession from the Society for Industrial and Applied Mathematics (SIAM). The award was presented to Golub at SIAM's Conference on Applied Linear Algebra in Madison, Wisconsin in May.

Golub received the award "for his many contributions to applied mathematics and to SIAM, especially for his strong and inspiring leadership and for his dedication to his numerous students, to whom he has given mathematical maturity and professional responsibility." The citation goes on to say, "SIAM particularly recognizes his formation of NAnet, his founding of two SIAM journals (on scientific and statistical computing and on matrix analysis and applications), and his successful efforts to bring the world community of applied mathematicians together, culminating in the First International Conference on Industrial and Applied Mathematics."

Grant for Innovation in Math and Science Education

The Charles A. Dana Foundation has awarded $737,000 to Philip Uri Treisman of the University of California, Berkeley to establish a center to help colleges improve the education of minority students in mathematics and science.

Called the Charles A. Dana Center for Innovation in Mathematics and Science Education, the center will aid U.S. colleges and universities in developing faculty efforts for increasing the numbers of minorities in science and mathematics. The center will draw upon Treisman's research, which focused on the difference in performance of Black and Asian students in calculus courses. Treisman, currently director of the Professional Development Program at U.C. Berkeley, created a workshop that dramatically improved the performance of Black students in these courses.

Last year, Treisman was honored by the same foundation with a $50,000 Dana Award for Pioneering Achievements in Health and Higher Education for his research on minority students' achievement and his educational innovations (see **News and Announcements**, *Notices*, April 1988, page 544).

Lehmann Receives R. A. Fisher Lectureship and Award

The R. A. Fisher Award of the Committee of Presidents of Statistical Societies was presented to Erich Lehmann of the University of California, Berkeley on August 24, 1988, at the Joint Statistical Meetings in New Orleans. Lehmann was honored for his distinguished contributions to mathematical statistics, especially in testing statistical hypotheses, nonparametric methods, and the theory of point estimation.

Lehmann received a Ph.D. in mathematics in 1946 from the University of California, Berkeley, where he has taught since the early 1940s. He has received three Guggenheim Fellowships, and has been elected to the American Academy of Arts and Sciences and the National Academy of Sciences. In addition, he is an Honorary Fellow of the Royal Statistical Society. With more than 90 publications to his credit, Lehmann is well known to statistical researchers and students for his concise and clear books. During his career, he supervised more than fifty Ph.D. students.

At the Meetings, Lehmann also delivered the R. A. Fisher Lecture, entitled "Model Specification: Fisher's Views and Some Later Strategies." The tradition of the Fisher Lecture, begun in 1963, honors both the contributions of Sir Ronald A. Fisher and the work of a current-day statistician in the advancement of statistical theory and applications.

–AMSTAT News

LMS 1988 Prizes

The Pólya Prize is awarded to C. T. C. Wall of the University of Liverpool for his significant contributions to algebraic, geometric, and differential topology.

The Senior Berwick Prize is awarded to D. B. A. Epstein of the University of Warwick for his papers entitled "Notes on notes of Thurston" (with P. Green and R. D. Canary) and "Convex hulls, a theorem of Sullivan, and measured pleated surfaces" (with A. Marden).

Junior Whitehead Prizes are awarded to S. M. Rees of the University of Liverpool for her work on ergodic theory and dynamical systems, to P. J. Webb of the University of Manchester for his work on the representation theory and cohomology of finite groups, and to A. Wiles of Princeton University and the University of Oxford for his work in number theory.

AMS Trustees Honor Twenty Year Employees

At its meeting in November 1987, the Board of Trustees of the Society adopted the following resolution:

"This year the Board of Trustees takes special note of the fact that three more employees of the Society have completed twenty years of service. The Board expresses its profound gratitude to MARCIA C. ALMEIDA, LEONORA T. DAVOL and THERESA S. DRENNAN, who bring to twenty-five the number of employees of the Society, past and present, who have devoted more than twenty years as members of the AMS staff. The Trustees offer their special thanks and their best wishes to these three long-term employees and wish them well in the future."

MARCIA CHRISTINE ALMEIDA was hired in 1967 as a full-time employee. Her duties at that time were miscellaneous clerical work: she had come in to help out in the Editorial Department.

When the Committee on Employment and Educational Policy came into being, Marcia worked with Dr. Lincoln Durst in the preparation of the data gathering for the Annual Survey. Since that time her duties have expanded to include working on other miscellaneous publications including the Professional Directory, the Combined Membership List, and Assistantships and Fellowships. In addition, she manages the prepress production of the Contemporary Math series, and she is a valued member of the Editorial Department.

Marcia has two children: Christine, 15, and Monica, 8. She lives with her husband, Ray, and their children in Riverside. She is an active member of the community where she has participated as a Brownie Leader and as manager of the 30-Week Club for her church. She is also a part-time student at Rhode Island College. This full roster of activities keeps Marcia tired, but she is looking forward to recharging her batteries during a 10-day vacation in Hawaii early this fall.

LEE DAVOL was hired as a full-time Varitypist in 1962—a time when the AMS office was located at Butler Hospital. She left in 1967 to take care of her two children, Rod and Lori-Beth, returning in June of 1971 to work part-time nights in what was then the South Main Street office. Soon after, Lee switched to part-time days, and she has been working that schedule ever since.

Lee has worked a total of 21 1/2 years of service for the Composition Department (or its equivalent). She has progressed, along with the AMS itself, from the Varitype machine to the Compuwriter and IBM "Selectric" Composer, to TEX and the computer terminal. Her present position is as a Technical Typist doing TEX work along with a myriad of other typing projects. Lee received her 20-year award in December of 1986.

TERRY DRENNAN joined the AMS in 1967 when the AMS was located on South Main Street. She became a member of the Editorial Department as an Editorial Assistant, and she continues her work in the Editorial Department where her contribution is greatly valued.

Terry is well known for her artistic and creative talents. Her interests include sewing, painting, flower arrangements, gardening, roller skating, all sorts of crafts, going to yard sales and arts and crafts shows.

She is married, and she and her husband, Dave, reside in East Providence. They have a daughter, Michelle, who lives in Rumford with her husband, Robert, and Terry's grandson, John Peter.

At its meeting in May 1988, the Board of Trustees of the Society adopted the following resolution:

"This year the Board of Trustees takes special note of the fact that two more employees of the Society have completed twenty years of service. The Board expresses its profound gratitude to SANDRA D'ALLESANDRO and BARBARA VEZNAIAN, who bring to twenty-seven the number of employees of the Society, past and present, who have devoted more than twenty years as members of the AMS staff. The Trustees offer their special thanks and their best wishes to these three long-term employees and wish them well in the future."

When SANDY D'ALLESANDRO was hired in March 1968 as a receptionist for the American Mathematical Society, she was operating a small PPX with 5 in and out trunks and approximately 40 extensions. Her duties also included some typing and light clerical duties. She is presently operating a board with 21 trunks and 160 extensions, as well as continuing with her clerical duties. Sandy is well liked by staff, AMS members and outside vendors, and it is hoped that she will stay with the AMS for many years to come.

After graduating from the University of Rhode Island as an English major, and doing graduate work in mathematics at Boston University, BARBARA VEZNAIAN joined the AMS in 1968 as an Editorial Assistant, hired by Ellen Swanson, then the Society's Director of Editorial Services. Barbara had served only a few weeks in the Editorial Department when she was tapped by Dr. Gordon Walker, then Executive Director, to head the Mathematical Offprint Service, a newly inaugurated information service for mathematicians. The Offprint Service (MOS) arranged to obtain offprints of articles to appear in mathematical journals, redistributing them to mathematician subscribers according to the subscribers' profiles of mathematical interest. Barbara managed arrangements with participating journals, subscribers, and subject classifiers, and headed a staff that accomplished the computer processing of offprints against profiles, and the distribution of thousands of offprints each month to more than 1100 subscribers. Barbara served as staff support for the group of mathematicians that developed the AMS (MOS) Subject Classification Scheme (1970) for mathematics.

The Offprint Service, and its successor, the Mathematical Title Service, were part of the Society's Information Systems Development Department. When cost forced the end of MOS and MTS, the department's director, Sam Whidden, invited Barbara to join its programming staff. Barbara trained as a programmer, participating in the design and development of many of the data processing applications that remain in regular production today. In 1974, Barbara became Manager of Programming and Systems Analysis.

In the late '70s, Barbara participated in, and helped supervise, conversion of all of the Society's applications from its original Univac computer to its DECSYSTEM-20. Barbara, along with her staff, played an important role in the design of the Mathematical Reviews Data Base, implemented on the DECSYSTEM-20 computers in 1983.

In 1984, the Information Systems Development Department became the Computer Services Division, and Barbara became Head of its Programming and Analysis Department. She manages a staff of twelve systems and application programmers and analysts serving all other departments of the Society's Providence office. She and her department are responsible for design, development, and implementation of all new Providence office computer applications, and are currently recreating all such applications on the Society's new VAX computers.

U.S. Team Places Sixth in Math Olympiad

A team of six American high school students placed sixth in the 29th International Mathematical Olympiad (IMO), held July 15 and 16 in Canberra, Australia. Five of the team members received silver medals.

The Americans had a team score of 153 out of 252. Ahead of them were teams from the Soviet Union (217), China and Romania (tied for second place with scores of 201), West Germany (174), and Vietnam (166). In all, 49 nations and 268 students participated in the IMO. In each of the two, 4 1/2 hour sessions, the students worked on three challenging mathematical problems.

"The U.S. team turned in a strong performance, earning five silver medals and a bronze on what was an unusually difficult set of problems," said U.S. team coach Gerald Heuer in an interview immediately after learning the results. "While we are somewhat disappointed at placing sixth, we have to admire the superb scores of the top five countries and we look forward to a stronger showing by the U.S. team in West Germany next year."

The IMO judges awarded individual first, second, and third prizes to deserving team members. Five U.S. team members received second prizes: Jordan Ellenberg of Potomac, Maryland; Tal Kubo of Brookline, Massachusetts; Samuel Kutin of Old Westbury, New York; Eric Wepsic of Boston, Massachusetts; and John Woo of Pepper Pike, Ohio. Hubert Bray of Houston, Texas received a bronze medal.

The U.S. team was chosen on the basis of performance in the U.S.A. Mathematical Olympiad, held April 26, and on the basis of an evaluation of their work at a rigorous 4-week training session this summer.

The Mathematical Olympiad activities are sponsored by seven national associations in the mathematical sciences, with arrangements made by the Mathematical Association of America. Financial support was provided by International Business Machines, the Army Research Office, the Office of Naval Research, Hewlett-

Packard, and the Matilda R. Wilson Fund.

News from the Institute for Mathematics and Its Applications
University of Minnesota

The Signal Processing six-week program this summer at IMA included a wide range of topics: image analysis and vision, radar, sonar, medical imaging, speech analysis and recognition, one-dimensional processing (operator theory methods, VLSI implementation), and X-Ray crystallography. The program began with two weeks of general survey talks followed by periods of concentration. One of the novel features was a joint IMA-3M Symposium which was held on July 19 at the 3M Center in St. Paul, Minnesota. The symposium included several talks by IMA visitors, presentation of problems by 3M scientists, and guided tours of 3M laboratories.

The 1988-1989 program on Nonlinear Waves has just begun. An opening workshop on Solitons in Physics and Mathematics, which is partly tutorial, will include as speakers Alan Newell, Mark Ablowitz, D. Kaup, Y. Yodama, H. Segur, D. Sattinger, and M. Kruskal. Another workshop on Solitons in Nonlinear Optics and Plasma Physics will take place in November. (For further details see the News and Announcements section of the April 1988 issue of *Notices.*)

Survey Examines Students' Math Performance

A recent study of students' mathematics achievement in Montgomery County, Maryland came to an all-to-familiar conclusion: the performance of Black and Hispanic students consistently trails that of White and Asian students. This gap in performance shows up in the early primary grades and has persisted despite gains in the Black and Hispanic students' achievement.

The two-year study, funded by the National Science Foundation, involved some 28,000 students in the public schools of Montgomery County. For more than a decade Montgomery County has sought to boost the performance of female, Black, and Hispanic students in academic areas such as mathematics, the report says. Indeed, the study found that, ten years ago, standardized tests showed Black and Hispanic students in Montgomery County were performing below national averages in their racial/ethnic groups, but today are performing better than the national average for students of all races.

Nonetheless, the perplexing question remains of why these students perform more poorly than do White and Asian students in Montgomery County. Starting off with lower performance in early grades is an important factor. "The evidence suggests that once a student falls below the standard level of performance in the curriculum for his/her grade level, he/she is not likely to ever again catch up," the report says.

As a result, the more advanced mathematics classes are dominated by White and Asian students. Even when Black students take the more advanced classes, they do not perform on standardized tests at the same level as students from the other racial/ethnic groups. The report says that in such classes, Black students tend to feel isolated and perceive an especially acute pressure to do well. "High-achieving Black students reported that they had to prove themselves to the teacher each time the entered a new mathematics class," the report said.

School counselors and principals interviewed for the study generally felt that the poor performance of Black and Hispanic students stemmed from problems in the home and cited economic factors and fragmentation of families. However, the study noted that parents in general believed mathematics to be important, and "parents of Black students were the most vocal in expressing this belief." The study recommended greater efforts to promote understanding between the school and the home.

The study also gathered data on gender differences in mathematics performance. While girls and boys performed equally well on standardized tests in early grades, the study found substantial differences in the junior and senior years of high school in their performance on the mathematics portion of the Scholastic Aptitude Test. "This difference in SAT mathematics performance was observed regardless of the amount and complexity of mathematics and science courses taken by the students, and despite the fact that female students received higher grades than male students in all mathematics classes," the report stated.

The study found that female students tended to have less confidence in mathematics and tended to perceive the subject as less useful than did male students. There were also differences in career aspirations, with males more likely than females to see themselves in occupations utilizing mathematics or in management positions.

The report says that such attitudes are influenced by parents and, to a lesser extent, by the school environment. With the exceptions of the top female mathematics students, female students receive less encouragement in mathematics from the school, home, and society, the report says. In questions put to parents, the survey found that mothers do not see themselves as competent in mathematics and that parents generally "still view mathematics and science careers as being primarily for men." A significant portion of school counselors and principals attributed differences in mathematics performance of males and females to such factors as a lack of interest on the part of females and the females' perception that they do not need mathematics for their careers.

The report offers many recommendations for addressing the problems it uncovered: remediation and enrichment programs, mechanisms to increase parental involvement and support, and ways of training and retraining teachers. The report also suggests that "school systems lauch public relations campaigns to change the image of mathematics" to make it seem more exciting.

In Montgomery County, a relatively affluent area near Washington, DC, students "receive educational services that are equal to or better than those provided elsewhere in the nation." The report says that the persistence of such problems suggests that they are "deep-seated and difficult to address" and may in fact be worse in other school districts across the nation.

Budapest Semesters in Mathematics

Budapest Semesters in Mathematics are now administered at Saint Olaf College. Recommended by educators and highly praised by former participants, this study abroad program will soon complete its fourth successful year. During these years, undergraduates from over forty colleges and universities from all over the U. S. and Canada have had the opportunity to derive benefits from the traditional excellence of Hungarian mathematics education.

- All courses are taught in English.
- Classes are held in small groups.
- Emphasis is on creative problem solving.
- Credits are transferable to American colleges and universities.
- Living costs are modest.

Semesters start in the first week of September and February each year, and are preceded by an optional two-week intensive language course. The deadline for applications for the fall semesters is April 30, and October 15 for the spring semesters. Early applications are encouraged and will be processed promptly. Tuition is \$2150 (U. S.) per semester.

For further information and application forms, contact the American Program Director: Professor Paul D. Humke, Department of Mathematics, Saint Olaf College, Northfield, MN 55057, 507-663-3113.

Errata

The **NSF News & Reports** section of the May/June issue of *Notices* contained a news item with the headline, "National R and D Funds at Eleven Year Low." Because of an inadvertent deletion, this headline was incorrect. The correct headline is, "Real Increase in National R and D Funds at Eleven Year Low."

Due to an editing oversight, the article, "Research Mathematicians in Mathematics Education, Part 1," which appeared in the July/August issue, did not carry a byline. The article was written by *Notices* Staff Writer Allyn Jackson.

The recipients of the Rollo Davidson Prizes were announced in the May/June issue. The university affiliation of one of the awardees, P. H. Baxendale, was incorrectly stated. Since 1973 he has been a lecturer in the Department of Mathematics, Aberdeen University. He is currently on leave of absence in Florida.

A few errors have come to our attention in the list of fifty-year AMS members, which appeared in the July/August issue. The name of member Haim Reingold was incorrectly listed. F. A. Ficken has been deceased for several years. Thomas W. Mullikin should not have been included in the list. In addition, there are persons who were elected to membership in 1938 effective in 1939 who are now in their fiftieth year of membership but who were not included in the list of fifty year members. This omission was due to the manner in which the list was compiled. At least one such individual has been identified, namely D. D. Miller.

National Science Foundation News & Reports

Reflections of Departing DMS Rotators

Rotators are crucial to the quality of the research programs at the NSF. Because they come directly from a research environment, rotators bring in current technical knowledge as well as fresh ideas and new perspectives. In the Division of Mathematical Sciences (DMS), where only about one-quarter of the staff members are permanent employees of the NSF, attracting highly qualified rotators is essential. Despite the difficulty of finding such people, the DMS has consistently maintained an excellent staff. This summer, six rotators are returning to the academic world while six new rotators are joining the DMS (see the DMS Staff List following this article). Interviews with the departing rotators show that they feel they have learned a great deal at the NSF.

"The experience is definitely a broadening one and a very rewarding one," says Nancy Flournoy, who has taken a position at American University after serving two years in the Statistics and Probability program. "The experience is one that could not be duplicated in terms of coming to an understanding of a broad variety of current research activity that is going on, not only in the field in which the rotator works, but across all of mathematics and extending to the other sciences as well."

Yashaswini Mittal, who also served in Probability and Statistics for 2 years and will return this year to Virginia Polytechnic Institute, believes that increasing awareness within the mathematical sciences community about the breadth and the political climate of the discipline would be beneficial to both the community and the NSF. "You cannot live an isolated life when you come to NSF," she says. "You get forced into knowing a lot of things, which is good, in the end. I enjoyed having a larger perspective, getting involved in all aspects that concerned the discipline."

Many are unaware of the program director's activities beyond sending out proposals for review and making awards. For example, "a tremendous amount of the activity goes into putting together the proposals of the NSF budgets and justifying them, and that's a scientific activity," says Flournoy of the annual DMS budget formulation process. "You have to be able to articulate what is important in your subfield and why, and also why it should be funded."

"I came to understand how intense the competition for funds is, how difficult it is to make the case for increased funding of mathematics, and how progress in this direction can be made," says Andre Manitius, who served as Program Director in Applied Mathematics for two years and has now left his one-year appointment as Deputy Division Director to accept a position at George Mason University. "I also saw how many things depend on the personal dedication of many people working for NSF."

Indeed, some regard program directors as paper-shuffling bureaucrats, but in fact the personal commitment and scientific knowledge the individual brings to the position is essential to the welfare of the program. William Lakin, who has now returned to Old Dominion University from a one-year stint as Program Director in Applied Mathematics, notes that a program director has several ways of attracting additional funding. "Proposed work is often of interest to more than one program at NSF," he says. "A program director can identify these other programs, form cooperative links, and often obtain split-funding from outside DMS for quality proposals. Outreach to other disciplines within the Foundation is sometimes difficult, but it's an essential part of the job." Program directors can also identify elements of proposals that fit funding priorities set within the DMS. For example, if the proposed research is a group activity, extra funds might be available for visitors, graduate students, or postdocs.

One of the important roles of program directors is to act as a link to the mathematical community on science policy matters. "I think it's good for the [mathematical] community to take an active part in how the science policy in mathematics should go," says William Adams, a Program Director for Algebra and Number Theory who has returned to the University of Maryland. "Lack of awareness is a big problem," he says, but the program directors' knowledge can help. "We can assist the mathematics community by explaining [science policy issues] so that they can take appropriate action."

In addition, Manitius notes that one of the roles of the DMS program officers is to "help create a better image for mathematics among people in other disciplines and other parts of NSF. This requires willingness to talk to other people, beyond your own discipline." Some of the other positive influences program directors can have is identifying lesser known but promising researchers and by identifying new directions where additional funds would make a large impact.

A certain amount of bureaucracy is inevitable at a federal agency, and rotators coming from a less structured research environment can make the change difficult. "Because of the presence of many rotators, there is some element of an academic atmosphere in the DMS," says Manitius. "At the same time, there are many constraints imposed by the government rules which frustrate the professional personnel." "Still," Mittal says, "NSF as a whole is a lot less bureaucratic than some other federal agencies, but even within NSF I think DMS is about as close to an academic situation as a federal agency can come."

The DMS also seems to do a particularly good job. "The DMS has, I believe, one of the best staffs among all the NSF divisions," says Manitius. "The quality standards of the review are quite high, and the peer review is taken very seriously." DMS program directors also have one of the largest workloads in the NSF. "The large workload and close competition creates some problems, mostly because it leads to delays in processing," he says. "To an outside observer, the time it takes the DMS to decide about a specific proposal may seem quite long. Seen from the inside, this time is not so long when one takes into account all the things that need to be done with a proposal and all the other things that a program director is supposed to do."

In addition to science policy activities, program directors also become involved in special activities within the NSF. For example, Adams saw to it that the Research Experiences for Undergraduates program got off to a healthy start in its first two years. Flournoy has been effective at establishing ties between the DMS and other disciplinary divisions at the NSF, and Mittal worked hard to consolidate the Probability and Statistics program and stimulated interest in the statistical community in the NSF's Science and Technology Centers (STC) program. Both effectively promoted the use of computation in their program.

Paul Goodey, back at the University of Oklahoma after two years as Program Director for Geometrical Analysis, was instrumental in formulating preliminary ideas for an initative in geometry and focused the attention of the DMS Advisory Committee on this subject. Lakin ran the panel for the the Research Opportunities for Women program, helped to establish stronger links with the other NSF divisions, and was the DMS Coordinator for proposed Cosmology Initiative involving the DMS and the physics and astronomy divisions.

In his three years at the DMS, Manitius has been actively involved in several initiatives, most notably a program to promote new interactions between mathematics and the biosciences and an initiative to fund joint projects involving U.S. reseachers and those at France's INRIA (National Institute for Research in Computer Science and Automation). He assisted the Office of Science and Technology Policy in their efforts to develop a cross-agency program which will combine the research of mathematicians, statisticians, data collectors, and epidemiologists in the mathematical modeling of the AIDS epidemic. In addition, as a Coordinator for the STC program, he oversaw the entire review of the center proposals having mathematical content, a particularly difficult process, since the program is in its first year and since many of the proposals were for interdisciplinary research efforts.

Finding people to serve as program directors is always difficult, and those who are rotating out point to a number of changes that would make the job more attractive, such as decreasing the workload, providing time for research, and improving the financial compensation for senior researchers. Often the rotators' departments at their home institutions do not like the idea of losing a faculty member for one or two years, and sometimes the rotators are even denied the standard salary raises. Part of the reason people come to the DMS is that they believe they can contribute something that is important and that the community will recognize as valuable. Addressing such issues is one way the community can show its recognition of and appreciation for rotators.

Mathematical Sciences Staff

The Program Directors for 1988-1989 are:

Classical Analysis
202-357-3455
John V. Ryff

Modern Analysis
202-357-3697
William L. Paschke

Geometric Analysis
202-357-3451
Russell B. Walker

Topology and Foundations
202-357-3457
Ralph M. Krause

Algebra and Number Theory
202-357-3695
Ann K. Boyle
Jonathan D. Lubin

Applied Mathematics
202-357-3686
Peter W. Bates
Bart S. Ng

Computational Mathematics
202-357-3691
Raymond C. Y. Chin

Statistics and Probability
202-357-3693
Mary Ellen Bock
Peter W. Arzberger

Special Projects
202-357-3453
Deborah F. Lockhart
Elbert A. Walker

The administrative staff includes:

Division Director
Judith S. Sunley
202-357-9669

Deputy Division Director
Bernard R. McDonald
202-357-9669

Administrative Officer
Tyczer Henson
202-357-3683

The permanent staff consists of Krause, McDonald, Ryff, and Sunley. The incoming rotators are Russell Walker, Montana State University; Lubin, Brown University; Ng, Indiana University-Purdue University in Indianapolis; Bock, Purdue University; Arzberger, University of Wisconsin at Madison; and Lockhart, Michigan Technological University.

Bernard R. McDonald became Deputy Division Director in August. A permanent employee of the Foundation, McDonald came to the DMS in 1983 from his position as Professor of Mathematics at the University of Oklahoma. He was Program Officer in Algebra and Number Theory for three years before moving to the Special Projects program in 1986.

McDonald will succeed Andre Manitius, who has taken a position as Professor in the School of Information Technology and Engineering at George Mason University. Manitius came to the DMS in 1985 as Program Director of Applied Mathematics and became Deputy Division Director in 1987. For the past year, he has also served as Coordinator for the NSF's Science and Technology Centers program. While at the NSF, Manitius was on leave from his position as Professor of Mathematical Sciences at Rensselaer Polytechnic Institute.

All of the DMS staff can be reached via electronic mail. To form an individual's address, take the first initial and last name, and append @note.nsf.gov for INTERNET (a collection of networks of which ARPANET is a subnetwork) or @nsf for BITNET. For example, to contact John Ryff through INTERNET, use the address jryff@note.nsf.gov.

Advisory Committee Meeting

The NSF Advisory Committee for the Mathematical Sciences will meet at NSF headquarters in Washington, DC on October 17-19, 1988. The Committee's advice plays an important role in setting priorities and developing long-range plans in the Division of Mathematical Sciences (DMS). The last meeting included informative presentations about the Congressional budget approval process (see "Congress and the NSF Budget," *Notices*, May/June 1988, page 707) as well as discussions with DMS staff. At the October meeting, the Committee will conduct its triannual oversight reviews of the standard research projects program in the DMS. To allow time for this additional task, the meeting will last three days instead of the usual two. The reviews will be held in closed-door session; however, the mathematical community is welcome to attend the rest of the meeting. Those who wish to attend or to suggest topics for discussion should contact Trudy Sensibaugh at the DMS at 202-357-9669; electronic mail address tsensibaugh@note.nsf.gov (INTERNET) or tsensibaugh@nsf (BITNET).

NSF Awards for Visiting Professorships

The National Science Foundation today announced 25 awards totalling $2.52 million under its 1988 Visiting Professorships for Women program.

As an important part of the NSF's initiative to enhance the participation of women in the U. S. science and engineering enterprise, the VPW program provides support for some of the nation's most productive and talented scientists and engineers.

The program enables female scientists and engineers from industry, government and academic institutions to serve as visiting professors. The visiting professors will perform research, and will conduct lecturing, counseling, and other activities to increase the visibility of female scientists and engineers and to encourage other women to pursue careers in science and engineering.

The 25 award winners were selected on the basis of a rigorous two-stage review process that focused on the excellence of the research and on the proposed plan for lecturing and serving as counselor and mentor to women entering research careers. The NSF awards range in size from $48,283 to $235,441, and in duration from nine to 24 months. In some cases host institutions are also contributing to the awards.

Two of the Visiting Professorships were awarded to mathematical scientists. They are Nancy G. Leveson, University of California, Irvine, California, to visit the Massachusetts Institute of Technology; Judith D. Sally, Northwestern University, to visit Purdue University.

Visiting Professorships for Women

The Visiting Professorships for Women program is designed to provide opportunities for women to advance their careers in the disciplines of science and engineering and to provide greater visibility of women scientists and engineers employed in industry, government, and academic institutions.

The program allows a woman scientist or engineer to pursue advanced research at an academic institution. In addition to her research responsibilities, the visiting professor undertakes lecturing, counseling, and other activities to increase the visibility of women scientists in the academic environment of the host institution and to provide encouragement for other women to pursue careers in science and engineering.

The research must be in a field normally supported by the NSF. The instruction and other activities may be at the undergraduate or graduate levels, be directed to the community at large, or involve some combination of such activities. The usual award will be for 12 months for a full- or part-time professorship, but awards for one academic semester or for 24 months will be considered.

The deadline for applications is **November 15, 1988**. For further information about guidelines and eligibility, contact the Program Director for Visiting Professorships for Women, National Science Foundation, 1800 G Street, N.W., Washington DC 20550; telephone 202-357-7734.

NSF-AWM Travel Grants for Women in Mathematics

The objective of the National Science Foundation-Association for Women in Mathematics Travel Grants is to enable women to attend research conferences in their field, thereby providing a valuable opportunity to advance women's research activities, as well as to increase the awareness that women are actively involved in research. If more women attend meetings, then the size of the pool from which speakers at subsequent meetings are drawn is increased, and thus the problem of the absence of women speakers at many research conferences is addressed.

The travel grants will support travel and subsistence to a meeting or conference in the applicant's field of specialization. A maximum of $1000 for domestic travel, and $2000 for foreign travel, will be applied.

Applicants must be women holding a doctorate in a field of research supported by the Division of Mathematical Science of the NSF, or have equivalent experience. A woman may not be awarded more than one grant in any two-year period, and should not have other available sources of funding, except possibly partial institutional support.

There will be four award periods per year, with applications due as follows: **November 1, 1988**; **February 1, 1989**; **May 1, 1989**; **August 1, 1989**.

Applicants should send a discussion of how the proposed travel grant would benefit their research program, and a curriculum vita, to the Association for Women in Mathematics, P. O. Box 178, Wellesley College, Wellesley, MA 02181.

Faculty Enhancement Program Awards

The NSF made 27 awards in the Undergraduate Faculty Enhancement Program, which is designed to help revitalize the teaching of undergraduate science, mathematics, and engineering. Begun this year with a budget of $3 million, the program sponsors national or regional workshops and seminars in which faculty learn about new techniques and new developments in their fields.

The program stipulates that there be sustained interaction among the participants and the project leaders, both during the course of a project and on a continuing basis thereafter. Establishment of computer networks, site visits by project leaders to participants' home institutions, and reunions at national meetings are among the means of accomplishing this objective. In some instances, participants may begin work on a project during the session—often dealing with incorporation of new material into classroom use—and pursue it at their home institutions, reporting back on its progress to other participants.

This year, approximately 700 undergraduate faculty will take part in the conferences and workshops. The projects address both theoretical and experimental topics, and several of them are interdisciplinary. All are residential and utilize the facilities of the host academic institutions to foster informal interaction among the participants in a collegial atmosphere. The awards cover the cost of instruction, facilities, and room and board to all participants, and, in many cases, offer a modest stipend.

The four awards in mathematics are described below.

The Mathematics Association of Two-Year Colleges of New Jersey, through **Union County College**, organized a workshop on applications of discrete mathematics. In two extended weekends (one was held last spring and another will be held this fall) thirty mathematics faculty from two-year colleges participated in workshops and lectures conducted by Fred S. Roberts of Rutgers University. During the summer, they worked on individual or small-group projects on which they reported at the second session. The principles of discrete mathematics and its applications in such fields as genetics, engineering, computer science, and social planning were covered. Jean Lane of Union County College is the principal investigator on this $47,386 grant.

The University of Montana convened an interdisciplinary group of 25 college teachers of biology and applied mathematics in two sessions to study the use of mathematical and computer models in biological resource conservation. The first, four-week summer session consisted of lectures, seminars, workshops, and field trips into wilderness areas in Montana, culminating in a group modeling project. During the coming academic year, the faculty participants will work on projects in modeling at their home institutions and report on their work and their integration of the material in their undergraduate teaching at a followup session the next summer. Robert W. McKelvey of the University of Montana is the principal investigator on this $97,917 grant.

Fort Lewis College in Durango, Colorado held a short course designed to provide an introduction to mathematical modeling and to the topics underlying the construction of mathematical models. The week-long course, held in July, also addressed the issues that must be resolved in the design of an undergraduate course in mathematical modeling. Thirty-five college faculty participated in twelve hours of class discussion on these topics and an additional six hours of instruction-discussion on specific models and the use of computers and software to supplement the modeling process. Participants also had the opportunity to work on specific models and had access to computer facilities. Gary W. Grefsrud of Fort Lewis College is the principal investigator on this $24,681 grant.

Consortium for Mathematics and Its Applications conducted two, two-week workshops this past summer, one in discrete mathematics at Northeastern University and one in geometry at Virginia Commonwealth University. Involving a total of 25 college teachers from across the country, the workshops focused on day-to-day interactions between the participants, support faculty from the universities involved, and experts in the particular fields. Each workshop culminated with the production of three or four sets of curriculum materials that the college teachers can use in their own classrooms and share with others throughout the country. These materials were edited in the summer, will be tested this fall, and will be made available to all interested teachers in the spring of 1989. Margaret B. Cozzens of Northeastern University is the principal investigator on this $141,387 grant.

The Undergraduate Faculty Enhancement program was established last year as part of a major NSF effort to upgrade undergraduate science, engineering, and mathematics. The projects described above exemplify the kinds of activities the NSF is funding in this area.

A new program announcement is now available (Forms and Publications, NSF, Washington DC 20550; telephone 202-357-7861). During the coming academic year, there are two deadlines for proposal: **October 14, 1988** and **March 3, 1988**. For more information on the program, call Duncan McBride, Program Director, at 202-357-7051.

Call for Nominations for Waterman Award

In 1975 Congress established the Alan T. Waterman Award to mark the 25th anniversary of the NSF and to honor the first Director of the NSF, Alan T. Waterman. This annual award recognizes an outstanding young scientist in the forefront of science. In addition to a medal and other recognition, the awardee receives grants of up to $500,000 for a period of up to three years for scientific research or advanced study in the biological, mathematical, medical, engineering, physical, social, or other sciences at the institution of the recipient's choice.

The award committee annually solicits nominations from a wide variety of sources. Candidates must be U.S. citizens or permanent residents and must be 35 years or younger, or not more than 5 years beyond the receipt of the Ph.D. degree by December 31 of the year in which the nomination is made. Candidates should have completed sufficient research to have demonstrated outstanding capability and exceptional promise for significant future achievement. In addition, candidates should exhibit quality, innovation, and potential for discovery in their research.

The deadline for nominations for the 1989 award is **December 31, 1988.** The award committee requires that the nominations be made on a special form, which may be requested from the Alan T. Waterman Award Committee, National Science Foundation, Washington, DC 20550. For additional information, contact the Executive Secretary, Lois J. Hamaty, 202-357-7512.

NSF Announces Awards for Experimental Computer Research Facilities at Four Universities

The National Science Foundation (NSF) has made awards to establish four major research facilities for computer research at universities in California, Illinois, North Carolina, and Rhode Island. The awards were announced today after a merit review of 23 proposals, and are the first-year installments of five-year grants that are anticipated to total more than $11,700,000 when the projects are completed.

Brown University in Providence, Rhode Island, has received a first-year award of $745,000 through NSF's Computer and Information Science and Engineering (CISE) Institutional Infrastructure program. The award will be used to begin developing a coordinated set of software tools to simplify complex design problems, such as the development of future computing systems. The software tools will create an environment that should significantly increase the productivity of designers. A primary goal of the project is to provide tools to support a variety of problem-solving methods in a single environment. The development of this environment will be based on a prototype computer-programming environment, called Garden, developed previously at Brown. Initial applications will be in the areas of software development and the design of Very Large Scale Integrated (VLSI) circuits. Total NSF funding for the project is anticipated to be $3,481,000.

Scientists at the University of California at Berkeley will use their first-year award of $934,327 to do research in the development of computer systems for solving problems that involve massive amounts of information. Researchers will develop a computing facility with a variety of storage media, including high-speed memory and more economical, but slower, magnetic disk and optical disk memory. The facility will have large amounts of each type of memory, which will be used to investigate effective ways to structure massive memory systems. A related emphasis will be on the development of software to make use of the memory. The facility will be used for research in artificial intelligence, text processing, programming systems, graphics, computer vision and scientific processing. NSF anticipates funding the project for up to $3,782,372 over five years.

The University of Illinois at Urbana will receive $519,692 during the first year and up to $2,448,657 over five years to establish a parallel-processing research laboratory, which will enable scientists to use more than one computer in tandem. Computers based on parallel processing can perform multiple tasks simultaneously and quickly. Processors and memory are organized and connected differently in different parallel-processing computers, with different designs having different strengths in application. The technology to be developed at Illinois will enable the best aspects of different designs to be used together for more powerful problem solving. Users will access this combined system, called Tapestry, from work stations and existing facilities via a high-speed network. Initial applications will be in the areas of computer vision and graphics, and differential equations.

A first-year award of $549,999 to the University of North Carolina will support the development of a capability for building prototypes of complete computing systems, including computer chips, system architecture, operating systems, compilers, applications software and user interfaces. The development of this capability will be done in such a way that it can be transplanted to other locations, thereby creating the possibility of a decentralized national capability for experimental computer systems research. Development of a portable system that can produce prototypes of complete computer systems may have an impact analogous to that which the successful MOSIS system has had on VLSI design. Total NSF funding for the North Carolina project is projected to be $2,079,997.

Besides NSF, the four universities have also made commitments to support researchers and their projects, and these institutions will assume an increasing share of the project costs each year throughout the grant period. After five years, the facilities should be able to operate independently of NSF support.

–NSF News Release

Research Experiences for Undergraduates

The Research Experiences for Undergraduates (REU) program is designed to provide opportunities to undergraduates students to participate in active research experiences in mathematics, science, and engineering. REU was launched in 1987 as part of the NSF's expansion of activities directed at undergraduates.

There are two kinds of awards made in the REU program: *Sites* and *Supplements*. REU Sites will conduct projects for a number of undergraduate students. Because the REU Sites projects must have a well-defined focus, most REU Sites are expected to be within the scope of a single discipline and/or single academic department, although an interdisciplinary project with cohesively integrated activities is acceptable. The normal size for REU Sites is about 8 students, and most are held during the summer months.

REU Supplements augment ongoing NSF research grants in order to provide research experiences for a small number of undergraduate students. Requests are made directly to the NSF program officer handling the original research award.

For both Sites and Supplements, student stipends for summer projects are expected to be at least $2000, with academic year stipends comparable on a pro rata basis. Total costs are expected to average around $4000 per student. The amount of indirect costs allowed for REU is limited to 25% of student stipends. Other eligible costs include salaries of involved faculty, relevant student housing costs, indirect costs, and a modest allowance for supplies. In addition, the student participants must be citizens or permanent residents of the U.S. and its possessions.

REU is run by the NSF research divisions and coordinated through the Office of Undergraduate Science, Engineering, and Mathematics Education in the Directorate of Science and Engineering Education. For descriptions of some of the REU projects funded by the Division of Mathematical Sciences, see "Research Experiences for Undergraduates," *Notices*, May/June 1988, page 686.

Requests for REU Supplements may be submitted at any time and require 2-3 months processing time. The deadline for Sites is *October 10* annually. For more information, contact the Office of Undergraduate Science, Engineering and Mathematics Education, Room 639, National Science Foundation, 1800 G Street NW, Washington, DC 20550; telephone 202-357-7051. For program announcements, request form 88-28 from the Forms and Publications Unit, Room 232 at the street address above, or call 202-357-7861.

News from Washington

National Medals of Science Awarded

On July 15, 1988, President Reagan awarded National Medals of Science to nineteen individuals in recognition of their achievements in mathematics, science, and engineering. Among the recipients were two mathematical scientists, Ralph E. Gomory of International Business Machines (IBM) Corporation and Joseph B. Keller of Stanford University.

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

Ralph E. Gomory was awarded the Medal for his scientific and industrial contributions. IBM provided *Notices* with biographical information and a description of Gomory's contributions:

Ralph E. Gomory, IBM senior vice president for science and technology, was honored for "his scientific contributions to the mathematics of discrete optimization, for bringing to a leading position one of industry's most significant research establishments, and for his contributions to public and private scientific enterprise."

Gomory was born May 7, 1929, in Brooklyn Heights, New York. He graduated from Williams College in 1950, studied at Cambridge University, and received his Ph.D. in mathematics from Princeton University in 1954. Gomory served in the Navy and was Higgins Lecturer in Mathematics at Princeton before joining IBM's newly founded Research Division in 1959 as a research mathematician.

In his student years (Williams, Cambridge, Princeton), Gomory did research on nonlinear differential equations, but voluntary active service in the Navy (1954-57) turned his attention to the applied mathematics of operations research. Back at Princeton he soon linked classical Diophantine analysis with the new linear programming to obtain cutting-plane and all-integer algorithms which established integer programming as a rigorous and vital theory. It remains an active area of research today.

At IBM Research in the early '60s, Gomory published imaginative papers with Paul Gilmore on the knapsack, traveling salesman and cutting-stock problems (the last of which won the Lanchester Prize of the Operations Research Society in 1964), and with T. C. Hu on flows in multiterminal networks and continua. In the late '60s he developed the asymptotic theory of integer programming and introduced the concept of corner polyhedra. In the early '70s he collaborated with Ellis Johnson in investigating subadditive functions related to group problems that had played a role in cutting-planes and corner polyhedra.

Gomory's research has been recognized (in addition to the Lanchester Prize) by the title of IBM Fellow, IBM's highest technical rank, and by the Harry Goode Memorial Award of the American Federation of Information Processing Societies and the John von Neumann Theory Prize given jointly by the Operations Research Society and the Institute of Management Science. He was elected to the National Academy of Sciences in 1972.

Gomory served as chairman of IBM Research's Mathematical Sciences Department from 1965-67 and 1968-70 during an important period of its growth and evolution. This period saw the beginning of Shmuel Winograd's work on limits of algorithms and of Benoit Mandelbrot's work on fractals.

Gomory became director of research for IBM in 1970, with direct responsibility for IBM's Research Division comprising the research laboratories at Yorktown Heights, NY (the Thomas J. Watson Research Center); San Jose, CA (now the Almaden Research Center), and Zurich, Switzerland. He has continued to be responsible for the Research Division ever since, reporting variously to the president or chief executive officer of IBM.

Gomory was very much aware of the need for practical as well as scientific results coming from the Research Division. He worked to establish an atmosphere in which purely scientific work could be done, and in which technology transfer into products could also occur. He made use of a number of new organizational approaches to technology transfer, of which one, the so-called "joint programs," has been particularly successful.

Members of the Research Division have made major contributions to IBM's products and to the computer industry. Yorktown Heights was the birthplace of what is now known as RISC architecture, and San Jose was the birthplace of the concept, theory and first prototype of relational data. Major contributions to semiconductor technology and to magnetic disc technology, particularly the first thin film head, have emerged.

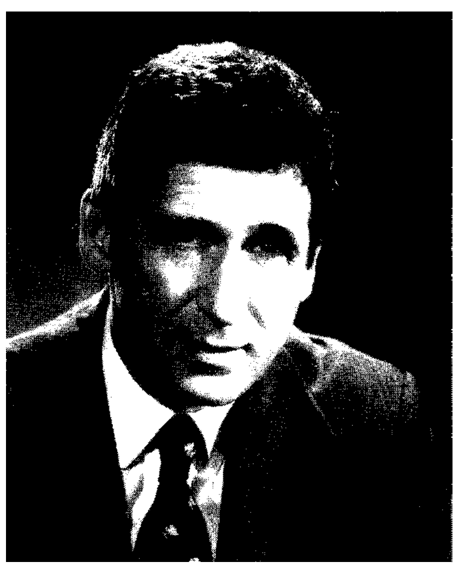
On the scientific side, Zurich did the work that resulted in two successive Nobel Prizes in physics, one for the Scanning Tunneling Microscope and one for the new high-temperature superconducting materials. These are only some highlights of a large body of both practical and theoretical work that has included major steps forward in lasers, solid state physics, algebraic complexity theory, and the evolution and application of fractals.

Gomory set clear goals for IBM's Research Division: to be famous for its science and technology, and vital to IBM. Through a sensitivity deriving from his own personal research, he created an atmosphere in which outstanding work could flourish together with practical contributions to the company. His technical leadership has been recognized by the award of the Medal of the Industrial Research Institute (IRI) in 1985, and by the Institute of Electrical and Electronics Engineers (IEEE) Engineering Leadership Recognition Award earlier this year.

Gomory was elected a vice president of IBM in 1973, named to the company's Corporate Management Board in 1983, and elected a senior vice president in 1985. In 1986, he was named to the newly created position he now occupies, which combines research with other technological functions.

Gomory is a trustee of Princeton University and of the Alfred P. Sloan Foundation. He was Andrew D. White (visiting) Professor-at-Large at Cornell from 1970-76, and he has served on visiting committees of Stanford, MIT, Princeton, Chicago and Yale. He was chairman of the Advisory Council of the Department of Mathematics at Princeton from 1984-85, and is chairman of the Harvard Visiting Committee for the Division of Applied Sciences.

Gomory is a member of the National Academy of Engineering, the American Academy of Arts and Sciences and the American Philosophical Society as well as the NAS, and a fellow of the Econometric Society. He has served on the Councils of the NAS, the NAE, the APS and the IRI.



Ralph E. Gomory

Gomory was worked on many studies for the National Research Council. In 1978-79 he was chairman of the group that brought out the first Five Year Outlook Report (on science and technology) from the NRC. Later he served on the NRC Governing Board, and he is currently a member of the Committee on Science, Engineering and Public Policy (COSEPUP).

In the last few years Gomory has written papers on the nature of technology development, on research in industry, and on industrial competitiveness. He is currently a member of the White House Science Council and chairman of the Advisory Committee to the President on High Temperature Superconductivity.

Joseph B. Keller was honored "for his outstanding contribution to the geometrical theory of diffraction. This is a major extension of geometrical optics which succeeds, after many centuries, in adding the physics of diffraction to the simple ray concepts of optics and of other wave motions."

Joseph B. Keller was born on July 31, 1923, in Paterson, New Jersey. He was educated at New York University, where he received his B.A. in 1943, his M.S. in 1946, and his Ph.D. in 1948. In 1948, Professor Keller began his teaching career at New York University as assistant professor of mathematics, before he became associate research professor in 1952. He was promoted to full professor in 1956, a position he held until 1979. He was concurrently the chairman of the mathematics department at NYU from 1967-1973. Since 1979, he has been a professor of mathematics at Stanford University.

Professor Keller was elected to the American Academy of Arts & Sciences in 1969, to the National Academy of Sciences in 1973, and to Foreign Membership of the Royal Society in 1986. He was vice president of the Society for Industrial and Applied Mathematics (1978-1979) and a Member at Large of the AMS Council (1985-1987).

Keller has received honorary doctorates from the Technical University of Copenhagen (1981) and from Northwestern University (1988). He has been awarded the Von Karman

Prize of the Society for Industrial and Applied Mathematics (SIAM), the Eringen Medal of the Society for Engineering Science, and the Timoshenko Medal of the American Society of Mechanical Engineers, and twice received the Lester R. Ford Award of the Mathematical Association of America. He has been the Gibbs Lecturer of the AMS and the von Neumann Lecturer of SIAM.

His areas of research interest include applied mathematics, acoustics, electromagnetic theory, fluid dynamics, and geometrical optics.

Bernard J. Matkowsky of Northwestern University was asked by the managing editor of *Notices* to comment on Keller's contributions. He responded:

Joseph Bishop Keller is one of the foremost contemporary creators of mathematical techniques to solve problems in science and engineering. He has earned this reputation by his outstanding research contributions to both mathematical methodolgy and to a wide variety of areas of application. He combines creativity in the development of mathematical methods with very deep physical insight and has an uncanny ability to describe real world problems by simple yet realistic models, to solve the mathematical problem by sophisticated techniques, many of which he himself created, and then to explain the results and their consequences in simple terms. He is a virtuoso in showing how to take ideas found useful in one area of science and adapt them for use in other areas. In addition, he has taught and trained generations of applied mathematicians who form what is referred to as the "Keller school of Applied Mathematics." Through his own work, as well as that of his students and other scientists with whom he has interacted, he has had a profound and lasting influence on the way that problems are formulated and solved mathematically.

One of Keller's most outstanding contributions is the Geometrical Theory of Diffraction (GTD), which he originated for solving problems of wave propagation. He began thinking about such problems in his work, during WW II, on problems of sonar for the Columbia University Division of War Research. GTD is an important extension of the Geometrical Theory of Optics (GTO), in which wave propagation is described by rays. The extension to GTD overcomes the difficulties of GTO which cannot account for phenomena such as diffraction, or the occurrence of signals where GTO predicts none. In his theory, Keller developed a systematic way to treat high frequency wave propagation problems and derived and solved the equations determining the rays, or paths, along which signals propagate, as well as those equations governing how energy propagates along those rays. These include predictions of what happens to the rays as they encounter obstacles or inhomogeneities of the medium in which they travel. Prior to Keller's work, only a few isolated problems were solved and understood, and there was no general theory which could be used by engineers and scientists for the solution of more complex and technologically important problems. Now there exist books devoted to Keller's theory, as engineers and scientists employ his systematic and general theory to this day.

Keller has also shown that the methods he developed for wave propagation could be extended to other classes of problems as well. For example, his fundamental work on semiclassical mechanics generalized the earlier work of Planck, Bohr, Sommerfeld, Wilson, Einstein, and Brillouin to derive the correct quantization rules for nonseparable systems, thus yielding results valid in any coordinate system. These results, referred to as the Einstein-Brillouin-Keller (E.B.K.) quantization rules, are currently employed by chemical physicists as well as other scientists. In his work on semiclassical quantization, he introduced an important measure corresponding to the number of times that a closed curve passes through a caustic surface. Later generalized to curves on Lagrangian manifolds by Maslov, this measure is referred to as the Keller-Maslov index. This work too was subsequently extended by Keller to eigenvalue problems in bounded domains, not necessarily associated with quantum mechanics, but governed by general systems of partial differential equations.

Joseph B. Keller

Keller's work has stimulated a vast literature both in the U.S. and abroad, not only in many areas of science and engineering in which his methods and results are routinely employed, but in the mathematics community as well. For example, his work has been the impetus for a number of developments in the theory of Fourier integral operators and Lagrangian manifolds.

Keller also considered problems of wave propagation through heterogeneous, turbulent, or random media. In this work he originated two methods which are very widely used: the Smoothing Method for problems involving small amplitude variations, and the Multiple Scale Method for problems corresponding to rapidly varying coefficients. This theory has since been taken up by others and has come to be known as the Theory of Homogenization, on which volumes have been written. His work was characterized by a simple formulation which overcame the nonuniformities restricting earlier theories.

No stranger to national service, Keller has worked on many problems related to national security and has served on various advisory boards, national panels, and committees. After his work on sonar for the Columbia University Division of War Research, he worked on problems of underwater explosions. In the early 1950s, he served, with von Neumann, on the Committee on Underwater Explosion of Atomic Bombs of the Armed Forces Special Weapons Project to consider proposed tests of the effects of A-bomb explosions on ships and submarines. Among the scientific consequences of his explosion work is the Keller-Kolodner theory of underwater explosion bubble oscillations, similarity solutions of spherical gas flows, and the Kranzer-Keller theory of water waves produced by explosions. These theories are still being used today.

In addition to his outstanding and wide-ranging research, Keller is a teacher and expositor par excellence. He has received awards from all the three major U.S. mathematical societies, from various engineering societies, as well as national societies in the U.S. and abroad. The approximately fifty Ph.D. students and numerous additional postdoctoral associates whom he has trained, now successful applied mathematicians in their own right, further attest to the impact that Keller has had. In short, Keller is one of the most prolific and important investigators and educators of our time.

Annual Department Chairs' Colloquium

The Board on Mathematical Sciences (BMS) of the National Research Council will hold its annual Department Chairs' Colloquium on October 14-15, 1988 at the Washington Marriott Hotel in Washington, DC. An earlier announcement of the colloquium appeared in the July/August issue of *Notices*, on page 819.

The program features the following presentations:

- *Computer Graphics and Mathematical Sciences Research*, organized by Edward Wegman, George Mason University. Three presentations with high visual content highlighting uses of computer graphics in research in core mathematics, applied mathematics and statistics, including examples of interesting mathematical and statistical problems arising in computer graphics.
- *Computers in the Classroom*, organized by Donald Kreider, Dartmouth College. Three presentations on uses of computers in teaching post-secondary mathematics and statistics, followed by a brief panel discussion on problems and opportunities.
- *Computation and Computational Methods in Mathematical Sciences Research*, organized by William Eddy, Carnegie-Mellon University. Three presentations on computational methods in research and research on computational methods in core mathematics, applied mathematics and statistics, followed by a brief panel discussion on where the field is going.
- *Supercomputers and Mathematical Sciences Research*, organized by Donald M. Austin, Department of Energy and Charles Holland, Air Force Office of Scientific Research. Three presentations on uses of supercomputers in research, research problems spawned by supercomputers, and opportunities for supercomputer access.
- *Mathematics in Industrial Problems*, Colloquium Banquet Address by Avner Freedman, Director of Institute for Mathematics and its Applications, University of Minnesota.
- *ICEMAP Agencies Roundtable*, organized by Judith S. Sunley, National Science Foundation. Presentation by agencies of Interagency Committee for Extramural Mathematics Programs (ICEMAP) on opportunities for funding mathematical and statistical research, and a roundtable discussion of current issues.
- *MS2000 and Report to the Nation*, organized by Bernard Madison, University of Arkansas. Update on activities, progress and plans for the MS2000 project (Mathematical Sciences in the Year 2000), including a presentation on the Report to the Nation by Lynn Arthur Steen, St. Olaf College.
- *BMS Update*, organized by Lawrence Cox, National Research Council. Update on programs and activities of the Board on Mathematical Sciences, including planning for the update of the David Report.
- *Washington Update*, Kenneth M. Hoffman, Joint Policy Board for Mathematics. Update on policy issues affecting the mathematical sciences.
- *Beyond the Individual Investigator Model: Workshop on Extraordinary Methods for Organizing and Funding Mathematical Sciences Research*, organized by Andre Manitius, George Mason University. Four presentations on methods for organizing and funding mathematical sciences research beyond the individual model, including research and technology centers, special years, and equipment and symposia grants.

The registration fee is $175 and covers the cost of handouts and meals (including a conference reception and banquet). Space is limited and advance registration is required. For more information, contact: Board on Mathematical Sciences, National Research Council, 2101 Constitution Avenue, NW, Room NAS 312, Washington, DC 20418; telephone 202-334-2421.

NRC Announces Minority Awards

The National Research Council (NRC) has announced awards in its programs for minority fellowships for postdoctoral research and for doctoral studies. Both programs are sponsored by the Ford Foundation and administered by the NRC.

According to Frank Press, chairman of the National Research Council, the Postdoctoral Fellowships for Minorities Program "gives outstanding teachers/scholars the freedom to pursue research interests without added teaching responsiblities." Among the 36 scholars receiving the postdoctoral fellowships are two in the mathematical sciences. MARK JOSEPH GOTAY, whose home institution is the United States Naval Academy, will use his fellowship to pursue research in mathematics at the Mathematical Sciences Research Institute, Berkeley, California. ISOM HARRIS HERRON of Howard University, will do research in the applications of mathematics at the University of Maryland.

The fellowships for doctoral studies are designed to increase the representation of minorities on the faculties of American colleges and universities. Forty predoctoral students will receive fellowships which include individual stipends and grants to graduate institutions in lieu of tuition and fees and which may extend up to three years. In addition, 14 doctoral candidates working on dissertations will receive one-year stipends. MARINA L. KAMAHELE will receive a predoctoral fellowship to study computer science at the University of Hawaii, Manoa. A predoctoral fellowship also will go to MARIA MARGARET MORRILL, who will study mathematics at the University of California, Los Angeles.

The deadline for the 1989 fellowship competitions is **November 14, 1988**. Information and applications are available from the Fellowship Office, National Research Council, 2101 Constitution Avenue, N.W., Washington, DC 20418; telephone 202-334-2872.

Staff Changes at AFOSR

Charles J. Holland, formerly Director of the Computer Science Division of the Office of Naval Research, has been appointed Director of the Mathematical and Information Sciences Directorate at the Air Force Office of Scientific Research (AFOSR). Holland replaces James M. Crowley, who will take a position in the Chief Scientist's Office at Air Force Systems Command. In addition, Eytan Barouch, professor of mathematics at Clarkson University, will become a program adviser at AFOSR.

Richard Miller, formerly Director of the Mathematical Optimization and Finite Mathematics programs at AFOSR, has returned to Iowa State University, where he is professor of mathematics.

Staff Changes at ONR

After serving about 1 1/2 years as Director of the Mathematics Division at the Office of Naval Research, John R. Cannon has accepted a position as Professor and Head of the mathematics department at Lamar University in Beaumont, Texas. His successor has not yet been named, but ONR will soon announce the search for a new director.

Julia Abrahams has accepted a position as Scientific Officer in the Probability and Statistics program. Before coming to ONR in July, Abrahams was Engineering Editor at Springer-Verlag. She received her Ph.D. in electrical engineering from Princeton University and taught that subject at Rice University and Carnegie-Mellon University. In 1983, she held a visiting position at ONR in the Probability and Statistics program. Her research interests include statistical communications theory, applied probability, and applied random processes.

Acknowledgement of Contributions

The officers and the staff of the Society acknowledge with gratitude gifts and contributions received during the past year. The inside cover of each issue of ***Mathematical Reviews*** carries the names of the sponsoring societies which support that publication. Contributing members of the Society paid dues of $132 or more. In addition to contributions to the AMS Centennial Research Fellowship Fund, there were a number of unrestricted general contributions. Some of the contributors have asked to remain anonymous. All of these gifts provide important support for the Society's programs. The names listed below include those whose contributions were received during the year ending March 31, 1988.

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Collier, Jarrell D.
Collier, William G., Jr.
Collins, Carol E.
Collins, Dennis G.
Collins, Donald J.
Collins, Karen L.
Collinsworth, John Grady
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Colquitt, Landon A.
Colson, Henry D.
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Comellas, Francesc
Comenetz, Daniel
Comez, Dogan
Comfort, Edwin H.
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Comfort, W. Wistar
Compton, Kevin J.
Conlon, Joseph G.
Conlon, Lawrence W.
Conlon, Samuel B.
Conn, Jack Frederick
Connelly, Robert
Conner, Luther T., Jr.
Connett, William C.
Connolly, Frank X.
Connolly, Mary V.
Connors, Edward A.
Conrad, Bruce P.
Conrey, J. Brian
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Contessa, Maria
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Cook, Joseph M.
Cook, Larry T.
Cook, Thurlow A.
Cooke, Kenneth L.
Cooke, Roger Lee
Cooley, Clifford R.
Coolsaet, Arnold A.
Coonen, Jerome T.
Cooper, E. D.
Cooper, Hilda L.
Cooper, J. B.
Copeland, Arthur H., Jr.
Copeland, Terry S.
Coppin, Charles A.
Coppotelli, Fred
Coram, Donald S.
Corazza, Paul J.
Corbacho, Eusebio T.
Cordero, Luis A.
Cordes, Craig M.
Cordes, Heinz O.
Corduneanu, Constantin
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Cornell, Gary
Correa, Nelson L.
Corrigan, Thomas Carney
Corsi Tani, Gabriella
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Costa, David G.
Costenoble, Steven R.
Cote, Louis J.
Cotter, Christopher S.
Cotton, Robert M.
Couch, W. Eugene
Coulter, Malcolm A.
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Covington, Judith L.
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Cowan, John C., III
Cowan, Richard E.
Cowens, J. Wayne
Cox, Gregory V.
Cox, Raymond H.
Cox, S. H., Jr.
Cox, Stephen E.
Coxson, Pamela G.
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Cozzens, Margaret Barry
Crabtree, J. B.
Craft, David L.
Craft, George A.
Craggs, Robert F.
Craig, Jessica Marguerite
Crane, George E.
Crane, Jane P.
Crane, Louis
Crank, Keith N.
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Crapo, Henry H.
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Craven, Bruce D.
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Creede, Geoffrey D.
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Croom, Frederick H.
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Cross, John S.
Cross, Ronald W.
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Crossman, Howard L.
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Crow, Edwin L.
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Cruthirds, John E.
Cude, Joe E.
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Cunkle, Charles H.
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Cunningham, Frederic, Jr.
Cunningham, Joel L.
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Cuntz, Joachim
Cuoco, Albert A.
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Currier, Albert W.
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Curry, John D.
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Curto, Raul E.
Cushing, Jim M.
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Dade, Everett C.
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Dahlin, Rolf B.
Dai, Taen-Yu
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Damiano, David B.
Damkohler, Wilhelm L.
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Dana, Martin P.
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Danset, Renaud
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Darafsheh, Mohammad-Reza
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De Lange, Jan
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De Snoo, Hendrik S. V.
De Villiers, Raoul A.
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Dulin, Bill J.
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Dumas, H. Scott
Dunbar, William Dart, Jr.
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Dunstan, Allyn W.
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Duskin, John W., Jr.
Dutt, J. E.
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Dye, Judy E.
Dym, Harry
Dynin, Alexander
Dyson, Verena H.
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Ealy, Clifton E., Jr.
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Earle, Clifford J., Jr.
Eaton, Timothy R.
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Edelstein-Keshet, Leah
Edet, Silas B.
Edgar, Hugh Maxwell Wallace
Edidin, Dan S.
Edmonds, Allan L.
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Edmondson, Don E.
Edrei, Albert
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Eigel, Edwin G., Jr.
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Eisenbud, David
Eisenstadt, B. J.
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El-Hodiri, Mohamed
Elia, Michele
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Eliason, Stanley B.
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Emmanuele, Giovanni
Emmer, Michele
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Endo, Youichi
Endsley, Neil H.
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Engl, Heinz W.
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Engler, Hans P.
Engquist, Bjorn
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Epp, Susanna S.
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Epstein, Bernard
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Erbe, Lynn H.
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Erbland, John P.
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Erdman, John M.
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Erickson, Roger P.
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Erlander, Sven
Erlandsson, Thomas
Errico, Thomas G.
Ervynck, Gontran J. O. H.
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Escobales, Richard H., Jr.
Eskew, Thomas Eugene
Eskin, Gregory
Eslinger, Robert C.
Esparza, Sergio O.
Essen, Matts R.
Esser, Anne-Marie Simon
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Etgen, Garret J.
Etheridge, William L.
Evans, Martin J.
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Everitt, William N.
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Ewing, Richard E.
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Faber, Richard L.
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Fabes, Eugene B.
Fabrega, Enfedaque Albert
Fack, T.
Fadell, Albert G.
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Fair, Wyman G.
Fairgrieve, Thomas F.
Falbo, Clement E.
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Fall, Thomas C.
Faltings, Kai
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Faran, James J.
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Farrell, Roger H.
Farrer, Brian H.
Farris, Frank A.
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Faurot, Donald P.
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Feeman, Timothy G.
Feferman, Solomon
Fegan, H. D.
Fegreus, John F.
Feibleman, James K.
Feichtinger, Hans Georg
Feigenbaum, Ruth I.
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Fein, Burton I.
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Feinsilver, Philip
Feit, Walter
Feldman, Arnold D.
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Feldman, Marcus B.
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Fell, James M. G.
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Fellows, Michael Ralph
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Fendrich, John W.
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Fennell, James G.
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Ferris, Ian M.
Ferro, Ruggero
Ferry, Steven C.
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Feuerbacher, Gary A.
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Field, Michael J.
Fieldhouse, D.
Fife, James H.
Figueiredo, Ana Maria
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Finch, David V.
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Finch, Steven Richard
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Fingerman, Joel
Finkelstein, Leib
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Finlayson, Henry C.
Finol, Carlos E.
Fischer, Arthur E.
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Fischer, David R.
Fischer, H.
Fischer, Hans R.
Fishback, William T.
Fisher, Stephen D.
Fishman, Louis
Fisk, Steve
Fitzgerald, Eugenia E.
Fitz-Gerald, Gary F.
Fitzgerald, Robert W.
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Fleissner, William G.
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Florence, John B.
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Foglio Susana, F. L. de
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Fong, Che-Kao
Fong, Kirby W.
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Fontaine, Anne T.
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Forelli, Frank
Foreman, David L.
Forkeotes, Ann A.
Forman, John W.
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Forster, Otto F.
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Foxby, Hans-Bjorn
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Freire Nistal, J. L.
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Friedberg, Stephen H.
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Frohman, Charles D.
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Fu, Yen-Tzu
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Fuchs, Wolfgang H.
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Galovich, Steve
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Goodman, James Thomas
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Konig, Heinz J.
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Li, Li-Ge
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Lim, Chong-Keang
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Lin, Zongzhu
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Little, Charles H. C.
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Liu, Hsi-Ching
Liu, Jianguo
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Liu, Li-Qian
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Liu, Tai-Ping
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Loud, Warren S.
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Loveys, James
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Markanda, Raj K.
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Moore, Rufus A.
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Moore, William E.
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Proctor, Robert A.
Promel, Hans Jurgen
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Protter, Murray H.
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1988 AMS Elections

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(two to be elected)
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American Journal of Mathematics	David Gieseker
Bulletin	Murray H. Protter
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Mathematical Reviews	Leonard D. Berkovitz John L. Selfridge
Mathematical Surveys and Monographs	David Kinderlehrer
Mathematics of Computation	Andrew M. Odlyzko
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(Preferential Ballot, four to be elected)

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Victor Klee
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*Uncontested offices

Election Information

The ballots for election of members of the Council and Board of Trustees of the Society for 1989 will be mailed on or shortly after September 10, in order for members to receive their ballots well in advance of the November 10 deadline. Prior to casting their ballots members are urged to consult the following articles and sections of the Bylaws of the Society: article I, section 1; article II, sections 1, 2; article III, sections 1, 2, 3; article IV, sections 1, 2, 4; article VII, sections 1, 2, 5. The complete text of the Bylaws appears on pages 1155–1160 of the November 1987 issue of *Notices*. A list of the members of the Council and Board of Trustees serving terms during 1988 appears in the **AMS Reports and Communications** section of this issue.

SUGGESTIONS FOR 1989 NOMINATIONS

Each year the members of the Society are given the opportunity to propose for nomination the names of those individuals they deem both qualified and responsive to their views and needs as part of the mathematical community. Candidates will be nominated by the Council to fill positions on the Council and Board of Trustees to replace those whose terms expire December 31, 1989. See the **AMS Reports and Communications** section of this issue for the list of current members of the Council and Board of Trustees. Members are requested to write their suggestions for such candidates in the appropriate spaces on the form in the next column.

REPLACEMENT BALLOTS

This year ballots for the AMS election will be mailed September 10, 1988, or within a day or two thereafter. The deadline for receipt of ballots in Providence is November 10, 1988.

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

To help alleviate this problem, the following replacement procedure has been devised: A member who has not received a ballot by October 10, 1988, or who has received a ballot but has accidentally spoiled it, may write after that date to the Secretary of the AMS, Post Office Box 6248, Providence, RI 02940, asking for a second ballot. The request should include the individual's member code and the address to which the replacement ballot should be sent. Immediately upon receipt of the request in the Providence office, a second ballot, which will be indistinguishable from the original, will be sent by first class or air mail. It must be returned in an inner envelope, which will be supplied, on the outside of which is the following statement to be signed by the member:

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

____

signature

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

SUGGESTIONS FOR 1989 NOMINATIONS

Council and Board of Trustees

Vice President (2)

Associate Secretaries (2)

Member of the *Bulletin* Editorial Committee (1)

Member of the *Colloquium* Editorial Committee (1)

Member of the *Mathematical Reviews* Editorial Committee (1)

Member of the *Mathematical Surveys* Editorial Committee (1)

Members of the *Mathematics of Computation* Editorial Committee (2)

Members of the *Proceedings* Editorial Committee (3)

Member of the *Transactions* and *Memoirs* Editorial Committee (1)

Members of the Committee to Monitor Problems in Communication (2)

Members-at-large of the Council (5)

Member of the Board of Trustees (1)

The completed form should be addressed to AMS Nominating Committee, Post Office Box 6248, Providence, RI 02940, to arrive no later than **November 10, 1988.**

American Mathematical Society

Expands Publication Program

In its Centennial year, the American Mathematical Society looks forward to increased opportunity to serve the mathematical community through an expanded publications program. One of the Society's central goals is to promote communication about mathematical sciences research through a diverse and dynamic publications program. As one of the world's largest mathematical publishers, the AMS is committed to providing the high quality, reasonably priced publications the mathematical community needs.

Several new book series and journals are planned to begin publication in 1988 and 1989. Some of them -- such as the History of Mathematics Series -- represent new directions for the Society. Others -- such as the translation of expository articles from the Japanese mathematical journal *Sūgaku* -- reflect the need for mathematicians to communicate more easily across international lines. All of them exemplify the Society's commitment to serving the mathematical community in the next century and beyond.

HISTORY OF MATHEMATICS SERIES

This series begins in 1988 with books about American mathematics during the past century. The titles in this series will present historical perspectives on individuals who have profoundly influenced the development of mathematics, as well as those who have made great contributions to the mathematical community, or will trace the development of special areas of research.

UNIVERSITY LECTURE SERIES

Lecture series provide an excellent forum for in-depth, and sometimes inspired, presentation of mathematical topics, but often benefit few beyond those attending them. To address this limitation, the AMS will publish books in the new University Lecture Series which will preserve important lecture series given at various institutions by outstanding mathematicians.

AMS REPRINTS

The Society receives many requests for help in obtaining copies of a number of excellent books that have gone out of print. As a service to the community, the AMS will publish the series AMS Reprints, consisting of important research monographs and graduate level textbooks that have been declared out of print by the original publishers.

SUGAKU EXPOSITIONS

Sūgaku, published by the Mathematical Society of Japan, is the Japanese counterpart of the *Bulletin of the AMS*. Each issue of *Sūgaku* contains several expository articles which provide highly informative accounts of a variety of current areas of mathematical research. The AMS will publish these articles in a new translation journal called *Sugaku Expositions*.

To submit a manuscript, contact
Director of Publication
American Mathematical Society
P.O. Box 6248
Providence, RI 02940 USA
(401) 272-9500 or
(800) 556-7774 in the continental U.S.

To begin a STANDING ORDER for titles in the History of Mathematics or University Lecture Series or to begin a subscription to *Sugaku Expositions*, contact the Membership and Sales Department at the AMS.

Meetings and Conferences of the AMS

FUTURE MEETINGS

Lawrence, Kansas
University of Kansas
October 28 – 29

Second Announcement

The eight-hundred-and-forty-fifth meeting of the American Mathematical Society will be held at the University of Kansas in Lawrence, Kansas on Friday, October 28, and Saturday, October 29, 1988.

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 titles are:

BJØRN DAHLBERG, Washington University, *Elliptic boundary value problems in non-smooth domains.*

STEVEN E. HURDER, University of Illinois at Chicago, *Geometry and the index theory of foliations.*

PETER SCOTT, University of Michigan, Ann Arbor, *Least area surfaces in 3-manifolds.*

SIDNEY M. WEBSTER, University of Minnesota, Minneapolis, *The integrability problems of complex analysis.*

Special Sessions

By invitation of the same committee, there will be twelve special sessions of selected twenty-minute papers. Topics and the names and affiliations of the organizers and a list of tentative speakers, when available, follow.

Partial differential equations – Geometric theory, ANDREW ACKER, Wichita State University

Geometry and mathematical physics, JOHN K. BEEM, University of Missouri and PHILLIP E. PARKER, Wichita State University. Tentative speakers include Ian M. Anderson, Brian DeFacio, Tevian Dray, Gerard Emch, Paul Ehrlich, Francis J. Flaherty, Gregory J. Galloway, Steven G. Harris, Justin Huang, David Lerner, Corrine Manogue, Bahram Mashhoon, Adrian Melott, Forest Miller, David Retzloff, John R. Urani, Walter Wei, Steve Wilkinson, and Chi-Ming Yau.

Numerical linear algebra, RALPH BYERS, University of Kansas. Tentative speakers include Greg Ammar, Jesse Barlow, Chris Beattie, Mike Berry, Chris Bischof, Ralph Byers, Biswa Datta, Al Geist, Bill Gragg, Nick Higham, Liz Jessup, George Miminis, Steven Nash, Alex Pothen, Noah Rhee, Dan Sorensesn, Dan Szyld, and Robert van de Geijn.

Algebraic geometry, BRUCE CRAUDER and SHELDON KATZ, Oklahoma State University. Tentative speakers are Alberto Albano, Donu Arapura, Jim Carlson, Susan Colley, Brucer Crauder, Lawrence Ein, Eileen Fritz, William Fulton, Tony Geramita, Brent Gordon, Brian Harbourne, Bruce Hunt, Sheldon Katz, Gary Kennedy, William Lang, Pablo Lejarraga, Genneady Lyubeznik, Juan Migliore, Prabhakar Rao, Igor Reider, Ahmad Rhayyel, Nick Shepherd-Barron, Roy Smith, Peter Stiller, and Robert Varley.

Control theory, TYRONE DUNCAN, University of Kansas

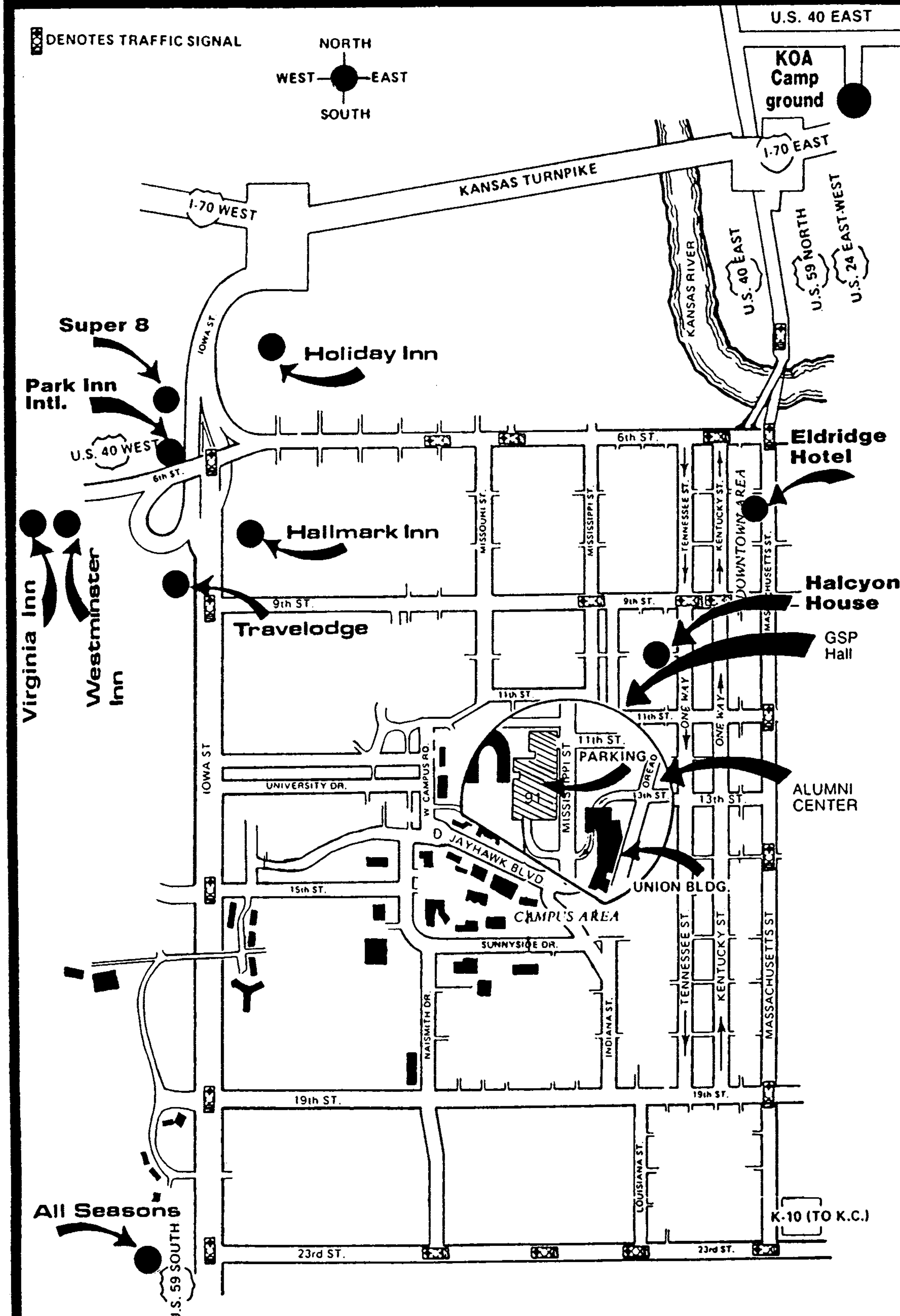
Applications of set theory, WILLIAM FLEISSNER, University of Kansas. Tentative speakers include Paul Bankston, Amer Berslagic, Paul Corazza, Peg Daniels, Sheldon Davis, Alan Dow, Gary Gruenhage, Win Just, John Kulesza, Withold Marciszwski, Arnie Miller, Jack Porter, Judy Roitman, Mary Ellen Rudin, Charles Scindwein, and Frank Tall.

Real analysis, JAMES FORAN, University of Missouri at Kansas City. Tentative speakers are Edward Arnold, Jack Brown, P. S. Bullen, Geraldo Soares De Souza, Henry Fast, Richard Gibson, H. P. Heinig, Paul Humke, Kenneth Kellem, Cheng-Ming Lee, Sandra Meinershagen, Krzysztof Ostaszewski, Darwin Peek, Zbigniew Piotrowski, and Daniel Waterman.

Flat bundles and geometric structures, WILLIAM MARK GOLDMAN, University of Maryland. Tentative speakers are D. Burns, S. Y. Choi, K. Corlette, S. Frank, D. Fried, D. Gallo, R. Hain, C. Hodgson, Y. Kamishima, R. Kulkarni, S. Luttinger, W. L. Lok, J. Millson, W. Neumann, J. Scherk, C. Simpson, J. Smillie, S. Tan, W. Thurston, D. Toledo and S. Zucker.

Operator theory and applications to geometry, STEVEN E. HURDER, University of Illinois at Chicago and NORBERTO SALINAS, University of Kansas. Tentative speakers include Kevin Clancey, Jeff Fox, James Heitsch, Gary Jensen, Palle Jorgensen, Franz Kamber, Jerry Kaminker, Steven Krantz, Mike Lamoureaux, Paul Muhly, Andrew

Map of Lawrence and the campus of the University of Kansas



Rich, Richard Rochberg, Walter Rudin, Philippe Tondeur, Albert Sheu, Keren Yan and Kehe Zhu.

Commutative algebra, DANIEL KATZ and JEFFERY LANG, University of Kansas

Potential theory and partial differential equations in nonsmooth domains, JILL PIPHER, University of Chicago and GREGORY VERCHOTA, University of Illinois at Chicago. Tentative speakers are Rodrigo Banuelos, Russell Brown, Eugene Fabes, Robert Fefferman, Carlos Kenig, John Lewis, Margaret Murray, Jill Pipher, Zhong-Wei Shen, Gregory Verchota, and Jang-Mei Wu.

3-manifolds, PETER SCOTT, University of Michigan. Tentative speakers are Colin Adams, Mark Baker, Mladen Bestvina, Marshall Cohen, Mark Feign, Bill Floyd, Dave Gabai, Cameron Gordon, Joel Hass, John Hempel, Ravi Kulkarni, Darren Long, Darryl McCullough, Bill Meeks, Geoff Mess, Bobby Meyers, Walter Neumann, Ulrich Oertrel, Alan Reid, Danny Ruberman, Marty Scharlemann, and Abby Thompson.

Contributed Papers

There will also be sessions for contributed ten-minute papers.

Registration

The registration desk will be located in the Level 4 Lobby of the Kansas Union and will be open on Friday, October 28, from 8:00 p.m. to 3:00 p.m., and Saturday, October 29 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.

To reach the registration area from Parking Lot 91, enter and walk through the understreet tunnel located at the southeast corner of Lot 91. When you enter the Kansas Union building, take the elevators on the south side of the stairwell to the Level 4 Lobby area.

Social Event

A social hour with a cash bar will be held on Friday evening, October 28 from 5:30 p.m. to 7:00 p.m. at the Adams Alumni Center located on the corner of 13th and Oread Streets.

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 Atlanta meeting announcement on page 68 of the January issue of *Notices*.

Accommodations

Blocks of rooms are being held at the lodging establishments listed below. Participants should make their own reservations directly with the hotel of their choice and be sure to identify themselves with the AMS meeting at the university. **Please make reservations by October 12, 1988.** After that date, reservations will be accepted on a space available basis only. Prices listed below are subject to change and do not include applicable taxes of 8 percent.

Westminister Inn
W. 6th Street
Telephone: 913-841-8410

Single $24 Double $32

Virginia Inn
W. 6th Street
Telephone: 913-843-6611

Single $24 Double $33

Park Inn
W. 6th Street
Telephone: 913-842-7030

Single $29 Double $37

All Seasons
Iowa Street
Telephone: 913-843-9100

Single $28 Double $33

Best Western
Iowa Street
Telephone: 913-841-6500

Single $28 Double $36

Rooms have not been blocked at the following locations but are included for informational purposes only.

Holiday Inn
McDonald Drive
Telephone: 913-841-7077 or Toll free 800-238-8000

Single $44 Double $50

Eldridge Hotel
Massachusetts Street
Telephone: 913-749-5011

Single $61 Double $68

Food Service

Most local lodging establishments have restaurants for breakfast, lunch, and dinner. The Kansas Union building houses several food service facilities ranging from salad bar to deli to traditional meals. Additionally, Lawrence has a variety of fine restaurants, such as the Eldridge

Hotel; Arthur Porters, 1511 W. 23rd Street; and Costello's Greenhouse restaurant, 3400 W. 6th Street. Fast food restaurants can be found throughout Lawrence. Information on area eating establishments will be included in your registration packet and will also be available at the registration area.

Travel

The University of Kansas main campus is located in Lawrence, about forty miles west of Kansas City International Airport which is served by most major airlines. Lawrence is also accessible by Greyhound buslines.

For those driving or renting cars at the airport, Lawrence can be reached by taking I-29 south (from the airport) to I-635 south to I-70 west. There are two exits for Lawrence: the East exit leads to the downtown area; the West exit leads to the campus and lodging establishments listed above.

Public limousine service to and from Kansas City International Airport is available from Corporate Coach, 913-841-5466, four times daily. Advance reservations are required and must be made **24 hours in advance.**

Parking and Local Travel

Courtesy visitor parking permits are available through the mathematics department at the university. Please send your written request to: The Department of Mathematics, University of Kansas, Strong Hall, Lawrence, KS 66045 **not later than October 1, 1988.**

Metered visitor parking at the University of Kansas is available in Lot 91 located just behind the Kansas Union. Visitors must park at metered spaces. The current rate is 25 cents per hour to a maximum of ten hours. Meters accommodate nickels, dimes and quarters. Visitors parking in nonmetered spaces will be ticketed.

Lawrence has local taxicab service information available at local motels and hotels.

Andy Roy Magid
Associate Secretary
Norman, Oklahoma

Claremont, California
Claremont McKenna College
November 12 – 13

Second Announcement

The eight-hundred-and-forty-sixth meeting of the American Mathematical Society will be held at Claremont McKenna College, Claremont, California, on Saturday and Sunday, November 12 and 13, 1988.

Invited Addresses

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, there will be three invited one-hour addresses. The speakers, their affiliations, and some of the titles follow:

WILLIAM JACOB, Oregon State University, *Galois cohomology and K-theory: Applications to division algebras and quadratic forms.*

ROBERT BROOKS, University of Southern California, *The spectrum of the Laplacian in 1988.*

FRANCIS BONAHON, University of Southern California, *Riemann surfaces and measured laminations.*

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 and a list of tentative speakers are:

Low dimensional geometry, FRANCIS BONAHON and DAVID GABAI, California Institute of Technology. Tentative speakers include: David Austin, Mladen Bestvina, Peter Braam, Andrew Casson, Daryl Cooper, David Gabai, Cameron Gordon, Matt Grayson, Joel Hass, Darren Long, Steve Kerckhoff, Eric Klassen, Darryl McCullough, Lee Mosher, Bob Penner, Marty Scharlemann, and Ron Stern.

Computers and software in mathematical research, ROBERT BORRELLI, Harvey Mudd College, and COURTNEY S. COLEMAN, Harvey Mudd College. Tentative speakers are: Frederick Dashiell, Jr., David Fisher, Ned Freed, Charles Lawson, Gottfried Mayer-Kress, and Robert Valenza.

The spectrum of the Laplacian, ROBERT BROOKS and S.-Y. CHENG, University of California, Los Angeles. Tentative speakers include: Isaac Chavel, Peter Doyle, Carolyn Gordon, Peter Perry, Peter Sarnak, Paul Yang and Steven Zelditch.

Differential and difference equations, STAVROS N. BUSENBERG, Harvey Mudd College, and MARIO MARTELLI, California State University, Fullerton. Tentative speakers are: N. Ailikakos, S. N. Chow, Donald Cohen, J. Cronin, Jim Cushing, Hector Fattorini, William Fitzgibbon, Patrick Fitzpatric, Frederick Howes, Russell Johnson, K. Kreith, G. Ladas, Edward Landesman, J. Lorenz, Joseph Mahaffy, Kenneth Palmer, Gary Rosen, K. Scmitt, George Sell, Hal Smith, Horst Thieme, and Pauline van den Driessche.

Division rings, WILLIAM JACOB and ADRIAN WADSWORTH, University of California, San Diego. Tentative speakers include: A. Blanchet, T. Craven, F. DeMeyer, D. Estes, B. Fein, L. Gerstein, T.-Y. Lam, J. Minac, P. Morandi, A. Rosenberg, D. Saltman, O. Taussky-Todd, R. Ware, and S. Yuzvinsky.

Contributed Papers

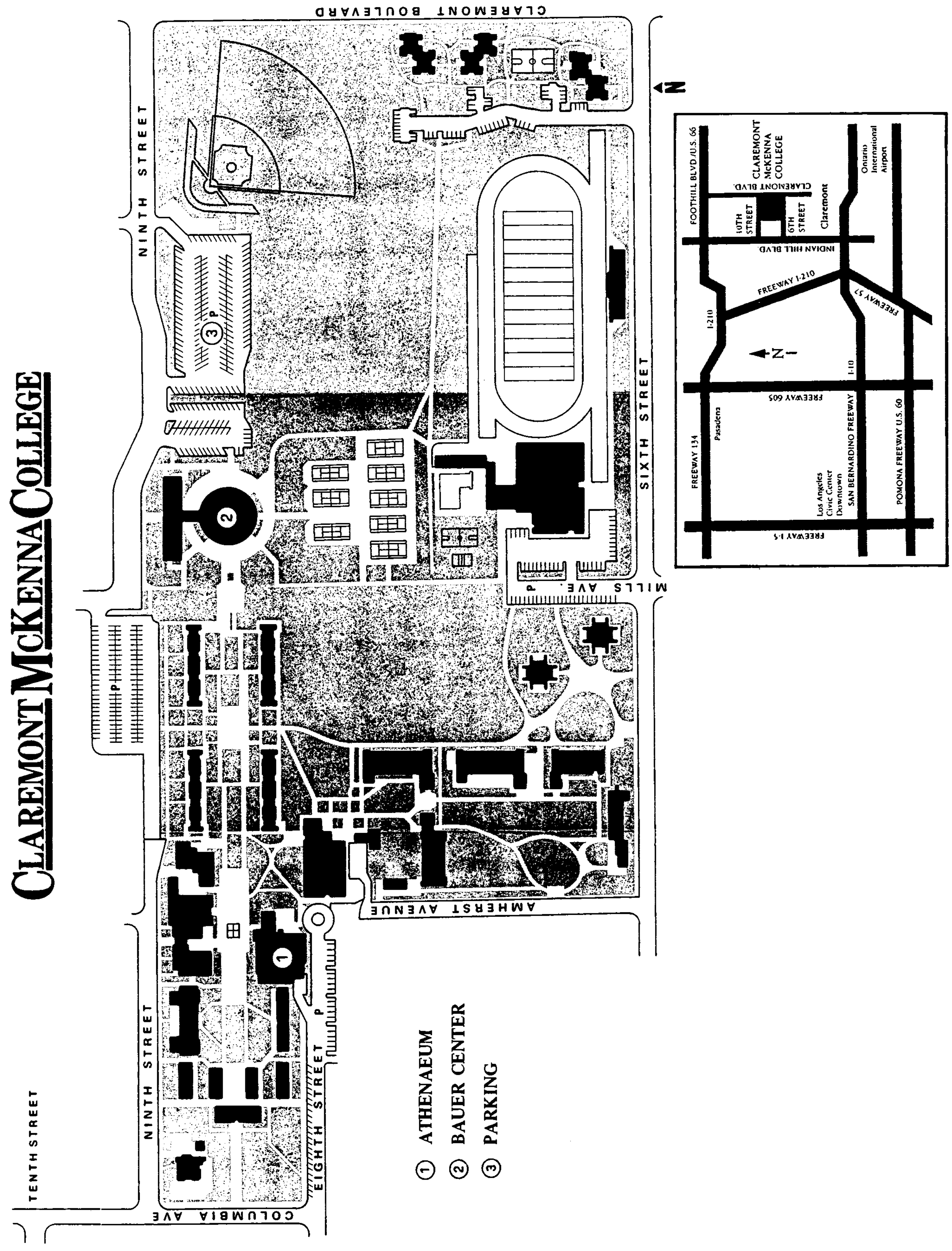
There will also be sessions for contributed ten-minute papers.

Activities of Other Organizations

The Mathematical Association of America will meet on Saturday, November 12. LEONARD GILLMAN, University of Texas and President of MAA, and MARVIN MARKUS, University of California at Santa Barbara, will give AMS-MAA joint invited addresses. There will be a luncheon at noon in the Athaeneum; the cost is $8. SOLOMON GOLOMB, University of Southern California will speak on *The numerical range.* There will be two special sessions titled *Mathematical notes and classroom capsules* and *Mathematics as a humanistic discipline.*

Registration

The meeting registration desk will be located in the lobby of Bauer Center. The desk will be open from 8:30 a.m.


CLAREMONT McKENNA COLLEGE
CLAREMONT BOULEVARD
NINTH STREET
SIXTH STREET
MILLS AVE.
AMHERST AVENUE
EIGHTH STREET
COLUMBIA AVE
TENTH STREET
P
1 ATHENAEUM
2 BAUER CENTER
3 PARKING
N
FOOTHILL BLVD/U.S. 66
CLAREMONT McKENNA COLLEGE
CLAREMONT BLVD.
10TH STREET
6TH STREET
Claremont
INDIAN HILL BLVD
FREEWAY I-210
FREEWAY 57
I-210
Ontario International Airport
FREEWAY 605
I-10
Pasadena
FREEWAY 134
Los Angeles Civic Center Downtown
SAN BERNARDINO FREEWAY
POMONA FREEWAY U.S. 60
FREEWAY I-5

to 2:00 p.m. on both Saturday and Sunday, November 12 and 13. The registration fees are $30 for both days for members of the AMS, $45 for nonmembers, and $10 for students and unemployed mathematicians. There is a special one-day fee for MAA members on Saturday only of $15.

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 Atlanta meeting announcement on page 68 of the January issue of *Notices*.

Accommodations

Rooms have been blocked at the following hotels and motels. Participants should make their own reservations directly with the hotel of their choice, identifying themselves as attending the American Mathematical Society's meeting at Claremont McKenna College. Rates quoted do not include applicable taxes and are subject to change.

Shuttle service from and to Ontario International Airport is provided free of charge. The driving time is 15 to 20 minutes.

Griswold's Inn (walking distance)
555 West Foothill Boulevard
(Corner of Indian Hill Boulevard)
Claremont, CA 91711
Telephone: 800-854-5733 (except California), 800-821-0341 (in California) or 714-626-2411

Rooms (1-4 persons): $60 plus tax

Rooms must be reserved before October 21.

Ramada Inn (2.5 miles)
840 South Indian Hill Boulevard
(Next to San Bernadino Freeway-Interstate 10)
Claremont, CA 91711
Telephone: 800-228-2828 or 714-621-4831

Rooms (1-2 guests): $49 plus tax
Additional person: $6 per night

Food Service

The hotels listed above have their own restaurants. In addition, there are many good restaurants in Claremont and the surrounding area. A list will be provided at the meeting.

Luncheon

There will be a joint luncheon for MAA and AMS participants on Saturday, November 12 at noon in the Athenaeum on the college campus.

Travel

Claremont is located 35 miles east of Los Angeles.

Most major airlines serve Ontario International Airport (California). The drive from LAX is slow on Friday afternoons, but not as slow on Saturdays and Sundays.

To get to the Bauer Center of Claremont McKenna College where registration and meetings will be held, you should head west on 9th Street from Claremont Boulevard. Please refer to the accompanying map.

Parking

Parking is available in the lots on the south side of 9th Street on the Claremont-McKenna College campus.

Lance W. Small
Associate Secretary
La Jolla, California

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.

Lawrence, October 1988

Bjørn Dahlberg
Steven E. Hurder
Peter Scott
Sidney M. Webster

Claremont, November 1988

William Jacob
Robert Brooks
Francis Bonahon

Phoenix, January 1989

Ralph P. Boas
John B. Conway
Percy Alec Deift
David Fried
Ronald L. Graham (AMS-MAA)
Peter Landweber
Cathleen S. Morawetz (AMS-MAA)
Steve Smale (AMS-MAA)
Luc Tartar

Worcester, April 1989

Igor Frankel
Thomas H. Parker
Karl Rubin
Adrian Ocneanu

Chicago, May 1989

Henri Gillet
Nicholas Lerner
Richard Rochberg
Shmuel Weinberger

Muncie, October 1989

Kenneth Meyer
Paul S. Muhly
Steven Sperber

Organizers and Topics of Special Sessions

The list below contains all the information about Special Sessions at meetings of the Society available at the time this issue of *Notices* went to the printer. The section below entitled **Information for Organizers** describes the timetable for announcing the existence of Special Sessions.

October 1988 Meeting in Lawrence
Central Section
Associate Secretary: Andy Roy Magid
Deadline for organizers: Expired
Deadline for consideration: Expired

Andrew Acker, *Partial differential equations–Geometric equations*
John K. Beem and Phillip E. Parker, *Geometry and mathematical physics*
Ralph Byers, *Numerical linear algebra*
Bruce Crauder and Sheldon Katz, *Algebraic geometry*
Tyrone Duncan, *Control theory*
William Fleissner, *Applications of set theory*
James Foran, *Real analysis*
William Mark Goldman, *Flat bundles and geometric structures*
Steven E. Hurder and Noberto Salinas, *Operatory theory and applications to geometry*
Daniel Katz and Jeffery Lang, *Commutative algebra*
Jill Pipher and Gregory Vechota, *Potential theory and partial differential equations in nonsmooth domains*
Peter Scott, *3-manifolds*

November 1988 Meeting in Claremont
Far Western Section
Associate Secretary: Lance W. Small
Deadline for organizers: Expired
Deadline for consideration: Expired

Francis Bonahon and David Gabai, *Low dimensional geometry*
Robert Borrelli and Courtney S. Coleman, *Computers and software in mathematical research*
Robert Brooks and S. -Y. Cheng, *The spectrum of the Laplacian*
Stavros N. Busenberg, *Differential and difference equations*
William Jacob and Adrian Wadsworth, *Division algebras*

January 1989 Meeting in Phoenix
Associate Secretary: Lance W. Small
Deadline for organizers: Expired
Deadline for consideration: September 21, 1988

Melvyn S. Berger, *Mathematics of nonlinear science*
John B. Conway, Harry Gonshor, and Martin Kruskal, *Surreal numbers*
Percy Deift, *Integrable systems*
David Eisenbud and Craig Huneke, *Commutative algebra and algebraic geometry*
David Fried and Joseph Christie, *Geometry of hyperbolic dynamical systems*
Larry C. Grove and M. F. Newman, *Computational group theory*
William A. Harris, *Singular perturbation theory*
Victor J. Katz and Florence Fasanelli, *History of Mathematics*
Albert Marden and Burton Rodin, *Computational aspects of complex analysis*
Sidney Port, *Stochastic processes*
Marc A. Rieffell, *Operator algebras and geometry*
Hal L. Smith and James Cushing, *Mathematics in population biology*

April 1989 Meeting in Worcester
Eastern Section
Associate Secretary: W. Wistar Comfort
Deadline for organizers: Expired
Deadline for consideration: January 4, 1989

Richard Herman and Adrian Ocneanu, *Operator algebras, Galois theory and representations*
James Lepowsky, *Infinite-dimentional symmetries in mathematics and physics*
Thomas H. Parker, *Gauge theory and differential geometry*
Karl Rubin and Glenn Stevens, *L-functions and arithmetic*
Lee Rudolph, *Knot theory and algebraic geometry in the large*

May 1989 Meeting in Chicago
Central Section
Associate Secretary: Andy Roy Magid
Deadline for organizers: Expired
Deadline for consideration: February 8, 1989

Jeffery Bergen, *Noncommutative ring theory*
Martin Butinas and Billy Rhoades, *Sequence spaces and summability*
Jonathan Cohen, *Numerical methods in harmonic analysis*
Vinay Deodhar, *Kazhdan-Lusztig theory and related topics*
Stephen Doty, *Algebraic groups and related topics*
Christine Haught, *Recursion theory*
Cary Huffman and Neal Brand, *Codes and designs*
Ronnie Lee and Steven Weintraub, *Algebraic topology of varieties*
S. P. Singh, *Nonlinear analysis and its applications*

August 1989 Meeting in Boulder
Associate Secretary: Andy Roy Magid
Deadline for organizers: November 15, 1988
Deadline for consideration: April 25, 1989

October 1989 Meeting in Hoboken
Eastern Section
Associate Secretary: W. Wistar Comfort
Deadline for organizers: January 15, 1989
Deadline for consideration: August 9, 1989

October 1989 Meeting in Muncie
Central Section
Associate Secretary: Andy Roy Magid
Deadline for organizers: January 15, 1989
Deadline for consideration: August 9, 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 the *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 the *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

Frank T. Birtel, Associate Secretary
Department of Mathematics
Tulane University
New Orleans, LA 70118
(Telephone 504 - 865 - 5646)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

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.

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.

1987–1988. **Academic Year Devoted to Differential Geometry**, University of North Carolina, Chapel Hill, North Carolina. (November 1987, p. 1137)

1987–1988. **Academic Year Devoted to Several Complex Variables**, Mittag-Leffler Institute, Djursholm, Sweden. (January 1987, p. 131)

1988-1989. **Academic Year Devoted to Operator Algebras**, Mittag-Leffler Institute, Djursholm, Sweden. (February 1988, p. 307)

March 6–December 24, 1988. **Mathematisches Forschungsinstitut Oberwolfach** (Weekly Conferences), Federal Republic of Germany. (March 1988, pp. 457-458)

April 17–December 24, 1988. **Mathematisches Forschungsinstitut Oberwolfach** (Weekly Conferences), Federal Republic of Germany. (October 1987, p. 995)

October 1988–August 1989. **Symposium on Singularity Theory and Its Applications**, University of Warwick, Coventry, United Kingdom. (May/June 1988, p. 724)

January 1–December 23, 1989. **Mathematisches Forschungsinstitut Oberwolfach** (Weekly Conferences), Federal Republic of Germany. (April 1988, p. 629)

September 1988

18–21. **IMACS International Symposium on System Modelling and Simulation**, University of Calabria, Province de Cosenza, Italy. (July/August 1988, p. 892)

18–24. **DMV-Jahrestagung 1988**, Regensburg, Federal Republic of Germany. (March 1988, p. 464)

19–23. **Sixth International Colloquium on Differential Geometry**, Universidad de Santiago de Compostela, Santiago de Compostela, Spain. (February 1988, p. 312)

19–23. **Histoire de la Relativite Generale**, Marseille, France. (March 1988, p. 464)

23–25. **Fall Foliage Combinatorial Group Theory Conference**, Shaker Village, New Hampshire. (May/June 1988, p. 729)

24–25. **Last Fall Foliage Topology Seminar**, Shaker Village, New Hampshire. (May/June 1988, p. 729)

*24–25. **Midwest Several Complex Variables Meeting**, Purdue University, West Lafayette, Indiana.

INFORMATION: S. R. Bell, Department of Mathematics, Purdue University, West Lafayette, Indiana 47907, 317-494-1956.

*24–27. **Conference on Numerical Solutions of Partial Differential Equations**, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

SPONSORS: Interdisciplinary Center for Applied Mathematics and Department of Mathematics, Virginia Polytechnic Institute and State University.
INVITED SPEAKERS: I. Babuska, University of Maryland; H. T. Banks, Brown University; J. Douglas, Purdue University; G. J. Fix, University of Texas-Arlington; J. G. Glimm, New York University; H. O. Kreiss, California Institute of Technology; J. L. Lions, College de France; R. A. Nicolaides, Carnegie-Mellon University; S. J. Osher, University of California; D. Russell, University of Wisconsin; E. Tadmor, Tel Aviv University.
INFORMATION: N. D. Smith, ICAM, Virginia Tech, 620 North Main Street-B2, Blacksburg, Virginia 24061-0531, 703-961-7667.

25–October 1. **International Symposium in Honor of René Thom**, Paris, France.

INFORMATION: V. Houllet, Colloque René Thom I. H. E. S., 35, route de Chartres, 91440 Bures-sur-Yvettte, France. Telephone: 33.1.69.07.48.53, poste 405. (Note changes from February 1988, p. 312)

* 26–28. **CSCW '88: Second International Conference on Computer-supported Cooperative Work**, Portland, Oregon.

SPONSORS: Association for Computing Machinery, with support from Lotus Development Corporation and Xerox Corporation.
PROGRAM: This conference will bring together academic and industry representatives from many disciplines including computer science, organization design, artificial intelligence, cognitive science, the social sciences and engineering. [Note: Conference attendance is limited, so advance registration is strongly encouraged.]
INFORMATION: J. Kling, Lotus Development Corporation, 617-577-8500, or S. Sylvia, 617-225-1860.

26–30. **Computational Intelligence '88**, University of Milano, Milano, Italy. (March 1988, p. 465)

26–October 1. **Fifth International Conference on Complex Analysis**, Halle, German Democratic Republic. (October 1987, p. 1000)

28–October 9. **Sixth International Summer School on Probability Theory and Mathematical Statistics**, Varna, Bulgaria. (July/August 1988, p. 892)

30–October 1. **Sixteenth Annual Mathematics and Statistics Conference**, Miami University, Oxford, Ohio. (April 1988, p. 637)

October 1988

1. **Algebra Day**, Carleton University, Ottawa, Canada. (July/August 1988, p. 892)

3–5. **Knowledge-Based Robot Control**, Bonas, France. (May/June 1988, p. 729)

4–6. **Colloque Ergoia 88 Ergonomie et Intelligence Artificelle**, Biarritz, France. (April 1988, p. 637)

5–7. **IFAC/IMACS/IFIP Symposium on Robot Control SYROCO '88**, Karlsruhe, Federal Republic of Germany. (July/August 1988, p. 893)

9–13. **International Conference on Computer Languages**, Castle Premier, Miami Beach, Florida. (March 1988, p. 465)

10–12. **IEEE Workshop on Visual Languages**, University of Pennsylvania, Pittsburgh, Pennsylvania. (March 1988, p. 465)

10–12. **Frontiers '88: Second Symposium on the Frontiers of Massively Parallel Computation**, George Mason University, Fairfax, Virginia. (July/August 1988, p. 893)

10–14. **Workshop on Mathematical Programming**, Catholic University of Rio De Janeiro, Brazil. (May/June 1988, p. 729)

12–14. **Sensor-Based Robots: Algorithms and Architectures**, Bonas, France. (May/June 1988, p. 729)

12–15. **Discrete Mathematics and Computer Science**, University of Montreal, Montreal, Quebec, Canada. (July/August 1988, p. 893)

21–22. **Tenth Midwest Probability Colloquium**, Northwestern University, Evanston, Illinois. (May/June 1988, p. 730)

24–26. **Twenty-ninth Foundations of Computer Science**, White Plains, New York. (July/August 1988, p. 893)

28–29. **Seventeenth Midwest Differential Equations Conference**, Iowa State University, Ames, Iowa. (May/June 1988, p. 730)

28–30. **Central Sectional Meeting**, Lawrence, Kansas.

INFORMATION: J. Balletto, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

30–November 4. **Ninth International Conference on Computer Communications**, Tel Aviv, Israel. (July/August 1988, p. 893)

31–November 18. **Workshop in Mathematical Ecology**, Trieste, Italy. (March 1988, p. 465)

November 1988

* 3–4. **Symposium on the Legacy of Emil Post**, City University of New York, City College, New York, New York.

PRINCIPAL SPEAKERS: G. Baumslag, City University of New York, City College; M. Davis, New York University, Courant Institute of Mathematical Sciences; S. Ginzburg, University of Southern California; J. Hartmanis, Cornell University; M. Minsky, H. Rogers, and G. Sacks, Massachusetts Institute of Technology.
INFORMATION: J. Barshay, Department of Mathematics, City University of New York, City College, New York, New York 10031, 212-690-5346.

4–5. **Southeast Differential Equations Conference**, Athens, Georgia. (March 1988, p. 465)

* 4–5. **Third Annual Pi Mu Epsilon Regional Conference**, Saint Norbert College, De Pere, Wisconsin.

INVITED SPEAKER: P. Straffin, Beloit College.
INFORMATION: R. Poss, Saint Norbert College, De Pere, Wisconsin 54115, 414-337-3198.

* 5. **New York Graph Theory Day 16**, The State University of New York, Purchase, New York.

SPONSOR: The Mathematics Section of the New York Academy of Sciences.
INVITED SPEAKERS: F. Harary and A. J. Hoffman.
ORGANIZING COMMITTEE: S. Auslander; F. Buckley; J. W. Kennedy; M. Lewinter; L. V. Quintas.
INFORMATION: M. Lewinter, Mathematics Department, State University of New York, Purchase, New York 10577, 914-253-5040.

* 7–11. **Workshop on Solitons in Nonlinear Optics and Plasma Physics**, Institute for Mathematics and Its Applications, Minneapolis, Minnesota.

ORGANIZERS: D. Kaup and Y. Kodama.
INFORMATION: Institute for Mathematics and Its Applications, University of Minnesota, Minneapolis, Minnesota 55455, 612-624-6066.

* 11–13. **Midwest Dynamical Systems Conference**, Emory University, Atlanta, Georgia.

INFORMATION: S. Batterson (404-727-7923) or J. Christy (404-727-7956), Emory University, Department of Mathematics, Atlanta, Georgia 30322.

12–13. **846th Meeting of the AMS**, Claremont, California.

INFORMATION: J. Balletto, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

12–13. **Twenty-fourth Midwest Partial Differntial Equations Seminar**, University of Notre Dame, Notre Dame, Indiana. (July/August 1988, p. 893)

13–17. **French-Israeli Conference on Combinatorics and Algorithms**, Israel. (February 1988, p. 313)

18–19. **Quantitative Approaches to Diabetes**, Sydney, Australia. (April 1988, p. 638)

20–25. **Eighth Annual Conference: Towards a Whole Decade for Scientific and Technological Cooperation for International Development**, Jamaica, West Indies. (March 1988, p. 465)

21–December 16. **College on Global Geometric and Topological Methods in Analysis**, Trieste, Italy. (March 1988, p. 465)

December 1988

5–8. **IMACS Conference on Expert Systems for Numerical Computing**, Purdue University, West Lafayette, Indiana. (July/August 1988, p. 893)

6–8. **First International Conference on Matter Elements Analysis**, Guangzhou, Guangdong, People's Republic of China. (October 1987, p. 1000)

12–15. **International Conference on Computer Vision**, Tarpon Springs, Florida. (May/June 1988, p. 730)

12–17. **International Course on Computational Geometry**, Dipartimento di Matematica, Università, Catania, Italy. (May/June 1988, p. 730)

13–15. **IMA/SIAM International Conference on Mathematics of Signal Processing**, Warwick, England. (April 1988, p. 638)

13–17. **KAC-Moody Lie Algebras and Physics Conference**, North Carolina State University, Raleigh, North Carolina. (July/August 1988, p. 894)

14–16. **Raj Chandra Bose Memorial Conference on Combinatorial Mathematics and Applications**, Calcutta, India. (July/August 1988, p. 894)

27–31. **Holiday Symposium on Fermat's Last Theorem**, New Mexico State University, Las Cruces, New Mexico.

PROGRAM: With partial support from the National Science Foundation, the symposium will focus on Fermat's Last Theorem and will consist of ten lectures, two each day, by J. Tate, of Harvard University. There will be additional sessions organized by J. Selfridge of Northern Illinois Universsity, as well as sessions for contributed papers, research ideas, and discussion. Some support will be available for a limited number of participants.
INFORMATION: R. J. Wisner, Fermat Symposium, Department of Mathematical Sciences, New Mexico State University,, Box 300001, Las Cruces, New Mexico 88003-0001, 505-646-3901. (Note changes from May/June 1988, p. 730.)

January 1989

2–5. **International Colloquium in Ring Theory**, Bar-Ilan University, Ramat-Gan, Israel. (May/June 1988, p. 730)

*2–5. **Fifth Haifa Matrix Conference**, Technicon City, Haifa, Israel.

ORGANIZING COMMITTEE: A. Berman; M. Goldberg; D. Hershkowitz; L. Lerer; R. Loewy; A. Zaks.
INFORMATION: A. Berman, Department of Mathematics, Technicon-Israel Institute of Technology, Haifa 32000, Israel.

*3–10. **Workshop on Two Phase Waves in Fluidized Beds, Sedimentation, and Granular Flows**, Institute for Mathematics and its Applications, Minneapolis, Minnesota.

ORGANIZERS: D. Joseph, B. Keyfitz, D. Schaeffer.
INFORMATION: Institute for Mathematics and its Applications, Minneapolis, Minnesota 55455, 612-624-6066.

4–6. **American Statistical Association Winter Conference: Statistics in Society**, San Diego, California. (March 1988, p. 465)

6–12. **Nonlinear Wave Equations**, George Mason University, Fairfax, Virginia. (April 1988, p. 638)

8–10. **Symposium in Honor of the Seventieth Birthday of Ted Harris**, Los Angeles, California. (May/June 1988, p. 730)

8–11. **First Caribbean Conference on Fluid Dynamics**, Saint Augustine, Trinidad, West Indies. (June 1987, p. 686)

*8–11. **Conference on the Arithmetic of Algebraic Curves**, University of Arizona, Tucson, Arizona.

CONFERENCE TOPICS: Arakelov theory; Tate-Shafarevich groups; Mordell's conjecture.
INVITED SPEAKERS: R. Coleman; B. Mazur; J. Tate; K. Ribet; K. Rubin; P. Vojta.
INFORMATION: S. Kamienny or W. McCallum, Department of Mathematics, University of Arizona, Tucson, Arizona 85721.

9–13. **Sixth Texas International Symposium on Approximation Theory**, College Station, Texas. (April 1988, p. 638)

9–14. **K-Theory and Dynamics**, University of Florida, Gainesville, Florida. (April 1988, p. 638)

*10–11. **AMS Short Course on Matrix Theory and Applications**, Phoenix, Arizona.

INFORMATION: M. Foulkes, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

11–14. **Joint Mathematics Meetings**, Phoenix, Arizona. (April 1987, p. 553)

INFORMATION: H. Daly, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02940.

15–20. **American Association for the Advancement of Science Annual Meeting**, San Francisco, California. (May/June 1988, p. 731)

23–27. **Workshop on Algorithms, Word Problems, and Classification in Combinatorial Group Theory**, Mathematical Sciences Research Institute, Berkeley, California. (February 1988, p. 313)

February 1989

*6–10. **Minisymposium on Plasticity**, Institute for Mathematics and its Applications, Minneapolis, Minnesota.

ORGANIZER: D. Joseph.
INFORMATION: Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota 55455, 612-624-6066.

*19–23. **Analyse quantitative de la sensibilité en optimisation**, Centre de recherches mathématiques, Université de Montréal.

ORGANIZERS: R. T. Rockafeller, Washington; R. Wets, Davis.

INFORMATION: F. H. Clarke, Director, Centre de recherches mathématiques, Université de Montréal, CP 6128-A, Montréal, Québec H3C 3J7 Canada.

21–23. **Seventeenth Annual Computer Science Conference**, Commonwealth Convention Center, Louisville, Kentucky. (May/June 1988, p. 731)

March 1989

* 6–10. **Workshop on Ellipticity in Evolution Equations**, Institute for Mathematics and its Applications, Minneapolis, Minnesota.

ORGANIZERS: D. Joseph, B. Keyfitz, D. Schaeffer.
INFORMATION: Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota 55455, 612-624-6066.

* 13–18. **East European Category Seminar (EECS '89)**, Sofia, Bulgaria.

PURPOSE: This seminar is a traditional annual meeting of scientists working on category theory and its applications in general. In the classical branches, topics covered will include logics, algebra, topology, geometry, analysis and in some modern applied extensions: theoretical computer science, system theory, programming, graph theory, theoretical physics, fuzzy sets theory and others.
INFORMATION: K. G. Peeva, IEC Sofia, POB 384, Bulgaria.

* 15–17. **Second IMACS International Symposium on Computational Acoustics**, Princeton University, Princeton, New Jersey.

CONFERENCE COMMITTEE: D. Lee, Naval Underwater Systems Center; A. Cakmak, Princeton University; R. Vichnevetsky, Rutgers University.
SPONSORS: IMACS (International Association for Mathematics and Computers in Simulation; NUSC (Naval Underwater Systems Center); ONR (Office of Naval Research); Princeton University.
SYMPOSIUM TOPICS: Computational methods to solve acoustics problems (including acroacoustics, seismoacoustics, and ocean acoustics) and in general wave propagation problems; computational aspects of the interaction between aero-, ocean- and seismoacoustics; new solution techniques which have been made possible with the advent of new computer architectures.
INFORMATION: D. Lee, Code 3122, Naval Underwater Systems Center, New London, Connecticut 06320, 203-440-4438.

19–22. **ENAR Spring Meeting**, Lexington, Kentucky. (March 1988, p. 465)

* 22–25. **Computer-Aided Proofs in Analysis**, University of Cincinnati, Cincinnati, Ohio.

PROGRAM: The theme of the conference is the use of the computer to help establish rigorous proof of theorems in various areas in analysis. The use of symbolic processors, interval arithmetic, and careful error analysis will be discussed. There will be a plenary lecture and contributed papers. The meeting has support from the University of Cincinnati, the Institute for Mathematics ans its Applications, and support from the NSF is anticipated.
CALL FOR PAPERS: Abstracts are due by February 15, 1989.
INFORMATION: D. Schmidt, Department of Computer Science, or K. Meyer, Department of Mathematics, University of Cincinnati, Cincinnati, Ohio 45221.

* 28–31. **Annual Scientific Conference of the Society of Applied Mathematics and Mechanics (GAMM)**, University of Karlsruhe, West Germany.

ORGANIZER: G. Alefeld.
PROGRAM: There will be approximately twelve main lectures and short communications from all fields of applied mathematics and mechanics.
INFORMATION: G. Alefeld, Institut für Angewandte Mathematik, Kaiserstraße 12, D-7500 Karlsruhe 1, West Germany.

April 1989

3–6. **IEEE International Conference on Control and Applications**, Jerusalem, Israel. (April 1988, p. 638)

* 3–14. **Workshop on Multidimensional Hyperbolic Problems and Computations**, Institute for Mathematics and its Applications, Minneapolis, Minnesota.

ORGANIZERS: J. Glimm, A. Majda.
INFORMATION: Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota 55455, 612-624-6066.

10–13. **IEEE Artificial Neural Networks Conference**, Sheraton International Conference Center, Reston, Virginia. (Note date change, March 1988, p. 465)

* 13–15. **Operators and Function Theory: The Role of de Branges's Spaces**, University of Arkansas, Fayetteville, Arkansas.

PRINCIPAL SPEAKER: D. Sarason, University of California, Berkeley.
OTHER INVITED SPEAKERS: J. Agler; S. Axler; L. de Branges; C. Cowen; J. Helton; T. Kriete; M. Rosenblum; J. Rovnyak; J. Shapiro; A. Shields.
CALL FOR PAPERS: Contributed papers should be submitted before February 15, 1989.
INFORMATION: J. Duncan or I. Monroe, Department of Mathematical Sciences, SCEN 301, University of Arkansas, Fayetteville, Arkansas 72701.

15–16. **Eastern Section Meeting**, College of the Holy Cross, Worcester, Massachusetts. (May/June 1988, p. 731)

* 16–20. **NCGA '89**, Philadelphia Civic Center, Philadelphia, Pennsylvania.

INFORMATION: NCGA '89 Education Coordinator, 2722 Merrilee Drive, Suite 200, Fairfax, Virginia 22031, 1-800-225-NCGA or 703-698-9600.

* 17–21. **Minisymposium on Computational Issues for Nonlinear Hyperbolic Waves**, Institute for Mathematics and its Applications, Minneapolis, Minnesota.

ORGANIZERS: J. Glimm, P. Woodward.
INFORMATION: Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota 55455, 612-624-6066.

May 1989

* 4–5. **Twentieth Annual Pittsburgh Conference on Modeling and Simulation**, Pittsburgh.

CONFERENCE TOPICS: Emphasis will be on computer science: artificial intelligence, expert systems, robotics, microprocessors, and personal computer applications and software.

CALL FOR PAPERS: Papers on all aspects of control theory and applications, as well as all of the traditional areas of modeling and simulation are of interest and are welcomed. Two copies of titles, authors, all authors' addresses, abstracts and summaries should be submitted by January 31, 1989. Notification of acceptance for presentation will be given by March 8, 1989. Instructions and model paper for the preparation of accepted papers will be mailed to each author. The final typed manuscript will be due by May 5, 1989.
INFORMATION: W. G. Vogt or M. H. Mickle, Modeling and Simulation Conference, 348 Benedum Engineering Hall, University of Pittsburgh, Pittsburgh, Pennsylvania 15261.

8–10. **Forty-Third Annual Quality Congress**, Toronto, Canada. (March 1988, p. 465)

8–12. **Workshop on Arithmetic Groups and Buildings**, Mathematical Sciences Research Institute, Berkeley, California. (March 1988, p. 465)

15–17. **1989 New Zealand Mathematics Colloquium**, Palmerston North, New Zealand. (May/June 1988, p. 731)

19–20. **Central Section Meeting**, Loyola University, Chicago, Illinois.

INFORMATION: J. Balletto, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

*22–24. **Workshop on Vortex Methods**, Mathematical Sciences Research Institute, Berkeley, California.

ORGANIZING COMMITTEE: C. Anderson; A. Chorin, Chairman; A. Majda; P. Marcus; M. Pulvirenti.
INFORMATION: I. Kaplansky, Director, Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley, California 94720.

*22–June 3. **NATO Advanced Study Institute on Orthogonal Polynomials and Their Applications**, The Ohio State University, Columbus, Ohio.

ORGANIZING COMMITTEE: M. Ismail; P. Nevai, Director; D. Stanton.
PRINCIPAL SPEAKERS: D. Bessis; W. Gautschi; Y. Genin; R. Haydock; T. Koornwinder; D. S. Lubinsky; I. Macdonald; E. A. Rahmanov; E. B. Saff; H. Stahl; G. Viennot.
INFORMATION: OPsConf, c/o P. Nevai, Department of Mathematics, The Ohio State University, 231 West Eighteenth Avenue, Columbus, Ohio 43210-1174.

23–27. **International Conference on Computing and Information**, Toronto, Ontario, Canada. (April 1988, p. 638)

*28–June 1. **Sixteenth International Symposium on Computer Architecture**, Jerusalem, Israel.

SPONSORS: IEEE Computer Society and the Association for Computing Machinery.
CALL FOR PAPERS: Industry-oriented papers will be accepted for evaluation until November 11, 1988. Authors are asked to submit five copies of papers in English and include a cover page, a 100-word abstract, and a list of five key words. All authors from the United States should forward papers to Arvind, Laboratory for Computer Science, Massachusetts Institute of Technology, 545 Technology Square, Cambridge, Massachusetts 02139. Papers from Europe and Israel should be sent to J. Gurd, Computer Science Department, University of Manchester, Manchester M13 9PL, United Kingdom. Authors from the Far East should send papers to M. Kitsuregawa, Institute of Industrial Science, University of Tokyo, Minato-ku, Tokyo 106, Japan.
INFORMATION: Sixteenth International Symposium on Computer Architecture, 90A Hayarkon Street, Post Office Box 3190, Tel Aviv 61031, Israel. Telephone: 972-3-246261.

28–June 10. **AMS-SIAM Summer Seminar on the Mathematics of Random Media**, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. (May/June 1988, p. 731)

29–June 1. **Third International Conference in Mathematics: Fractional Calculus and Its Applications**, Nihon University, Tokyo, Japan. (May/June 1988, p. 731)

*30–June 30. **Analytic Number Theory, Modular Forms and Related Topics**, Centre de recherches mathématiques, Université de Montréal.

ORGANIZERS: J. Friedlander, University of Toronto; H. Iwaniec, Rutgers University; R. Murty, McGill University.
INFORMATION: F. H. Clarke, Director, Centre de recherches mathématiques, Université de Montréal, CP 6128-A, Montréal, Québec H3C 3J7 Canada.

June 1989

*5–7. **An International Symposium on Asymptotic and Computational Analysis**, Winnipeg, Canada.

CONFERENCE THEMES: Asymptotic solutions to differential equations; asymptotic approximations of integrals; singular perturbation theory; applications of asymptotics; special functions; computational analysis.
PROGRAM: There will be one-hour and half-hour invited research or survey presentations. In addition, there will be a limited number of contributed talks (15 minutes each).
INFORMATION AND PAPER SUBMISSION: R. Wong, Department of Applied Mathematics, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada, 204-474-8167.

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.

INFORMATION: N. G. Zamani, Department of Mathematics and Statistics, University of Windsor, Windsor, Ontario, Canada N9B 3P4.

*6–10. **Analytic Number Theory**, Centre de recherches mathématiques, Université de Montréal.

ORGANIZERS: R. Murty, McGill University; J. Friedlander, Toronto University; H. Iwaniec, Rutgers University.
INFORMATION: F. H. Clarke, Director, Centre de recherches mathématiques, Université de Montréal, C. P. 6128-A, Montréal, Québec H3C 3J7 Canada.

*7–9. **Canadian Applied Mathematics Society Tenth Annual Meeting**, Winnipeg, Canada.

MAJOR THEMES: Asymptotic and Computational Analysis; Two-point

Boundary Value Problems and Matrix Computation.

INFORMATION AND PAPER SUBMISSION: R. Wong, Department of Applied Mathematics, University of Manitoba, Winnipeg, Manitoba R3T 2N2 Canada 204-474-8167.

12–16. **Computers and Mathematics**, Massachusetts Institute of Technology, Cambridge, Massachusetts. (July/August 1988, p. 894)

July 1989

3–7. **Computational Ordinary Differential Equations**, London, England. (April 1988, p. 638)

10–12. **International Conference on Computational Techniques and Applications**, Griffith University, Brisbane. (April 1988, p. 639)

10–21. **Microprogram on Noncommutative Rings**, Mathematical Sciences Research Institute, Berkeley, California. (May/June 1988, p. 731)

30–August 4. **Sixteenth Annual Conference and Exhibition on Computer Graphics and Interactive Techniques (SIGGRAPH '89)**, Hynes Auditorium, Boston, Massachusetts. (March 1988, p. 466)

30–August 12. **Harmonic Analysis on Reductive Groups**, Bowdoin College, Brunswick, Maine. (January 1988, p. 160)

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)

6–10. **1989 Joint Statistical Meetings**, Washington, District of Columbia. (March 1988, p. 466)

13–19. **Fourth Conference on Differential Equations and Applications**, Rousse, Bulgaria. (May/June 1988, p. 731)

20–September 6. **Nineteenth Ecole d'ete de Calcul des Probabilities**, Saint-Flour, Cantal. (March 1988, p. 466)

28–September 1. **IFIP 89: Eleventh World Computer Conference**, San Francisco, California. (April 1988, p. 639)

29–September 6. **Forty-seventh Session of the International Statistical Institute**, Paris, France. (April 1988, p. 639)

September 1989

16–October 20. **Sixth World Congress on Medical Information**, Beijing, China. (April 1988, p. 639)

25–29. **Third International Conference on the Theory of Groups and Related Topics**, Australian National University, Canberra. (May/June 1988, p. 732)

October 1989

21–22. **Eastern Section Meeting**, Stevens Institute of Technology, Hoboken, New Jersey. (May/June 1988, p. 732)

27–28. **Central Section Meeting**, Ball State University, Muncie, Indiana. (May/June 1988, p. 732)

January 1990

17–20. **Joint Mathematics Meetings**, Louisville, Kentucky. (April 1987, p. 553)

INFORMATION: H. Daly, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02940.

May 1990

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.

INFORMATION: M. Castellet, Director, Centre de Recerca Matematica, Institut D'Estudis Catalans, Apartat 50 - 08193 Bellaterra, Barcelona, Spain.

August 1990

6–9. **1990 Joint Statistical Meetings**, Anaheim, California. (March 1988, p. 466)

January 1991

16–19. **97th Annual Meeting**, San Francisco, California.

INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

August 1991

17–21. **American Sociological Association Annual Meeting**, Cleveland, Ohio. (May/June 1988, p. 732)

19–22. **1991 Joint Statistical Meetings**, Atlanta, Georgia. (March 1988, p. 466)

New AMS Publications

THEORETICAL AND MATHEMATICAL PHYSICS, A Collection of Survey Articles, Part III: On the Fiftieth Anniversary of the Institute
V. S. Vladimirov (Editor-in-Chief), E. F. Mishchenko, and A. K. Gushchin
(Proceedings of the Steklov Institute, Volume 175)

The Steklov Mathematical Institute was formed in 1934 by the Soviet Academy of Sciences. In commemoration of the fiftieth anniversary of the institute, the Academic Council, acting on the initiative of the Director, I. M. Vinogradov, decided to publish a cycle of "Trudy of the Steklov Institute of the Academy of Sciences." The cycle consists of surveys of work on certain important trends and problems in mathematics that were pursued at the institute. The choice of the form and character of the surveys was left to the authors.

This book, which represents the third issue in the cycle, contains surveys of investigations in certain domains of theoretical and mathematical physics, in particular, statistical physics, mathematical diffraction, axiomatic quantum field theory, the theory of boundary value problems for the equations of mathematical physics, and the gas dynamics of explosion. Fundamental results on the microscopic theory of superfluidity and superconductivity are presented, as well as a number of results on the theory of functions of several complex variables and multidimensional Tauberian theory having important applications in mathematical physics.

Contents

1980 *Mathematics Subject Classifications*: 32, 35, 40, 41, 42, 45, 76, 78, 81, 82 and others
ISBN 0-8218-3119-4, LC 88-22154
ISSN 0081-5438
265 pages (softcover), September 1988
Individual member $70, List price $117,
Institutional member $94
To order, please specify STEKLO/175N

COMBINED MEMBERSHIP LIST

This CML is a comprehensive directory of the membership of the AMS, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics. The list is distributed as a privilege of membership to AMS members in even-numbered years and the MAA members in odd-numbered years. The CML is an invaluable reference for keeping in touch with colleagues and for making connections in the mathematical sciences community in the U.S. and abroad.

There are two lists of individual members. The first is a complete alphabetical list of all members in all three organizations. For each member, the CML provides his or her address, title, department, institution, and telephone number (if available), electronic address (if indicated), and also indicates the mathematical organizations to which the individual belongs. The second lists individual members according to their geographic locations. In addition, the CML lists all academic and institutional members and provides addresses and telephone numbers of mathematical sciences departments.

1980 *Mathematics Subject Classification*: 00
ISBN 0-8218-0113-9
448 pages (softcover), September 1988
Individual member $20, List price $34,
Institutional member $27
To order, please specify CML/88/89N

Use the order form in the back of this issue or call 800-556-7774 to use VISA or MasterCard.
Shipping and handling charges will be added.

The following book description is being reprinted with a corrected Table of Contents.

A CENTURY OF MATHEMATICS IN AMERICA, Part I
Peter L. Duren, Editor
with the assistance of Richard A. Askey and Uta C. Merzbach

In the 100 years since the founding of the AMS, the American mathematical community has grown from a small group heavily dependent on European mathematicians to a large and influential group that in many areas sets the standard for the rest of the world. By the 1930s, there was a flourishing mathematical community to welcome the influx of mathematicians fleeing Europe. These refugees supplied additional strength and new vigor to a field that increased dramatically as a result of World War II and the postwar recognition of mathematics.

This volume, the first in the new History of Mathematics series, brings together a variety of perspectives on the political, social, and mathematical forces that have shaped the American mathematical community in the past century. Humorous, edifying, and poignant, this book presents the personal recollections of a number of mathematicians who have influenced the development of mathematics in this country.

One of the highlights of the volume is Lipman Bers's paper which was presented as an AMS-MAA Joint Invited Address in Atlanta in January 1988 and which gives a moving account of the reception that he and other European refugee mathematicians received in this country. Described here are some of the success stories of this century—such as classification of finite simple groups, delineated by Daniel Gorenstein—as well as some of the problems—such as the McCarthy period, chronicled by Chandler Davis. Paul R. Halmos, one of the most influential textbook writers, tells of the textbooks he used when he was a student and young professor and how they influenced him. Among the papers reprinted here are some that have appeared in journals not ordinarily read by mathematicians, such as the article by science historian Nathan Reingold, which appeared in *The Annals of Science*.

Mathematicians, historians of science, and students alike will find this book illuminating and rewarding. That the lessons of the past can guide the resolution of present problems makes this book important reading for all who are concerned with the development of mathematics. It will also make a fine addition to any library collection.

Contents

Use the order form in the back of this issue or call 800-556-7774 to use VISA or MasterCard.
Shipping and handling charges will be added.

1980 *Mathematics Subject Classification*: 01
ISBN 0-8218-0124-4, LC 88-22155
ISSN 0899-2428
486 pages (hardcover), August 1988
Individual member $34, List price $57,
Institutional member $46
To order, please specify HMATH/1N

Please note: **Special combination prices** have been established for the reviews volumes below. The book descriptions are being re-run from previous *Notices* issues.

Reviews in Partial Differential Equations, 1980–86 and **Reviews in Global Analysis, 1980–86.**
Special combined price. **Individual member $283**, List price $472, Institutional member $378, Reviewer $236
To order, please specify REVPGLO/86N

Reviews in Partial Differential Equations, 1980–86 and **Reviews in Numerical Analysis, 1980–86**
Special combined price. **Individual member $262**, List price $436, Institutional member $349, Reviewer $218
To order, please specify REVPNAN/86N

REVIEWS IN PARTIAL DIFFERENTIAL EQUATIONS, 1980–86
Introduction by Murray H. Protter

Comprising a significant portion of present-day research in analysis, the area of partial differential equations encompasses a broad spectrum of topics, from classical work in linear second-order equations to more recent work in a general nonlinear setting. In addition, the subject has deep and fundamental ties to a wide variety of scientific areas outside mathematics. This important reference work makes the vast subject of partial differential equations much more accessible both to specialists working in this area and to those interested in related areas of mathematics and its applications.

These five volumes contain the more than 19,200 reviews that appeared in *Mathematical Reviews* from 1980 through 1986 and have a primary or secondary classification in Partial Differential Equations (classification number 35). Relevant cross-references are provided with each review. The fifth volume of this set contains author and key indexes which make it very easy to locate items written by a specific author or to get information about collections or conference proceedings dealing with partial differential equations.

Contents

1980 *Mathematics Subject Classifications*: 35Q20; 35M05, 35J65
ISBN 0-8218-0103-1, LC 88-6681
4040 pages, 5 volumes (softcover), July 1988
Individual member $177, List price $295,
Institutional member $236, Reviewer $148
To order, please specify REVPDE/86N

REVIEWS IN GLOBAL ANALYSIS, 1980–86
Introduction by Anthony J. Tromba

The term "global analysis" refers to the general area of analysis on manifolds, in which the methods of modern algebra, analysis, geometry, and topology are blended. Although the beginnings of these ideas can be traced to the 17th century, major contributions in this direction were made by Lie, Riemann, and Poincaré toward the end of the last century, followed by the work of G. D. Birkhoff, E. Cartan, and Morse in the early part of this century. However, it is only in recent years that the subject has attained its present central position in mathematics. The subject has many rich applications to fields outside mathematics—such as mechanics, quantum physics, and general relativity—as well as within mathematics itself.

Today, this vital and active field is undergoing a virtual explosion of new and important results. *Reviews in Global Analysis* makes information about the most recent contributions to this rapidly growing field accessible both to specialists working in global analysis, and to those in other areas of pure and applied mathematics.

These five volumes contain the more than 18,000 reviews that appeared in *Mathematical Reviews* from 1980 through 1986 and have a primary or secondary classification in Global Analysis (classification number 58). Relevant cross-references are provided with each review. The fifth volume of this set contains author and key indexes, making it very easy to locate items written by a specific author or to get information about collections or conference proceedings dealing with global analysis.

Contents

1980 *Mathematics Subject Classification*: 58
ISBN 0-8218-0104-X, LC 88-10565
4060 pages, 5 volumes (softcover), August 1988
Individual member $177, List price $295,
Institutional member $236, Reviewer $148
To order, please specify REVGLO/86N

REVIEWS IN NUMERICAL ANALYSIS, 1980–86
Introduction by Gene H. Golub

These five volumes bring together a wealth of bibliographic information in the area of numerical analysis. Containing over 17,600 reviews of articles, books, and conference proceedings, these volumes represent all the numerical analysis entries that appeared in *Mathematical Reviews* between 1980 and 1986. Classified according to the 1980 Mathematics Subject Classification scheme, the reviews are listed in each subsection according to their *MR* classification number. Accompanying each entry is a list of all subsequent reviews that cite the entry as a reference. In addition, author and key indexes appear at the end of volume 5.

1980 *Mathematics Subject Classifications*: 65XX, 76XX, 41XX, 35XX
ISBN 0-8218-0102-3, LC 87-25478
3750 pages, 5 volumes (softcover), January 1988
Individual member $150, List price $250,
Institutional member $200, Reviewer $125
To order, please specify REVNAN/86N

Use the order form in the back of this issue or call 800-556-7774 to use VISA or MasterCard.
Shipping and handling charges will be added.

AMS Reports and Communications

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.

George E. Andrews, Kenneth Millet, M. Susan Montgomery, and Paul J. Sally, Jr. have been appointed by President G. D. Mostow to the ad hoc *Committee on Fellowship Policy.* Professor Montgomery will serve as chairman.

Charles Fefferman (1991) and Jun-ichi Igusa (1991) have been appointed by President G. D. Mostow to the *Committee to Select the Winner of the Steele Prize.* Continuing members of the committee are Frederick J. Almgren, Jr. (1989), Luis A. Caffarelli (1990), William S. Massey (1989), chairman, Frank A. Raymond (1989), Neil J. A. Sloane (1990), Louis Solomon (1989), Richard P. Stanley (1989), Michael E. Taylor (1990).

President G. D. Mostow has appointed Hyman Bass, James McKenna, Cathleen S. Morawetz, Warren Page, Gian-Carlo Rota and Alan D. Weinstein to the *Liaison Committee with AAAS.*

Larry Baggett, William L. Briggs, Richard Andrew Holley, Frieda K. Holley, William H. Jaco (ex officio), Andy Roy Magid (ex officio), Arlan Ramsay, William N. Reinhardt, Kenneth A. Ross (ex officio), and Richard L. Roth have been appointed by Presidents G. D. Mostow, AMS, and Leonard Gillman, MAA, to the *Committee on Arrangements for the Boulder Meeting August 7-10, 1989.* Professor Ramsay will serve as chairman.

Richard A. Askey (Section L) and Jerry L. Bona (Section Q) have been appointed as the Society's representatives to the *American Association for the Advancement of Science* by President G. D. Mostow. Terms expire on May 27, 1989.

Statistics on Women Mathematicians Compiled by the AMS

At its August 1985 meeting, the Council of the AMS approved a motion to regularly assemble and report in *Notices* information on the relative numbers of men versus women in at least the following categories: membership in the AMS; invited hour addresses at AMS meetings; speakers at special sessions at AMS meetings; and members of editorial boards of AMS journals.

It was subsequently decided that this information would be gathered by determining the sex of the individuals in the above categories based on name identification and that additional information on the number of Ph.D.'s granted to women would also be collected using the AMS Annual Survey. Since name identification was used, the information for some categories necessitated the use of four classifications:

Male: names that were obviously male;

Female: names that were obviously female;

Unknown: names that could not be identified as clearly male or female (i.e., only initials given); and

Foreign: foreign names that could not be identified as clearly male or female.

The following is the second reporting of this information. Updated reports will appear annually in *Notices.*

Members of the AMS Residing in the U.S.

Male:	12,167	75%
Female:	2,196	14%
Unknown:	752	5%
Foreign:	982	6%
Total checked:	16,097	

Invited Hour Address Speakers at AMS Meetings (1978–1987)

Male:	366	92%
Female:	25	6%
Unknown:	2	1%
Foreign:	3	1%
Total checked:	396	

Speakers at Special Sessions at AMS Meetings (1983–1987)

Male:	2,713	78%
Female:	203	6%
Unknown:	342	10%
Foreign:	220	6%
Total checked:	3,478	

Trustees and Council Members

	1987	1986	1985	1984
Total:	65	65	71	70
Male:	52 80%	56 86%	61 86%	62 89%
Female:	13 20%	9 14%	10 14%	8 11%

Members of Editorial Boards of AMS Journals

	1987		1986		1985		1984		1983		1982		1981		1980		1979		1978	
Total:	133		109		102		93		90		83		85		82		82		67	
Male:	125	94%	104	95%	94	92%	85	91%	84	93%	77	93%	79	93%	77	94%	78	95%	64	96%
Female:	8	6%	5	5%	8	8%	8	9%	6	7%	6	7%	6	7%	5	6%	4	5%	3	4%

Ph.D.'s Granted to U.S. Citizens

	1987		1986		1985		1984		1983		1982		1981		1980		1979		1978	
Total:	362		386		396		433		455		519		567		578		596		634	
Male:	289	80%	304	79%	315	80%	346	80%	366	80%	431	83%	465	82%	491	85%	503	84%	545	86%
Female:	73	20%	82	21%	81	20%	87	20%	89	20%	88	17%	102	18%	87	15%	93	16%	89	14%

Officers and Committee Members

Terms expire on December 31 of the year given unless otherwise specified.

Numbers to the left of headings are used as points of reference in a index to AMS committees which follows this listing. Primary and secondary headings are:

1. Officers

President	G. D. Mostow	1988
President-Elect	William Browder	1988
Vice-Presidents	Barry Simon	1989
	William P. Thurston	1989
	Karen Uhlenbeck	1988
Secretary	Everett Pitcher	1988
Associate Secretaries	Frank T. Birtel	1988
	W. Wistar Comfort	1988
	Andy Roy Magid	1989
	Lance W. Small	1989
Treasurer	Franklin P. Peterson	1988
Associate Treasurer	Steve Armentrout	1988

1.1. Liaison Committee

All members of this committee serve *ex officio*.

Chairman	G. D. Mostow
	Franklin P. Peterson
	Everett Pitcher

2. Council

2.0.1. Officers of the AMS

President	G. D. Mostow	1988
President-Elect	William Browder	1988
Vice-Presidents	Barry Simon	1989
	William P. Thurston	1989
	Karen Uhlenbeck	1988
Secretary	Everett Pitcher	1988
Associate Secretaries*	Frank T. Birtel	1988
	W. Wistar Comfort	1988
	Andy Roy Magid	1989
	Lance W. Small	1989
Treasurer	Franklin P. Peterson	1988
Associate Treasurer	Steve Armentrout	1988

2.0.2. Representatives of Committees

American Journal of Mathematics	Spencer Bloch	1988
Bulletin	Morris W. Hirsch	1989
	Edgar Lee Stout	1988
Colloquium	Raoul H. Bott	1990
	Charles L. Fefferman	1988
Journal of the AMS	Michael Artin	1991
Committee to Monitor Problems in Communication	Marian B. Pour-El	1989
Mathematical Reviews	Melvin Hochster	1989
Mathematical Surveys and Monographs	R. O. Wells, Jr.	1988
Mathematics of Computation	Walter Gautschi	1989
	Hugh C. Williams	1988
Proceedings	William J. Davis	1988
	Irwin Kra	1988
	Andrew M. Odlyzko	1989
	Donald S. Passman	1988
Science Policy Committee	Ronald G. Douglas	1989
Transactions and Memoirs	Ronald L. Graham	1988

2.0.3. Members-at-Large

James G. Arthur	1988	Yiannis N. Moschovakis	1989
Jane P. Gilman	1988	Linda A. Ness	1989
Richard K. Guy	1990	Marc A. Rieffel	1989
Rhonda J. Hughes	1990	Harold M. Stark	1990
Robion C. Kirby	1990	Jean E. Taylor	1988
Irwin Kra	1990	Chuu-Lian Terng	1988
H. Blaine Lawson, Jr.	1989	William A. Veech	1988
Albert Marden	1990	Robert F. Williams	1988
		Carol S. Wood	1989

* Only one Associate Secretary at a time is a voting member of the Council, namely the cognizant Associate Secretary for the scientific sessions.

2.1. Executive Committee of the Council

	William Browder	*ex officio*
	Irwin Kra	1990
Chairman	G. D. Mostow	*ex officio*
	Everett Pitcher	*ex officio*
	Jean E. Taylor	1988
	William P. Thurston	1991
	William A. Veech	1989

3. Board of Trustees

	Steve Armentrout	*ex officio*
Chairman	Ramesh A. Gangolli	1989
	Frederick W. Gehring	1992
Secretary	Ronald L. Graham	1991
	M. Susan Montgomery	1990
	G. D. Mostow	*ex officio*
	Franklin P. Peterson	*ex officio*
	Paul J. Sally, Jr.	1988

4. Committees

4.1. Editorial and Communications Committees

4.1.1. Abstracts Editorial Committee

All members of this committee serve *ex officio.*

	Frank T. Birtel
	W. Wistar Comfort
	Andy Roy Magid
Chairman	Everett Pitcher
	Lance W. Small

4.1.2. American Journal of Mathematics, Society's Representatives

	M. Salah Baouendi	1989
Chairman	Spencer Bloch	1988

4.1.3. Bulletin (New Series)

Chairman	Morris W. Hirsch	1989
	Roger E. Howe	1990
	Edgar Lee Stout	1988

Associate Editors for Research Announcements

William B. Arveson	1990	Ronald L. Graham	1990
Spencer Bloch	1990	Victor W. Guillemin	1990
Gergory L. Cherlin	1989	Frank S. Quinn III	1990
Percy Alec Deift	1990	Peter B. Shalen	1990
Michael B. Fried	1990	Nolan R. Wallach	1990

Associate Editors for Research – Expository Articles

Lenore Blum	1989	David A. Vogan, Jr.	1989
Barry Mazur	1989	Alan D. Weinstein	1989
Richard S. Palais	1990	Guido L. Weiss	1990

4.1.4. Colloquium

Chairman	Raoul H. Bott	1990
	Charles L. Fefferman	1988
	H. Jerome Keisler	1989

4.1.5. Committee to Monitor Problems in Communication

	Sheldon Axler	1989
	Jozef Dodziuk	1988
Consultant	Nancy Gubman	
	Arthur M. Jaffe	1988
	Richard G. Larson	1990
	William H. Jaco	*ex officio*
	Richard S. Palais	1990
Chairman	Marian B. Pour-El	1989

4.1.6. Contemporary Mathematics

	M. Salah Baouendi	1988
	Daniel M. Burns	1989
	David Eisenbud	1989
	Jonathan Goodman	1990
	William H. Jaco	1988
	Gerald J. Janusz	1989
Chairman	Irwin Kra	1988
	Jan Mycielski	1990

Associate Editor: Thomas F. Banchoff

4.1.7. Journal of the AMS

Chairman	Michael Artin	1992
	H. Blaine Lawson, Jr.	1991
	Richard B. Melrose	1990
	Wilfried Schmid	1990
	Robert E. Tarjan	1992

Associate Editors

James G. Arthur	1992	Joe Harris	1990
Peter Bickel	1990	Hendrik W. Lenstra, Jr.	1991
Gerd Faltings	1991	Andrew Majda	1992
Charles L. Fefferman	1992	Hugh L. Montgomery	1990
Michael H. Freedman	1990	Paul H. Rabinowitz	1991
Daniel Friedan	1991	Karen Uhlenbeck	1992
Ronald L. Graham	1992	W. Hugh Woodin	1990

4.1.8. Mathematical Reviews

	Leonard Berkovitz	1988
Chairman	Melvin Hochster	1989
	Hans F. Weinberger	1990

4.1.9. Mathematical Surveys and Monographs

	Victor W. Guillemin	1989
	Irwin Kra	1988
	M. Susan Montgomery	1990
Chairman	R. O. Wells, Jr.	1988

Associate Editor: Thomas F. Banchoff

4.1.10. Mathematics of Computation

Chairman	Walter Gautschi	1989
	Donald Goldfarb	1990
	John E. Osborn	1989
	Hugh C. Williams	1988

Associate Editors

James Bramble	1989	Carl Pomerance	1989
Bille C. Carlson	1989	René Schoof	1989
Eugene Isaacson	1989	Larry L. Schumaker	1988
Heinz-Otto Kreiss	1990	Ridgway Scott	1989
James N. Lyness	1989	Daniel Shanks	1990
Harald Niederreiter	1990	Frank Stenger	1989
Syvert P. Nørsett	1988	Hans J. Stetter	1988
Andrew M. Odlyzko	1988	G. W. Stewart	1989
Frank W. J. Olver	1989	Vidar C. Thomée	1989
Stanley J. Osher	1989	Lars B. Wahlbin	1989
Beresford N. Parlett	1988	John W. Wrench, Jr.	1990

4.1.11. Notices

	Robert J. Blattner	1990
	Ralph P. Boas	1988
	Lucy J. Garnett	1990
Chairman	Everett Pitcher	*ex officio*
	Mary Ellen Rudin	1988
	Nancy K. Stanton	1990
	James A. Voytuk	*ex officio*
	Steven H. Weintraub	1988

Associate Editors

Special Articles	Ronald L. Graham
	Jeffrey C. Lagarias

4.1.12. Proceedings

	William Adams	1988
	J. Marshall Ash	1988
	Thomas H. Brylawski	1989
	Dennis Burke	1989
	Frederick R. Cohen	1991
	John B. Conway	1988
Chairman	William J. Davis	1991
	Thomas J. Jech	1988
	Barbara Keyfitz	1991
	Irwin Kra	1988
	R. Daniel Mauldin	1989
	Kenneth R. Meyer	1991
	Paul S. Muhly	1990
	Andrew M. Odlyzko	1989
	George C. Papanicolaou	1991
	Donald S. Passman	1988
	Louis J. Ratliff, Jr.	1991
	Jonathan M. Rosenberg	1991
	William D. Sudderth	1991
	James E. West	1991
	Warren J. Wong	1991

Associate Editor

Andreas Blass

4.1.13. Proceedings of Symposia in Applied Mathematics

	Stuart S. Antman	1988
	Giles Auchmuty	1989
Chairman	Jane Cronin Scanlon	1988

4.1.14. Transactions and Memoirs

	James E. Baumgartner	1991
	James W. Cannon	1989
	Ralph L. Cohen	1990
	Eugene B. Fabes	1988
	Ronald Getoor	1990
Chairman	Ronald L. Graham	1988
	Jerry L. Kazdan	1990
	Roger D. Nussbaum	1991
	Carl Pomerance	1991
	David J. Saltman	1990
	Audrey A. Terras	1991
	Robert J. Zimmer	1990

4.1.15. Translation from Chinese

	Sun-Yung Alice Chang
	S.-Y. Cheng
Chairman	Tsit-Yuen Lam
	Tai-Ping Liu
	Chung-Chun Yang

4.1.16. Translation from Japanese

	Shoshichi Kobayashi
Chairman	Katsumi Nomizu

Standing Committees

4.1.17. History of Mathematics

	Richard A. Askey
Chairman	Peter L. Duren
	Bruno Harris
	Uta C. Merzbach

4.1.18. Subcommittee on Russian Mathematical History

	V. I. Arnol'd
	Richard Askey
	S. G. Gindikin
	N. K. Nikol'skii
Chairman	Allen Shields

4.1.19. Reprinted Books

	Eugenio Calabi
	Charles W. Curtis
Chairman	Oscar S. Rothaus

4.1.20. University Lecture Series

	Theodore W. Gamelin
	Donald S. Ornstein
Chairman	Hugo Rossi
	Leonard L. Scott

4.2. Committees of the Board of Trustees

4.2.1. Agenda and Budget

All members of this committee serve *ex officio*.

Steve Armentrout
Ramesh Gangolli
G. D. Mostow
Franklin P. Peterson
Everett Pitcher
Jean E. Taylor

4.2.2. Appeals Committee on Discounted Subscriptions

Consultant	Carol-Ann Blackwood	
Consultant	Melvin Hochster	
	William H. Jaco	*ex officio*
Chairman	Morton Lowengrub	
	Franklin P. Peterson	
	Paul J. Sally, Jr.	

4.2.3. Audit

	Frederick W. Gehring	
	M. Susan Montgomery	

4.2.4. Computer Operations and Facilities, Visiting Committee on

	Jill P. Mesirov	1988
Chairman	S. Tucker Taft	1989
	Peter J. Weinberger	1990

4.2.5. Corporate Relations

Chairman	Ramesh A. Gangolli	
	Maria M. Klawe	
	Oscar S. Rothaus	

4.2.6. Endowment

	Andrew M. Gleason	
Chairman	W. Ted Martin	
	Cathleen S. Morawetz	

4.2.7. Investment

	Steve Armentrout	*ex officio*
	Ramesh A. Gangolli	
Chairman	Franklin P. Peterson	*ex officio*

4.2.8. Legal Aid

	Steve Armentrout	
Chairman	Morton L. Curtis	
	Todd Dupont	
	Murray Gerstenhaber	

4.2.9. Liaison Committee

All members of this committee serve *ex officio.*

Chairman	G. D. Mostow	
	Franklin P. Peterson	
	Everett Pitcher	

4.2.10. Long Range Planning

All members of this committee serve *ex officio.*

	Ramesh A. Gangolli	
	Irwin Kra	
	William H. Jaco	*ex officio*
	Franklin P. Peterson	
	Everett Pitcher	
Chairman	William A. Veech	

4.2.11. Membership

Chairman	Frederick W. Gehring	1990
	Melvin Henriksen	1990
	Irwin Kra	1990
	Jill P. Mesirov	1989
	Hugo Rossi	1988

4.2.12. The Publication Program

	Steve Armentrout	1988
	Peter L. Duren	1989
	Ramesh Gangolli	1989
Chairman	Murray Gerstenhaber	1988
Consultant	Mary C. Lane	
	William H. Jaco	*ex officio*
	Andrew M. Odlyzko	1989
	Everett Pitcher	*ex officio*
	Hugo Rossi	1989
	Paul J. Sally, Jr.	1989

4.2.13. Salaries

	Steve Armentrout	*ex officio*
	Ramesh A. Gangolli	*ex officio*
Chairman	Ronald L. Graham	
	Franklin P. Peterson	*ex officio*

4.2.14. Staff and Services

Chairman	Steve Armentrout	*ex officio*
	Franklin P. Peterson	*ex officio*
	Paul J. Sally, Jr.	

Ad Hoc Committee

4.2.15. Institutional Membership

Consultant	Carol-Ann Blackwood	
	Ramesh Gangolli	
Chairman	Frederick W. Gehring	
	William A. Veech	
	James A. Voytuk	*ex officio*

4.3. Internal Organization of the American Mathematical Society

Standing Committees

4.3.1. Committee on Committees

	James G. Glimm	1988
	William H. Jaco	1988
Chairman	Irwin Kra	1988
	G. D. Mostow	*ex officio*
	Everett Pitcher	*ex officio*
	Paul H. Rabinowitz	1988
	Audrey A. Terras	1988
	William A. Veech	1988

4.3.2. Election Scheduling

	Jane P. Gilman	
	Irwin Kra	
Chairman	William P. Thurston	
	William A. Veech	
	James A. Voytuk	

4.3.3. **Nominating Committee**

	M. Salah Baouendi	1988
	Roger C. Alperin	1989
	Ronald DeVore	1989
	Paul C. Fife	1988
Chairman	Jane P. Gilman	1989
	Carl Pomerance	1988
	Leonard Scott	1989
	William P. Ziemer	1988

Ad Hoc Committees

4.3.4. **Centennial Committee**

	Felix E. Browder
	Harold M. Edwards
	Andrew M. Gleason
	G. D. Mostow
Chairman	Everett Pitcher

4.3.5. Centennial Program Committee

	Hyman Bass
Chairman	Felix E. Browder
	Philip A. Griffiths
	John W. Milnor
	Cathleen S. Morawetz

4.3.6. Poster Committee

Chairman	Thomas F. Banchoff
	F. Alberto Grunbaum
	Nelson Lee Max

4.3.7. Public Information Committee

	John W. Addison, Jr.
Chairman	Yousef Alavi
	William G. Chinn
	Ronald R. Coifman
	Ronald L. Graham
	Peter J. Hilton
	Donald R. Lick
	Jean Pedersen
	C. Taubes

4.3.8. Travel Grants for the AMS Centennial

Chairman	Richard W. Beals
	John W. Bunce
	Anthony W. Hager
	William F. Lucas
	P. Emery Thomas
	Frank Uhlig

4.3.9. **Proposed Structure of JPBM**

	Robert M. Fossum
	Marc A. Rieffel
Chairman	Jean E. Taylor

4.3.10. **1987 Election Tellers**

	Krzysztof Galicki
	Alexander Smith

4.4. Program and Meetings

Standing Committees

4.4.1. **Program Committee for National Meetings**

	Peter B. Gilkey	1990
	George A. Hagedorn	1990
	Linda Keen	1988
	Hugh L. Montgomery	1989
	Everett Pitcher	*ex officio*
Chairman	Paul H. Rabinowitz	1988
	Nolan R. Wallach	1988

4.4.2. **Central Sectional Meetings (Select Hour Speakers for)**

Chairman	Donald G. Aronson	1988
	David Drasin	1989
	Jerry Kaminker	1988
	Andy Roy Magid	*ex officio*
	Robert J. Zimmer	1989

4.4.3. **Eastern Sectional Meetings (Select Hour Speakers for)**

	Ruth M. Charney	1989
	W. Wistar Comfort	*ex officio*
	Richard H. Herman	1988
Chairman	Lesley M. Sibner	1988
	Thomas Crawford Spencer	1988

4.4.4. **Far Western Sectional Meetings (Select Hour Speakers for)**

	Ronald J. DiPerna	1989
	William M. Kantor	1989
	Heinz-Otto Kreiss	1988
Chairman	Murray M. Schacher	1988
	Lance W. Small	*ex officio*

4.4.5. **Southeastern Sectional Meetings (Select Hour Speakers for)**

	Frank T. Birtel	*ex officio*
	Jon F. Carlson	1988
	Patrick B. Eberlein	1989
Chairman	Frank S. Quinn III	1988
	————	1989

4.4.6. **Agenda for Business Meetings**

	M. Salah Baouendi	1988
Chairman	Everett Pitcher	
	Carol L. Walker	1988

4.4.7. **Gibbs Lecturers for 1989 and 1990, Committee to Select**

	Jane Cronin Scanlon
Chairman	Thomas Crawford Spencer
	Shmuel Winograd

4.5. Status of the Profession

Standing Committees

4.5.1. Academic Freedom, Tenure, and Employment Security

	Jerome A. Goldstein	1989
	Thomas G. Kurtz	1990
	Barbara L. Osofsky	1990
	Robert R. Phelps	1989
Chairman	Halsey L. Royden	1988
	Gail S. Young	1989

4.5.2. Centennial Fellowships

Terms expire on June 30

Chairman	Frederick J. Almgren, Jr.	1989
	David Eisenbud	1990
	Lawrence Craig Evans	1990
	Dorian Goldfeld	1989
	Victor L. Klee, Jr.	1990
	John W. Morgan	1989
	Karen Vogtmann	1990

4.5.3. Human Rights of Mathematicians

	Michael I. Brin	1990
	Bettye Anne Case	1989
	Patrick X. Gallagher	1989
	Herman R. Gluck	1989
	Leon A. Henkin	1988
	Neil I. Koblitz	1988
	Joel L. Lebowitz	1990
Chairman	Alice T. Schafer	1990

4.5.4. Professional Ethics

	C. Edmund Burgess	1990
	Frank L. Gilfeather	1990
	Paul R. Halmos	1988
Chairman	Linda Keen	1989
	Anneli Lax	1988

4.5.5. Recruitment of Young Mathematicians

	Paul J. Sally, Jr.
Chairman	James D. Stasheff
	Lynn A. Steen

4.5.6. Science Policy

	Hyman Bass	1990
Chairman	Ronald G. Douglas	1989
	Frank L. Gilfeather	1990
	James G. Glimm	1989
	Ronald L. Lipsman	1989
	James W. Maxwell	*ex officio*
	G. D. Mostow	*ex officio*
	Robert Osserman	1988
	John C. Polking	1990
	Judith D. Sally	1988
	David A. Sanchez	1989
	William P. Thurston	1989
	Guido L. Weiss	1988

4.5.7. Service to Mathematicians in Developing Countries

Chairman	Raymond G. Ayoub
	James A. Donaldson
	James Eells
	Donald M. Hill
	Marshall H. Stone

Ad Hoc Committees

4.5.8. Applied Mathematics

	Constantine Dafermos
	David S. Kinderleher
	Eduardo Daniel Sontag
Chairman	Jean E. Taylor

4.5.9. Cooperation with the Chinese

	S.-Y. Cheng
	Ronald L. Graham
Chairman	Richard S. Palais

4.5.10. Fellowship Policy

	George E. Andrews
	Kenneth Millet
Chairman	M. Susan Montgomery
	Paul J. Sally Jr.

4.6. Prizes and Awards

Standing Committees

4.6.1. National Awards and Public Representation

	William Browder	*ex officio*
Chairman	G. D. Mostow	*ex officio*
	David Mumford	1989
	Everett Pitcher	*ex officio*

4.6.2. Steele Prizes

Terms expire on June 30

	Frederick J. Almgren, Jr.	1989
	Luis A. Caffarelli	1990
	Charles L. Fefferman	1991
	Jun-ichi Igusa	1991
Chairman	William S. Massey	1989
	Frank A. Raymond	1989
	Neil J. A. Sloane	1990
	Louis Solomon	1989
	Richard P. Stanley	1989
	Michael E. Taylor	1990

Ad Hoc Committees

4.6.3. Automatic Theorem Proving, Committee to Recommend Winners of Prizes for

Chairman	David Mumford
	Jacob T. Schwartz
	John L. Selfridge

4.6.4. Bôcher Prize for 1989, Committee to Select the Winner of

	Paul J. Cohen
Chairman	Richard B. Melrose
	Louis Nirenberg

4.7. Institutes and Symposia

Standing Committee

4.7.1. Summer Institutes and Special Symposia

Terms expire on February 28

Steven L. Kleiman	1990
Haynes R. Miller	1991
Paul H. Rabinowitz	1989
Raghavan Narasimhan	1991
Thomas Crawford Spencer	1990
Robert B. Warfield, Jr.	1989

4.7.2. Liaison Committee with AAAS

Hyman Bass
James McKenna
Cathleen S. Morawetz
Warren Page
Gian-Carlo Rota
Alan D. Weinstein

4.8. Joint Committees

4.8.1. AMS-AAAS-MAA Committee on Opportunities in Mathematics for Underrepresented Minorities

	Manuel P. Berriozabal	1988
	Sylvia T. Bozeman	1989
	James A. Donaldson	1988
Chairman	Gloria F. Gilmer	1988
	Shirley Malcom	*ex officio*
	Rogers J. Newman	1989
	Clarence E. Stephens	1989
Consultant	Argelia Veléz-Rodriguez	

4.8.2. AMS-ASA-IMS-MAA-NCTM-SIAM Committee on Women in the Mathematical Sciences

NCTM members' terms expire April 1 of the year given.

	Grace M. Burton (NCTM)	1990
	Susan J. Devlin (ASA)	
	Marjorie M. Enneking (NCTM)	1989
	Susan Geller (AMS)	1987
	Marjorie G. Hahn (IMS)	
	Jeanne W. Kerr (AMS)	1989
Chairman	Carole B. LaCampagne (AMS, MAA)	1987
	Jeanne LaDuke (MAA)	1989
	Suzanne Marie Lenhart (AMS)	1989
	Betty K. Lichtenberg (NCTM)	1989
	Joyce R. McLaughlin (SIAM)	1990
	Ingram Olkin (IMS)	
	Janet Peterson (SIAM)	1988
	Linda Petzold (SIAM)	1989
	Alice T. Schafer (MAA)	1988
	Elizabeth L. Scott (IMS)	
	Bhama Srinivasan (AMS)	1989

4.8.3. AMS-ASL-IMS-SIAM Committee on Translations from Russian and Other Slavic Languages

Chairman	Courtney S. Coleman (AMS)	1989

AMS Subcommittee Members

Consultant	V. I. Arnol'd	
	Joseph N. Bernstein	1990
	Charles V. Coffman	1988
Chairman	Courtney S. Coleman	1989
	Allen Devinatz	1988
Consultant	S. G. Gindikin	
	Vladislav V. Goldberg	1988
	John R. Isbell	1988
	Anatole Katok	1990
	L. G. Makar-Limanov	1989
	Paul G. Nevai	1989
Consultant	N. K. Nikol'skii	

ASL Subcommittee Members

	Vladimir Lifschitz	1990
Chairman	Elliott Mendelson	1989
	Gregory Minc	1990
	B. F. Wells	1989

IMS Subcommittee Members

Chairman	Eugene B. Dynkin
	B. Pittel
	A. Rukhin
	W. J. Studden

4.8.4. AMS-IMS-SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences

Terms expire on June 30

	William B. Arveson (AMS)	1989
	John A. Burns (SIAM)	1988
	Martin Golubitsky (SIAM)	1988
	Roger E. Howe (AMS)	1992
	Daniel J. Kleitman (AMS)	1989
Chairman	Ingram Olkin (IMS)	1988
	Mary Ellen Rudin (AMS)	1989
	Lesley M. Sibner (AMS)	1990
	Stephen G. Simpson (AMS)	1990

4.8.5. AMS-MAA Ad Hoc Advisory Committee on a Newletter on Collegiate Mathematics Education

	Jerry L. Bona
Chairman	Joseph A. Gallian
	Frank Morgan
	Doris W. Schattschneider

4.8.6. AMS-MAA Arrangements Committee for the Phoenix Meeting January 11-14, 1989

	William H. Jaco	*ex officio*
Chairman	John McDonald	
	Kenneth A. Ross	*ex officio*
	Lance W. Small	*ex officio*

4.8.7. AMS-MAA Arrangements Committee for the Boulder Meeting August 7-10, 1989

	Larry W. Baggett	
	William L. Briggs	
	Richard Andrew Holley	
	Frieda K. Holley	
	William H. Jaco	*ex officio*
	Andy Roy Magid	*ex officio*
Chairman	Arlan Ramsay	
	William N. Reinhardt	
	Kenneth A. Ross	*ex officio*
	Richard L. Roth	

4.8.8. AMS-MAA Joint Program Committee for the AMS Centennial

Chairman	Hugh L. Montgomery
	M. Susan Montgomery
	Ivan Niven
	Richard S. Palais

4.8.9. AMS-MAA Joint Meetings Committee

All members of this committee serve *ex officio.*

Consultant	H. Hope Daly
Chairman	William H. Jaco
	Everett Pitcher
	Kenneth A. Ross
	Alfred B. Willcox

4.8.10. AMS-MAA Committee on Employment and Educational Policy

	Morton Brown (MAA)	1989
	Stefan A. Burr (AMS)	1989
Chairman	Edward A. Connors (AMS)	1988
	Philip C. Curtis, Jr. (MAA)	1990
	Don O. Loftsgaarden (MAA)	1990
	David J. Lutzer (MAA)	1989
	James W. Maxwell	*ex officio*
	Audrey A. Terras (AMS)	1988

4.8.11. Data Subcommittee

Chairman	Edward A. Connors	1990
Consultant	Lincoln K. Durst	
	John D. Fulton	1988
	James Hurley	1988
	Charlotte Lin	1989
	Don O. Loftsgaarden	1990
	David J. Lutzer	1990
	James W. Maxwell	*ex officio*
	Donald E. McClure	1990
	Donald C. Rung	1989

4.8.12. Employment Concerns Subcommittee

	Morton Brown	1989
	Audrey A. Terras	1989
	Robert J. Thompson	1988
Chairman	Barnet M. Weinstock	1989

4.8.13. Short Course Subcommittee

Chairman	Stefan A. Burr	1989
	R. Peter DeLong	1991
	Lisl Novak Gaal	1989
	Robert P. Kurshan	1990
	Barbara L. Osofsky	1988
	Marjorie L. Stein	1990
	James J. Tattersall	1990

4.8.14. AMS-MAA-SIAM Joint Committee on Employment Opportunities

	Ronald M. Davis (MAA)	1990
	Calvin T. Long (MAA)	1988
	James W. Maxwell	*ex officio*
Chairman	Brian J. McCartin (SIAM)	1989
	John W. Petro (AMS)	1988
	Donald C. Rung (AMS)	1990
	Robert S. Stepleman (SIAM)	1988

4.8.15. AMS-MAA-SIAM Joint Administrative Committee

All members of this committee serve *ex officio.*

	I. Edward Block (SIAM)
	James W. Daniel (SIAM)
	Shmuel Winograd (SIAM)
	Leonard Gillman (MAA)
	William H. Jaco (AMS)
	Franklin P. Peterson (AMS)
Chairman	Everett Pitcher (AMS)
	Kenneth A. Ross (MAA)
	Alfred B. Willcox (MAA)

4.8.16. AMS-MAA-SIAM Joint Policy Board for Mathematics

I. Edward Block (SIAM)	*ex officio*
Charles William Gear (SIAM)	*ex officio*
Leonard Gillman (MAA)	*ex officio*
Donald L. Kreider (MAA)	1992
William H. Jaco (AMS)	*ex officio*
G. D. Mostow (AMS)	*ex officio*
Everett Pitcher (AMS)	1988
Werner C. Rheinboldt (SIAM)	1988
Alfred B. Willcox (MAA)	*ex officio*

4.8.17. Joint Policy Board for Mathematics

Head, Office of Governmental and Public Affairs:
Kenneth M. Hoffman
Public Information Director: Kathleen Holmay
Telephone of Public Information Director: 301-588-6168

JPBM Office of Governmental and Public Affairs
818 Connecticut Avenue, N.W., Suite 515
Washington, DC 20006
Telephone: 202-659-6444
Telephone of Public Information Director:
301-588-6168

4.8.18. JPBM Joint Coordinating Committee on Public Understanding of Mathematics

Ronald L. Graham (AMS)
Joseph B. Keller (SIAM)
Lynn A. Steen (MAA)

4.8.19. JPBM Committee for Mathematics Department Heads

Terms expire in January

	Donald F. Reynolds	1990
	Donna Szott	1990
	Thomas W. Tucker	1990

4.8.20. AMS-SIAM Committee on Applied Mathematics

	Constantine M. Dafermos	1989
	James M. Hyman	1990
	Donald E. McClure	1988
Chairman	George C. Papanicolaou	1989
	Francis Sullivan	1988
	Robert F. Warming	1990

4.8.21. AMS-SIAM-SMB Committee on Mathematics in the Life Sciences

	Jack D. Cowan	1991
	Michael C. Mackey	1989
	Hans G. Othmer	1988
Chairman	Richard E. Plant	1988
	John M. Rinzel	1989

4.8.22. AMS-SIAM Committee to Screen Applicants for Graduate Study from the People's Republic of China

David Benney
Robert Bryant

5. Representatives

5.0.1. Advisory Board of the National Translations Center of the John Crerar Library

Ralph P. Boas

5.0.2. Commission on Professionals in Science and Technology

Edward A. Connors

5.0.3. Committee on the American Mathematics Competition

Term expires on June 30

Guido L. Weiss 1990

5.0.4. Conference Board of the Mathematical Sciences

G. D. Mostow 1988

5.0.5. Fulkerson Prize Committee

Alan J. Hoffman

5.0.6. American Association for the Advancement of Science

Terms expire on May 27

Section A	Louise Hay	1989
Section L	Richard A. Askey	1989
Section Q	Jerry L. Bona	1989

5.0.7. U.S. National Committee on Theoretical and Applied Mechanics

Term expires on October 31

Stüart S. Antman 1988

6. Index

Miscellaneous

Personal Items

Sheeram S. Abhyankar, Marshall Distinguished Professor of Mathematics at Purdue University, has been appointed to the additional positions of Professor of Industrial Engineering and Professor of Computer Sciences at that institution.

Laura Anderson, a senior mathematics major at the California Institute of Technology, recently received the E. T. Bell Undergraduate Mathematics Research Prize.

Eric Babson, a senior mathematics major at the California Institute of Technology, recently received the E. T. Bell Undergraduate Mathematics Research Prize.

Charles P. Boyer, formerly of Clarkson University, has been appointed Professor of Mathematics and Statistics at the University of New Mexico.

Verena H. Dyson has retired from the University of Calgary with Emeritus status and is spending the combinatorial group theory year at the Mathematical Sciences Research Institute, Berkeley, California.

Martin C. Golumbic, of the IBM Israel Scientific Center and Associate Professor at Bar-Ilan University, has been appointed founding Editor-in-Chief of the *Annals of Mathematics and Artificial Intelligence.* He has also been elected to the board of the Israel Association of Artificial Intelligence.

Kenneth I. Gross, formerly of the University of Wyoming and the National Science Foundation, has been appointed Professor of Mathematics at the University of Vermont. He will become Chairman of that Department in January 1989.

Jonathan L. King, of the University of Maryland, will be spending the 1988-1989 academic year at the Mathematics Department at the University of California, Berkeley, on a National Science Foundation Postdoctoral Research Fellowship, starting August 20, 1988.

Donald Knuth received an honorary Doctor of Science degree from Oxford University on June 22, 1988.

William I. Layton, of Newberry College, was named Professor of the Year at that Awards Day Convocation on April 14, 1988.

Lori Nelson, of Rockford College, is the recipient of that institution's 1988 Martha Peirce McGavock Prize in Mathematics and the 1987-1988 Bessie Irving Miller Award.

Ganapati P. Patil, of Pennsylvania State University, is the recipient of a Special Distinguished Statistical Ecologist Award from the International Association for Ecology. He has also received the most significant paper award from the American Fisheries Society for his paper on "Risk Analysis in the Georges Bank Haddock Fishery – A Pragmatic Example of Dealing with Uncertainty."

Bruno Remillard, co-winner of the Pierre Robillard Award, has been appointed Professor of Mathematics at the Université du Québec, Montréal, Québec.

Raymond Sidney, a freshman at the California Institute of Technology, recently received a Morgan Ward prize.

Weiping Yin, Professor of Mathematics at University of Science and Technology of China, will be visiting the Mathematical Sciences Research Institute, Berkeley, California, from January 16, 1989, to April 15, 1989. His field of research interest is several complex variables.

Deaths

Orville G. Harrold Jr., of Chico, California, died on May 16, 1988, at the age of 78. He was a member of the Society for 55 years.

Maurice Horowitz, of Mobile, Alabama, died on June 6, 1988, at the age of 67. He was a member of the Society for 30 years.

Houston Lewis, of Richardson, Texas, died in May 1988, at the age of 47. He was a member of the Society for 3 years.

Shu-Tien Li, Chairman and President of the Li Institute of Science and Technology, died on March 28, 1988, at the age of 88. He was a member of the Society for 28 years.

R. C. Lyndon, of the University of Michigan, died on June 8, 1988, at the age of 70. He was a member of the Society for 45 years.

Evelyn Nelson, of McMaster University, died on August 1, 1987, at the age of 43. She was a member of the Society for 21 years.

Edward S. Quade, of Laguna Hills, California, died on June 4, 1988, at the age of 79. He was a member of the Society for 53 years.

Bruce L. Reinhart, of the University of Maryland, died on July 19, 1988, at the age of 57. He was a member of the Society for 35 years.

Verne Schwab, of Johns Hopkins University, died on April 18, 1988, at the age of 65. He was a member of the Society for 25 years.

Shigeaki Togo, Professor at the Hiroshima Institute of Technology and Professor Emeritus of the Hiroshima University, Japan, died on June 7, 1988, at the age of 66. He was a member of the Society for 30 years.

Ralph M. Warten, Professor Emeritus of California Polytechnic State University, died on July 6, 1988, at the age of 62. He was a member of the Society for 30 years.

Frederick J. Ziegler, of Albuquerque, New Mexico, died on March 15, 1988, at the age of 34. He was a member of the Society for 10 years.

Erratum

In the May/June 1988 issue of *Notices*, page 747, Nils A. Baas (Norway) was incorrectly listed as a visiting mathematician at the Massachusetts Institute of Technology for 1988-1989.

Visiting Mathematicians

(Supplementary List)

This list of visiting mathematicians includes only foreign mathematicians visiting in the United States and Canada.

Visiting Foreign Mathematicians

Name and Home Country	Host Institution	Field of Special Interest	Period of Visit
Alvarez Lopez, Jesus A. (Spain)	University of Illinois at Urbana-Champaign	Differential Geometry	8/88 - 5/89
Arai, Toshiyasu (Japan)	University of Illinois at Urbana-Champaign	Logic	8/88 - 5/89
Arnoud, Pierre (France)	University of Florida	Dynamical Systems	8/88 - 12/88
Bather, John (United Kingdom)	Harvard University	Mathematical Statistics	6/88 - 10/88
Bhattacharya, Tilak (India)	Northwestern University	Partial Differential Equations, Applied Mathematics	9/88 - 8/90
Billington, Elizabeth (Australia)	Auburn University	Combinatorics	7/88 - 12/88
Cioranescu, Ioana (West Germany)	Auburn University	Analysis	9/88 - 6/89
Erdős, Paul (Hungary)	University of Florida	Number Theory, Analysis and Combinatorics	2/89 - 3/89
Garbey, Marc (France)	Argonne National Laboratory	Bifurcation Phenomena and Combustion	9/88 - 8/89
Guan, Yude (People's Republic of China)	University of Illinois at Urbana-Champaign	Applied Mathematics	8/88 - 5/89
Herzog, Joachim (West Germany)	University of Illinois at Urbana-Champaign	Number Theory	8/88 - 5/89
Herzog, Marcel (Israel)	University of Hawaii	Group Theory	8/88 - 1/89
Jarden, Moshe (Israel)	University of Florida	Algebra and Logic	8/88 - 9/88
Krajicek, Jan (Czechoslovakia)	University of Illinois at Urbana-Champaign	Logic	8/88 - 5/89
Manfredi, Juan Jose (Spain)	Northwestern University	Partial Differential Equations, Complex Analysis	9/88 - 8/89
Manocha, H. L. (India)	Auburn University	Analysis	9/88 - 6/89
Monajemi, Assad (Iran)	Harvard University	Applied Statistics	6/88 - 10/88
Petridis, Nickolas (Greece)	University of Illinois at Urbana-Champaign	Geometry	8/88 - 12/89
Renault, Jean (France)	University of Colorado, Boulder	C^*-algebras, Foliations	9/88 - 12/88
Saigo, Megumi (Japan)	University of Victoria	Special Functions, Fractional Calculus	3/88 - 3/89
Schulz, Rainer (West Germany)	Auburn University	Algebra	9/87 - 6/89
Serre, Jean-Pierre (France)	Harvard University		9/88 - 12/88
Sersouri, Abderrazzak (Morocco)	University of Illinois at Urbana-Champaign	Analysis	8/88 - 5/89
Song, Hyung-Soo (Korea)	University of Minnesota	Topological Dynamics	8/88 - 8/89
Soulé, Christoph (France)	Harvard University	Algebraic K-theory	2/89 - 5/89

Szabados, Jossef (Hungary)	University of Florida	Approximation Theory	8/88 - 12/88
Urbas, John I. (Australia)	Northwestern University	Partial Differential Equations	1/89 - 6/89
Villari, Gabriele (Italy)	University of Illinois at Urbana-Champaign	Ordinary Differential Equations	8/88 - 12/89
Wiegmann, Klaus (West Germany)	University of Rochester	Several Complex Variables	9/88 - 12/88
Yang, Seung Kab (South Korea)	University of Florida	Analysis	8/88 - 5/89
Yin, Weiping (People's Republic of China)	University of Notre Dame; Mathematical Sciences Research Institute	Several Complex Variables	10/88 - 1/89 1/89 - 4/89
Zin, Yuan-xun (People's Republic of China)	University of Florida	Differential Equations and Computational Physics	8/88 - 12/88

Backlog of Mathematics Research Journals

Backlog. Information on the backlog of papers for research journals, primarily those published in North America, is reported to the Providence Office by those editorial boards which elect to participate. The figures are an estimate of the number of printed pages which have been accepted, but are in excess of the number required to maintain copy editing and printing schedules.

Observed Waiting Time. The quartiles give a measure of normal dispersion. They do not include extremes which may be misleading. Waiting times are measured in months from receipt of manuscript in final form to publication of the issue. When a paper is revised, the waiting time between an editor's receipt of the final revision and its publication may be much shorter than is the case otherwise, so these figures are low to that extent.

The observations are made from the latest issue published, before the deadline for this issue of *Notices*, from journals that have actually been received by a subscriber in the Providence, Rhode Island, area; in some cases this may be two months later than publication abroad. If the waiting time as defined above is not given in the journal, if no new issue has been received since the last survey, or if the latest issue is for some reason obviously not typical, no times are given in this report and such cases are marked NA (not available or not applicable).

Journal	Number Issues per Year	Approximate Number Pages per Year	Backlog of Printed Pages 12/15/87	Backlog of Printed Pages 6/30/88	Editor's Estimated Time for Paper Submitted Currently to be Published (in Months)	Observed Waiting Time in Latest Published Issue (in Months) Q_1	M	Q_3
Acta Inform.	6	720	0	0	5	5	6	7
Aequationes Math.	6	640	0	0	8	10	13	25
Alg. Groups Geom.	4	600	0	0	8	6	8	14
Algorithmica	4	512	128	NR	3	6	6	7
Amer. J. Math.	6	1476	800	900	7	14	24	29
Ann. of Math.	6	1260	500	1000	9	18	19	21
Ann. Probab.	4	1600	0	250	12	13	16	18
Ann. Sci. École Norm. Sup.	4	650	0	0	15	7	8	9
Ann. Statist.	4	1750	300	140	7	11	11	13
Appl. Math. Optim.	6	576	192	NR	4	12	13*	19
Arch. Hist. Exact Scis.	8	800	0	0	8-9	10	11	12
Arch. Math. Logic	2	200	0	NA	-		NA	
Arch. Rational Mech. Anal.	16	1600	0	0	11-12	11	11	11
Bull. Austral. Math. Soc.	6	1000	200	0	9	11	12	13
Canad. J. Math.	6	1530	400	NR	14	18	20	34
Canad. Math. Bull.	4	NR	NR	256	NR	14	19	24
Circuits Systems Signal Proc.	4	512	0	0	0		NA	
Comm. Algebra	12	2700	2186	2250	14	8	18	18
Comm. Math. Phys.	24	4224	0	0	5	5	7	8
Comm. Partial Diff. Equations	12	NR	NR	300	NR	6	8	11
Computing	8	768	-	NR	7	5	7	9
Constr. Approx.	4	448	112	NR	3	12	13	13
Discrete Comput. Geom.	6	600	370	450	16	19	21	26
Duke Math. J.	6	1500	400	500	9	9	14	15

Journal	Number Issues per Year	Approximate Number Pages per Year	Backlog of Printed Pages 12/15/87	6/30/88	Editor's Estimated Time for Paper Submitted Currently to be Published (in Months)	Observed Waiting Time in Latest Published Issue (in Months) Q_1	M	Q_3
Houston J. Math.	4	600	600	700	24	28	34**	36
Illinois J. Math.	4	704	835	889	21	20	22	24
IMA J. Appl. Math.	6	500	100	88	9	10	12	14
IMA J. Math. Appl. Med. Biol.	4	350	80	80	9		NA	
IMA J. Math. Control Inform.	4	350–400	70	NR	3–4		NA	
IMA J. Numer. Anal.	4	600	0	100	5	7	9	11
Indiana Univ. Math. J.	4	NR	NR	100	NR	19	20	21
Inst. Hautes Études Sci. Publ. Math.	2	NR	NR	NR	NR	14	21	27
Internat. J. Math. Math. Sci.	4	832	232	0	6-8	9	14	17
Invent. Math.	12	2688	0	0	7	6	7	8
Israel J. Math.	12	1500	100	NR	6	6	8	10
J. Algorithms	4	NR	NR	NR	NR	17	22	30
J. Amer. Math. Soc.	4	1000	0	NA	9		NA	
J. Appl. Math. Simulation	4	370	100	0	4		NA	
J. Assoc. Comput. Mach.	4	1000	100	215	18	10	11	12
J. Austral. Math. Soc. Ser. A	6	844	800	800	24	17	19	21
J. Austral. Math. Soc. Ser. B	4	512	0	43	15	9	11	12
J. Classification	2	300	0	0	0		NA	
J. Comput. System Sci.	6	1000	300	0	18	10	14	21
J. Differential Geom.	4	1100	1000	900	10	15	16	19
J. Integral Equations Appl.	4	600	0	NA	8		NA	
J. Math. Biol.	6	600	100	NR	8	6	8	19
J. Math. Phys.	12	3200	0	0	5	16	16*	16
J. Nigerian Math. Soc.	1	NR	NR	0	NR		NA	
J. Operator Theory	4	800	200	NR	12	10	12	15
J. Symbolic Logic	4	1216	500	450	18	16	16	18
Linear Algebra Appl.	14	NR	NR	300	NR	11	12	15
Manuscripta Math.	12	1536	0	0	5	4	6	6
Math. Ann.	14	2464	0	0	8–10	10	13	14
Math. Comp.	4	1500	0	0	12	10	11	15
Math. Oper. Res.	4	NR	NR	NR	NR	17	18	19
Math. Programming Ser. A	6	720	190	250	15	16	20	24
Math. Social Sci.	6	600	180	450	11	13	14	14
Math. Systems Theory	4	320	0	0	0	5	7	8
Math. Z.	12	1824	0	0	11–12	9	10	12
Mem. Amer. Math. Soc.	6	2000	0	0	1–2	14	16	26
Michigan Math. J.	3	480	30	0	12–16	11	13	13
Monatsh. Math.	8	704	0	NR	10	8	12	13
Numer. Funct. Anal. Optim.	6	700	0	0	5	5	6	6
Numer. Math.	12	1488	0	0	5–7	7	7	8
Oper. Res.	6	1008	575	NR	9	12	13	14
Pacific J. Math.	10	2000	NR	NR	11	10	11	15
Probab. Theor. Relat. Fields	12	1920	0	0	12	7	7	8
Proc. Amer. Math. Soc.	12	3850	100	600	13	16	17	18
Proc. London Math. Soc.	6	NR	NR	150	NR	10	16	18
Quart. Appl. Math.	4	800	600	600	17	13	15	19
Quart. J. Math. Oxford Ser. (2)	4	512	128	192	12–18	15	17	20
Results Math.	8	800	100	NR	9	9	10	14
Rocky Mountain J. Math.**	4	1000	1845	2000	24	24	25**	29
Semigroup Forum	3	384	0	0	0	5	6	7

Research Journals Backlog

Journal	Number Issues per Year	Approximate Number Pages per Year	Backlog of Printed Pages 12/15/87	Backlog of Printed Pages 6/30/88	Editor's Estimated Time for Paper Submitted Currently to be Published (in Months)	Observed Waiting Time in Latest Published Issue (in Months) Q_1	M	Q_3
SIAM J. Appl. Math.	6	1480	654	613	20	10	11*	12
SIAM J. Comput.	6	1290	40	190	25	12	13*	14
SIAM J. Control Optim.	6	1500	232	204	26	10	12*	13
SIAM J. Discrete Math.	4	600	0	0	18	6	7*	12
SIAM J. Math. Anal.	6	1500	142	177	27	12	13*	13
SIAM J. Matrix Anal. Appl.	4	600	0	0	16	9	9*	10
SIAM J. Numer. Anal.	6	1450	525	363	28	13	13*	13
SIAM J. Sci. Statist. Comput.	6	1200	86	0	24	8	10*	11
SIAM Rev.	4	680	84	123	30	11	12*	20
Topology Appl.	9	990	825	NR	10	15	16	17
Trans. Amer. Math. Soc.	12	5000	200	100	12	15	16	16

NR means no response received.
NA means not available or not applicable.
* From date accepted.
** This journal is ending a moratorium on the acceptance of new papers on September 30, 1988. Waiting times for papers submitted after that date should be much shorter.
*** Dates of revision not indicated in this journal.

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SUGGESTED USES for classified advertising are books or lecture notes for sale, books being sought, positions available, exchange or rental of houses, and typing services.

THE 1988 RATE IS $.85 per word with a minimum of $42.50. The same ad in 6 consecutive issues is $4.00 per word. The same ad in 10 consecutive issues is $7.00 per word. Type will be set solid unless centering and spacing are requested. A centered line of any length or the equivalent in white space is $10.00 (one-time charge). A word is defined as a group of characters with space at each end. Prepayment is required of individuals but not of institutions. For an additional $10.00 charge, announcements can be placed anonymously. Correspondence will be forwarded.

DEADLINES are listed on the inside front cover.

U. S. LAWS PROHIBIT discrimination in employment on the basis of color, age, sex, race, religion or national origin. "Positions Available" advertisements from institutions outside the U. S. cannot be published unless they are accompanied by a statement that the institution does not discriminate on these grounds whether or not it is subject to U. S. laws. Details and specific wording may be found following the Classified Advertisements in the January and July/August issues of the *Notices*.

SITUATIONS WANTED ADVERTISEMENTS from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-556-7774 and speak to Paula Montella for further information.

SEND AD AND CHECK TO: Advertising Department, AMS, P.O. Box 6248, Providence, Rhode Island 02940. Individuals are requested to pay in advance, institutions are not required to do so.

POSITIONS AVAILABLE

CARNEGIE MELLON UNIVERSITY
Zeev Nehari Assistant Professorship in Mathematics

These positions have been instituted in the Department of Mathematics of Carnegie Mellon University to honor the memory of Professor Zeev Nehari, a member of the Department from 1954 to his death in 1978. Applicants are expected to show exceptional research promise as well as clear evidence of achievement. The position available is for two academic years, beginning in September, 1989 and extendable for one additional year when mutually agreeable. It carries a reduced academic year teaching load of six hours per week during one semester and three hours per week during the other. The applicant should have research interests which intersect those of current faculty of the Department. Applicants should send a vita, list of publications, and a statement describing current and planned research, and arrange to have at least three letters of recommendation sent to the committee. All communications should be addressed to: Zeev Nehari Assistant Professorship Committee, Department of Mathematics, Carnegie Mellon University, Pittsburgh, PA 15213. Carnegie Mellon University is an Affirmative Action/Equal Opportunity Employer.

The University of British Columbia
Department of Mathematics

The Department is seeking an outstanding candidate for a tenure track Assistant Professorship to begin 1 July 1989, in one of the following areas: numerical analysis, especially applied to partial differential equations, combinatorics/combinatorial optimization, partial differential equations. For an exceptionally well-qualified candidate, this position may be upgraded to a junior Associate Professorship. Applicants should have a proven research record of high quality and have demonstrated interest and ability in teaching. Preference will be given to candidates who have one or more years of postdoctoral experience. This position is subject to final budgetary approval. The salary will be commensurate with experience and research record. Applicants should send a C.V. including list of publications, statement of research and teaching interests and arrange for three letters of recommendation to be sent directly to: Dr. David Boyd, Head, Department of Mathematics, University of British Columbia, Vancouver, B.C., Canada V6T 1Y4. Applications must be received before 1 January 1989. In accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada.

STANFORD UNIVERSITY

Stanford University solicits application for one or more positions in theoretical computer science. Appointments in the Computer Science Department or, if appropriate, jointly or fully in a related department such as Mathematics, Operations Research, or Statistics, are possible. Persons at both junior and senior levels will be considered, and an outstanding record of achievement, commensurate with the proposed level, is expected.

Candidates are expected to have a commitment to excellence in teaching and a record of competence in at least one field of computation theory, including, but not limited to, such subjects as: Combinatorial optimization, Complexity theory, Computational geometry, Database and knowledge systems, Design and analysis of algorithms, Discrete mathematics, Distributed algorithms, Logic and its applications, Mathematical programming, Parallel algorithms and architectures, Principles of programming languages, or Security of protocols.

Candidates should send a vita and names of at least four references to: Prof. Jeffrey D. Ullman, Department of Computer Science, Stanford Univ., Stanford CA 94305. Stanford is an equal opportunity/affirmative action employer.

THE OHIO STATE UNIVERSITY
DEPARTMENT OF MATHEMATICS

The Department of Mathematics of The Ohio State University hopes to fill several positions, both visiting and permanent, effective Autumn Quarter, 1988. Candidates in all areas of applied and pure mathematics are invited to apply. Significant research accomplishments or exceptional research promise, and evidence of good teaching ability, will be expected of successful applicants.

Please send credentials and have letters of recommendation sent to Professor Joseph Ferrar, Department of Mathematics, The Ohio State University, 231 W. 18th Avenue, Columbus, Ohio 43210. Review of resumes will begin immediately.

The Ohio State University is an Equal Opportunity/Affirmative Action Employer.

POSITIONS AVAILABLE

NEW FACULTY
in
COGNITIVE AND NEURAL SYSTEMS
at
BOSTON UNIVERSITY

Boston University seeks a tenure track assistant professor starting in Fall, 1989, for its M.A. and Ph.D. Program in Cognitive and Neural Systems. This program offers an integrated curriculum offering the full range of psychological, neurobiological, and computational concepts, models, and methods in the broad field variously called neural networks, connectionism, parallel distributed processing, and biological information processing, in which Boston University is a leader. Each faculty member will have a joint appointment in the Ph.D. program and in one or more of the departments of mathematics, biology, computer science, and psychology. Candidates should have extensive analytic or computational research experience modelling a broad range of real-time nonlinear neural networks, especially in one or more of the areas: adaptive pattern recognition, speech and language, cognitive information processing, self-organization, and conditioning and attention. Send a complete curriculum vitae and three letters of recommendation to Search Committee, Cognitive and Neural Systems Program, Room 240, 111 Cummington Street, Boston University, Boston, MA 02215 preferably by November 15, 1988, but no later than January 1, 1989. Boston University is an Equal Opportunity/Affirmative Action employer.

MATHEMATICS FACULTY

Instructor/Asst. Prof. to teach a variety of college level and remedial courses. Master's degree required. Teaching experience preferred. Hiring range $20,000-25,000. To be filled Nov. 18, 1988. Send resume to John Leddy, Acting Director of Personnel/Affirmative Action, State University of New York College of Technology, Delhi, N.Y. 13753 EEO/AA Employer

Tennessee Technological University
Department of Mathematics
Cookeville, Tennessee 38505

Applications are invited for a tenure-track position in Statistics at the rank of Assistant Professor, available 1 January 1989. Ph.D. in Statistics, or equivalent, experience in both Applied and Mathematical Statistics, evidence of excellent teaching ability at all levels, and strong interest in research are required. Duties include teaching undergraduate and graduate courses, directing graduate students, consulting and research activities, and helping develop Statistics courses for science and engineering students. Position is open until filled. Send transcript and curriculum vitae, and have three letters of recommendation sent, as soon as possible, to: Chairman, Search Committee, Department of Mathematics, Box 5054, TTU, Cookeville, TN 38505. EOE/AA.

DEPARTMENT OF MATHEMATICS, UNIVERSITY OF OTTAWA. Applications are invited for THREE tenure track positions starting July 1, 1988 (one still subject to budgetary approval). Candidates must have demonstrated research ability. 1. Assistant or associate professor; all areas are invited. Ability to teach in English and French is required for tenure but not for appointment. 2. Assistant professor; preference for all areas of analysis or (P)DEs. Ability to teach in English and French required for tenure but not for appointment. According to Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents. 3. Professeur adjoint ou agrégé de préférence en analyse, analyse numérique, équations différentielles, géométrie algébrique ou différentielle, ou statistique. L'enseignement attaché à ce poste sera en français. Conformément aux exigences prescrites en matière d'immigration au Canada, la priorité sera accordée aux citoyens canadiens et résidents permanents. For any of these posts, send a résumé and have three letters of reference sent before December 16 to: W. D. Burgess, Dept. Math., University of Ottawa, Ottawa, CANADA K1N 6N5

THE UNIVERSITY OF
ALABAMA AT BIRMINGHAM
DEPARTMENT OF MATHEMATICS

The Department of Mathematics has faculty positions at all ranks. The department is especially interested in establishing a group in Numerical PDE/Scientific computation over the next five years. Access to the Alabama Super Computer (using a Sun Station and a T-1 line to a Cray X-MP/24) will be available in the near future. Other areas which will enhance our proposed Ph.D. in Applied Mathematics will be seriously considered. Applicants for senior positions must demonstrate excellence in research, while applicants for junior positions must exhibit the promise of excellence. Send as soon as possible a curriculum vitae, list of publications, a few selected reprints, and the names of three references to Search Committee, Department of Mathematics, University of Alabama at Birmingham, Birmingham, AL 35294. UAB is an Affirmative Action/ Equal Opportunity Employer.

DEPARTMENT OF MATHEMATICS
THE UNIVERSITY OF
WESTERN ONTARIO

Applications or nominations are invited for the position of Chairman, Department of Mathematics, Faculty of Science. The effective date of the appointment is July 1, 1989.

Applications or nominations should be addressed to:

Dr. W. S. Fyfe,
Dean,
Faculty of Science,
Natural Sciences Centre,
The University of Western Ontario,
London, Ontario, Canada.
N6A 5B7

Applications or nominations should be submitted by January 1, 1989. In accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada.

An Equal Opportunity Employer.

POSITIONS AVAILABLE

CANISIUS COLLEGE
DEPARTMENT OF MATHEMATICS

A 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. The teaching load is twelve hours per semester. Salary and fringe benefits are competitive commensurate with credentials and experience.

Applicants should send resume, transcripts and three letters of recommendation to Dr. Richard H. Escobales, Chairman, Department of Mathematics, Canisius College, Buffalo, New York, 14208. AA/EOE.

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.

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.

THE ROCKY MOUNTAIN MATHEMATICS CONSORTIUM

announces publication of

THE JOURNAL OF INTEGRAL EQUATIONS AND APPLICATIONS

The Journal of Integral Equations and Applications is a continuation of the "Journal of Integral Equations", and will be devoted to the theory, applications and numerical analysis of integral equations of all types. The primary aim of this international journal is to publish high-quality research papers in the area of integral equations and their applications, and will be particularly devoted to:

The deterministic and probabilistic theory of linear and nonlinear integral equations of various types, integrodifferential equations and related operator equations.

Numerical analysis and approximation methods for integral equations.

Applications of integral equations in the sciences, engineering, and technology.

The journal will also publish occasional survey and expository articles presenting, in some depth, recent advances with respect to particular topics. It will serve as a forum for an exchange of ideas that will stimulate significant contributions in new fields and promote the most salient aspects of the theory of integral equations.

The scope and methodologies will embrace classical and complex analysis methods, functional analysis techniques and topological/geometric methods for development of the theory of integral equations.

The editors of the Journal of Integral Equations and Applications will be P. M. Anselone, Oregon State University; and M. Z. Nashed, University of Delaware. The institutional subscription price will be $150.00 (rates for individual subscriptions available upon request). Inquiries and orders should be directed to the Rocky Mountain Mathematics Consortium, Dept. of Mathematics, Arizona State University, Tempe, AZ 85287-1904 (phone 602-965-3788).

POSITIONS AVAILABLE

NEW SENIOR FACULTY
in
COGNITIVE AND NEURAL SYSTEMS
at
BOSTON UNIVERSITY

Boston University seeks a full professor or associate professor starting in Fall, 1989, to act as Co-Director for its M.A. and Ph.D. Program in Cognitive and Neural Systems. The Co-Director will play a major role in curriculum development, administration, and training of mathematically advanced graduate students. The program curriculum offers the full range of psychological, neurobiological, and computational concepts, models, and methods in the broad field variously called neural networks, connectionism, parallel distributed processing, and biological information processing, in which Boston University is a leader. The faculty member will have a joint appointment in the Ph.D. program and in one or more of the departments of mathematics, biology, computer science, and psychology. Candidates should have extensive analytic and computational research experience and an international reputation for modelling a broad range of real-time nonlinear neural networks, enabling them to teach graduate courses including the areas of adaptive pattern recognition and self-organization. Send a complete curriculum vitae and at least three letters of recommendation to Search Committee, Cognitive and Neural Systems Program, Room 240, 111 Cummington Street, Boston University, Boston, MA 02215, preferably by November 15, 1988, but no later than January 1, 1989. Boston University is an Equal Opportunity/Affirmative Action employer.

STANFORD UNIVERSITY

Stanford University solicits applications for a tenured senior faculty person to lead a proposed new Stanford Institute of Computation Theory. The Institute will initially be a part of the Computer Science Department in the School of Engineering and will have the participation of the Departments of Mathematics, Operations Research, and Statistics. An appointment in the Computer Science Department or, if appropriate, jointly or fully in a related department such as Mathematics, Operations Research, or Statistics, is possible.

Candidates are expected to have a commitment to excellence in teaching and an outstanding record of research in at least one field of computation theory, including, but not limited to, such subjects as: Combinatorial optimization, Complexity theory, Computational geometry, Database and knowledge systems, Design and analysis of algorithms, Discrete mathematics, Distributed algorithms, Logic and its applications, Mathematical programming, Parallel algorithms and architectures, Principles of Programming languages, or Security of protocols. In addition, demonstrated leadership abilities, administrative skills, and interpersonal skills are required for this position.

Candidates should send a vita and names of at least four references to: Prof. Jeffrey D. Ullman, Department of Computer Science, Stanford Univ., Stanford CA 94305. Stanford is an equal opportunity/affirmative action employer and energetically solicits applications from women and targeted minorities.

THE UNIVERSITY OF FLORIDA
Department of Mathematics

The Department of Mathematics is in the third year of a five-year program to fill over 20 new tenure-track faculty positions with mathematicians of exceptional caliber. The Department invites applications for six tenure-track positions for the fall semester, 1989. Applications from junior candidates are especially welcome.

Outstanding candidates in all areas of applied and pure mathematics are invited to apply for these positions. Senior candidates should have distinguished research records, and junior candidates are expected to have made significant research contributions. Every candidate is expected to possess a strong commitment to teaching.

One position will be reserved for a senior candidate in Partial Differential Equations. Strong preference will be given to Arithmetic Geometers and Number Theorists in filling a second position. Among other areas of interest to the Department are Dynamical Systems, Algebraic Geometry and Harmonic Analysis.

Candidates should forward a resume (including a list of publications) and should arrange for at least three letters of recommendation to be sent to:

David A. Drake, Chair
Department of Mathematics
University of Florida
201 Walker Hall
Gainesville, Florida 32611

All applications for the academic year 1989–1990 should be complete by December 31, 1988. The University of Florida is an equal opportunity employer.

POSITIONS AVAILABLE

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY-DEPARTMENT OF MATHEMATICS. We anticipate making one or more tenure-track appointments at the assistant professor level or above beginning in the fall of 1989. A Ph.D. is required. Very strong research potential required for junior-level appointments and demonstrated outstanding record for senior-level appointments. Applications will be accepted until March 15, 1989, or until the positions are filled. Applicants should send vita and three letters of reference to: Chairman, Search Committee, Department of Mathematics, Virginia Tech, Blacksburg, VA 24061-0123. Virginia Tech is an Equal Opportunity/Affirmative Action Employer.

QUEEN'S UNIVERSITY AT KINGSTON
DEPARTMENT OF
MATHEMATICS AND STATISTICS

Applications are invited for a tenure track position in discrete mathematics beginning July, 1990. The successful applicant must have and maintain a solid research record in such areas as graph theory, enumeration, and combinatorial designs.

Those interested are requested to arrange that a curriculum vitae and letters of recommendation from three or more referees be received at the address below by October 31, 1988. At least one letter should comment on the candidate's teaching ability.

Professor L. L. Campbell, Head
Department of Mathematics and Statistics
Queen's University
Kingston, Ontario
K7L 3N6

In accordance with Canadian Immigration requirements, this advertisement is directed to Canadian citizens and permanent residents. Candidates of either sex are equally encouraged to apply.

Department of Mathematics
University of Alberta

Applications are invited for tenure-track positions, subject to budgetary approval, in Approximation Theory (File AP-1), Numerical Optimization or Partial Differential Equations (File NP-1), in Number Theory (File NT-1), or closely related areas and Algebraic or Differential Topology (File AT-1) at the Assistant 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 October 31, 1988. Please quote file numbers when responding to this advertisement. The University of Alberta is committed to the principle of equity in employment.

CARNEGIE MELLON UNIVERSITY
Department of Mathematics

The Department expects to make one or two tenure-track appointments, to begin in the Fall of 1989. Although these appointments are expected to be at the Assistant Professor level, we also solicit exceptionally well-qualified applicants for more advanced positions. We particularly seek candidates in the area of numerical analysis, but also will consider any areas of research which strongly intersect those of the current faculty of the Department. Candidates should send a resume to: Appointments Committee, Department of Mathematics, Carnegie Mellon University, Pittsburgh, PA 15213. Carnegie Mellon University is an Affirmative Action/Equal Opportunity Employer.

The University of British Columbia
Department of Mathematics

The Department is seeking an outstanding candidate for a tenure track Assistant Professorship to begin 1 July 1989, in one of the following areas: mathematical physics, probability, operator algebras, algebra/number theory. Applicants should have a proven research record of high quality and have demonstrated interest and ability in teaching. Preference will be given to candidates who have one or more years of postdoctoral experience. This position is subject to final budgetary approval. The salary will be commensurate with experience and research record. Applicants should send a C.V. including list of publications, statement of research and teaching interests and arrange for three letters of recommendation to be sent directly to: Dr. David Boyd, Head, Department of Mathematics, University of British Columbia, Vancouver, B.C., Canada V6T 1Y4. Applications must be received before 1 January 1989. In accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada.

CARNEGIE MELLON UNIVERSITY
Department of Mathematics

The Department of Mathematics at Carnegie Mellon University anticipates an opening at the level of full Professor. Applications are invited from mathematicians and applied mathematicians with exceptionally strong accomplishments in research and considerable experience in teaching. Candidates' research interests should overlap significantly with those of Department members. Applications should be sent to: Senior Appointments Committee, Department of Mathematics, Carnegie Mellon University, Pittsburgh, PA 15213. Carnegie Mellon University is an Affirmative Action/Equal Opportunity Employer.

POSITIONS AVAILABLE

Faculty Position—**Mathematics**. Mesa State College announces the availability of three tenure track positions in mathematics beginning late August, 1989. Specialization in statistics is wanted for one of them. Required are a Ph.D. and strong commitment to teaching as well as interest in professional achievement beyond teaching. Rank commensurate with qualifications. Send resume with three references to William Putnam, Dean, School of Natural Sciences and Mathematics, Mesa State College, Grand Junction, Colorado, 81502. To assure consideration, applications should be received by October 17, 1988. Mesa State College is an AA/EO employer.

The Ohio State University
Department of Mathematics
Research Instructorships in Mathematics

Applications are invited for the position of research instructor in mathematics for the academic year 1989-90. Candidates should hold a Ph.D. (or equivalent) in mathematics and show strong research promise.

Please send credentials and have letters of recommendation sent to Professor Joseph Ferrar, Department of Mathematics, The Ohio State University, 231 W. 18th Avenue, Columbus, Ohio 43210. The Ohio State University is an Equal Opportunity/Affirmative Action Employer.

OREGON STATE UNIVERSITY

Assistant Professor position in Algebra, (Number Theory), Numerical Analysis, or Geometric-Topology will become available September, 1989. Salary depends on qualifications. Closing date January 20, 1989. Write to:

Professor Bent Petersen
Staff Selection Committee
Department of Mathematics
Oregon State University
Corvallis, Oregon 97331

Oregon State University is an Affirmative Action/Equal Opportunity Employer and complies with Section 504 of the Rehabilitation Act of 1973. OSU has a policy of being responsive to the needs of dual-career couples.

CORNELL UNIVERSITY

DIRECTOR, CENTER FOR THEORY AND SIMULATION IN SCIENCE AND ENGINEERING

Cornell University seeks qualified individuals for the above position, which will be filled not later than July 1, 1989.

The Theory Center

- Sponsors interdisciplinary research and graduate instruction in computational science and engineering.
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- Contains the ACF (Advanced Computational Facility) for experimentation on prototype highly parallel machines.

The Director

Must be an outstanding scientist of international stature and have broad research and administrative experience in computational science.

Will be appointed professor in an appropriate Cornell department and expected to maintain his or her research program in computational science.

The Theory Center provides a national focus on the interface of science and engineering research with computational science. The Director is expected to have the personal qualities required to act as a national spokesperson for computational science.

For consideration please send your resume and a letter highlighting your qualifications to: Joseph Ballantyne, Vice President for Research and Advanced Studies, CORNELL UNIVERSITY, 312 Day Hall, Ithaca, NY 14853-2801.

Respond on or before September 30, 1988

CORNELL THEORY CENTER

Affirmative Action / Equal Opportunity Employer

POSITIONS AVAILABLE

UNIV. OF N.C. AT CHAPEL HILL,
DEPT. OF MATHEMATICS,
CHAPEL HILL, N.C. 27514

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; however, applications received by January 15, 1989, are assured of full consideration. Send 4 letters of recommendation, vitae, and abstracts of current research to Search Committee, %Pat Levin, Mathematics Department, Box 3250 Phillips Hall, UNC at Chapel Hill, Chapel Hill, NC 27599. EO/AA Employer. Women and minorities are encouraged to identify themselves voluntarily.

UNIVERSITY OF MINNESOTA, DULUTH
Department of Mathematics and Statistics

Tenure-track Asst. Prof. & tenure-track or tenured Assoc. Prof. starting 9/1/89. Teach 2 courses per quarter at grad & undergrad level; assist in master's program in applied & computational math; do research. Required: Ph.D. in applied math or related field by 9/1/89. Desired: 5 years professional experience, appropriate research area, effective teaching & advising experience, publications, industrial or governmental experience in math. Salary competitive. Send resume, 3 letters of recommendation, & transcripts (if degree received within past 5 years) to Harlan Stech, MG 108, 10 University Drive, Duluth, MN 55812, by 1/15/89. 218-726-8272 THE UNIVERSITY OF MINNESOTA IS AN EQUAL OPPORTUNITY EDUCATOR AND EMPLOYER AND SPECIFICALLY INVITES AND ENCOURAGES APPLICATIONS FROM WOMEN AND MINORITIES.

FACULTY APPOINTMENT
Department of Mathematical Sciences
The Johns Hopkins University

Applications are invited for a senior appointment in the area
•Numerical Analysis and Optimization for Fall 1989. Junior applicants will also receive consideration. Selection will be based on demonstration of excellence in research, teaching, and innovative application. Applicants are asked to furnish vita together with a letter describing professional interests and aspirations, and to arrange for three letters of recommendation to be sent, by October 15, 1988, to:

Professor Jong-Shi Pang
Department of Mathematical Sciences
The Johns Hopkins University
Baltimore, Maryland 21218

The Johns Hopkins University is an Equal Opportunity/Affirmative Action Employer. Employment is offered without discrimination on the basis of race, color, religion, sex or national origin.

DEPARTMENT OF MATHEMATICS
THE UNIVERSITY OF
WESTERN ONTARIO

Applications or nominations are invited for the position of Chairman, Department of Mathematics, Faculty of Science. The effective date of the appointment is July 1, 1989.

Applications or nominations should be addressed to:

Dr. W. S. Fyfe,
Dean,
Faculty of Science,
Natural Sciences Centre,
The University of Western Ontario,
London, Ontario, Canada.
N6A 5B7

Applications or nominations should be submitted by January 1, 1989. In accordance with Canadian immigration requirements, this advertisement is directed to Canadian citizens and permanent residents of Canada.

An Equal Opportunity Employer

YORK UNIVERSITY
Department of Mathematics
Toronto, Canada

Applications are invited for a tenure-track position in STATISTICS, rank open, to commence July 1, 1989. Applicants should have proven ability or demonstrated potential for research in Statistics and the ability to teach Applied Statistics at the undergraduate and graduate levels. One or more limited-term or tenure-track positions, rank and FIELD OPEN, are also anticipated, subject to university approval. Resumes and three letters of recommendation should be sent by January 1, 1989 to: **Joan Wick Pelletier, Chair, Department of Mathematics, 4700 Keele Street, North York, Ontario, M3J 1P3 Canada**. York University is implementing a policy of employment equity. Qualified women and men are invited to apply. In accordance with Canadian Immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada.

DEPARTMENT OF STATISTICS
UNIVERSITY OF CALIFORNIA,
BERKELEY

Pending final budgetary approval, applications are invited for several special Neyman Visiting Assistant Professor positions, beginning Fall, 1989 or Spring, 1990. The appointment is of two-year duration (but can be shorter by mutual agreement) and is not renewable. Applicants should have exhibited exceptional research potential in any of the following areas: Theoretical or applied statistics, computational statistics, probability theory, applied probability. Appointees will be expected to teach as well as to carry out a vigorous program of research. Send applications or inquiries (including resume and names of three references) by March 15, 1989 to: R. J. Beran, Chairman, Department of Statistics, University of California, Berkeley, California 94720. The University of California is an Equal Opportunity, Affirmative Action Employer.

POSITIONS AVAILABLE

TRINITY UNIVERSITY
SAN ANTONIO, TEXAS
ASSISTANT/ASSOCIATE PROFESSOR OF MATHEMATICS

Trinity University invites applications and nominations for a tenure-track position in mathematics, appointment beginning August, 1989. The appointment will be made at the rank of Assistant Professor or Associate Professor, depending on qualifications. Responsibilities include teaching nine credit hours per semester, continuing scholarly activity, assisting in curriculum development as appropriate to the needs of the department and the university, advising and committee service.

Minimum qualifications are the Ph.D. in Mathematics or Applied Mathematics with excellence in and strong commitment to teaching. Preference given to candidates with teaching and research interests in one or more of the following areas: applied mathematics, numerical analysis, classical analysis, differential equations.

Founded in 1869, Trinity University occupies a modern campus overlooking the San Antonio skyline. Purposely small and selective, with about 2700 students, Trinity stresses a high quality, undergraduate liberal arts and science program. San Antonio is a city of approximately 850,000 people situated in a metropolitan area of 1.2 million.

Closing date for applications is January 27, 1989. Send vita, transcripts and three letters of reference to:

Dr. Donald F. Bailey, Chairman
Department of Mathematics
Trinity University
715 Stadium Drive
San Antonio, Texas 78284

Trinity University is an equal opportunity affirmative action employer.

POSTE D'ATTACHE DE RECHERCHE EN MATHÉMATIQUES NUMÉRIQUES

Le **Centre de recherche en sciences et en ingénierie des molécules** (CERSIM) et le **Département de mathématiques et de statistique** sollicitent des candidatures pour un poste d'attaché de recherche pour une durée possible de 3 ans débutante le **1er janvier 1989**. Ce poste d'attaché de recherche pourra être intégré au Départment de mathématiques et de statistique.

La personne retenue

* fera de la recherche portant sur la simulation numérique des écoulements de polymères et ce, dans le cadre d'une action structurante;
* contribuera à la direction d'étudiant(e)s des 2ème et 3ème cycles.

La personne interessée doit

* détenir un doctorat en mathématiques ou un diplôme jugé équivalent avec spécialisation en résolution numérique des équations aux dérivées partielles par la méthode des éléments finis;
* manifester de l'intérêt pour la recherche multidisciplinaire et le travail d'équipe.

Dans la perspective d'une intégration au Département de mathématiques et de statistique, les qualités d'enseignant de la personne intéressée et ses capacités à s'exprimer en français seront prises en considération.

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.

Le curriculum vita doit parvenir avant le **30 septembre 1988** à l'adresse suivante:

Robert Côté
Départment de mathématiques et de statistique
Faculté des sciences et de génie
Université Laval, Québec
G1K 7P4

Le 23 juin 1988

Head, School of Civil Engineering
Purdue University

The Schools of Engineering at Purdue University invite nominations and applications for the position of Head, School of Civil Engineering. The successful candidate will possess outstanding leadership qualities and administrative abilities. The candidate shall be eligible for appointment as full professor with immediate tenure based on a distinguished record of scholarly activity to include teaching, research and service in the engineering profession.

Purdue is a land grant institution. The Schools of Engineering constitute one of the largest and highest quality engineering instructional and research organizations in the United States. The School of Civil Engineering currently has 58 faculty members and over 600 graduate and undergraduate students excluding freshmen. Research activities cover a broad range of topics and account for an annual expenditure of approximately $3 million. The curriculum spans a wide spectrum of Civil Engineering disciplines, with emerging technologies being continuously integrated into both instruction and research. The candidate selected shall be an innovative individual with a firm grasp and understanding of the current and future needs of the Civil Engineering profession.

The position will be available as early as 1 July 1989. Applications will be considered until the position is filled. Screening of applications will begin 1 August 1988. Nominations and applications should be sent to:

Dr. Henry T. Yang
Dean, Schools of Engineering
Purdue University
West Lafayette, IN 47907

Purdue University is an Equal Opportunity/Affirmative Action employer.

POSITIONS AVAILABLE

GROVE CITY COLLEGE POSITION IN MATHEMATICS

Grove City College, an independent, Christian college of liberal arts and sciences, affiliated with the Presbyterian Church (U.S.A.), seeks a Ph.D. in mathematics for the fall of 1989. ABD's are invited to apply. Rank and salary are open. A strong evangelical Christian commitment is expected. This is a teaching position; scholarly activity of genuine interest to the teacher (not publication for publications' sake) is encouraged. Calculus and upper level teaching assignments. Good locale, excellent facilities, top-rated students and Christian environment. Send vitae to Dr. Jerry H. Combee, Vice President for Academic Affairs, Grove City College, Grove City, PA 16127. Grove City College is an equal opportunity employer.

WILLIAMS COLLEGE DEPARTMENT OF MATHEMATICS WILLIAMSTOWN, MASSACHUSETTS 01267

We anticipate three positions, probably at the rank of assistant professor, for Fall, 1989. For one position, there is a preference for statistics or operations research.

Strong commitment to both teaching and scholarship is essential. The teaching load is five 1-semester courses per year, plus a "Winter Study" in alternate Januaries, beginning in the second year.

Please send a vita and three letters of recommendation on teaching and research to Frank Morgan, Chair. Evaluation of applications will begin November 15 and continue until positions are filled.

Since Williams is an affirmative action/equal opportunity employer, we encourage applications from women and minorities.

University of Puerto Rico Department of Mathematics Río Piedras, PR 00931

Applications are invited for at least 4 tenure-track positions at the Assistant Professor level beginning August, 1989. Candidates must have a Ph.D., a commitment to undergraduate teaching and potential for continuing research. Conversational knowledge of Spanish is a plus. Positions are open in Computer Science, Probability, Statistics, Operations Research, Numerical Analysis, Ordinary and Partial Differential Equations, Functional Analysis, Algebra and Topology. Salary around $23,820 for 9 months of teaching. Applications considered until June 1, 1989. Send resume and three letters of recommendation to J. M. López, Head, Department of Mathematics, University of Puerto Rico, P.O. Box BF, Río Piedras, PR 00931. EOE/AA.

POSITIONS AVAILABLE

DEPARTMENT HEAD
MATHEMATICS AND STATISTICS
LOUISIANA TECH UNIVERSITY

Louisiana Tech University invites applications for Head, Department of Mathematics and Statistics. The Departments of Chemistry, Mathematics and Statistics, and Physics make up the School of Science within the College of Arts and Sciences. The Department Head has responsibility for all facets of departmental activity, which include curriculum development, budgeting, recruiting, scheduling, and faculty evaluation. As the Department's chief administrative officer, he/she will report to the Dean of the College through the Director of the School. The Department is comprised of approximately twenty-five full-time faculty members. Salary is commensurate with qualifications. The position will be available on/after December 1, 1988.

Applicants must hold a Ph.D. in Mathematics or Statistics, have an established record of research and scholarly activity, and be able to provide strong academic leadership.

Please submit application, resume, and three letters of reference by November 1, 1988 to:

Dean
College of Arts and Sciences
Louisiana Tech University
Ruston, LA 71272

An Affirmative Action/Equal Opportunity Employer

Florida State University. Department of Mathematics, Tallahassee, FL 32306. Applications are invited for a tenure-track assistant professorship with appointment beginning in August, 1989. The candidate should be a numerical analyst with experience in the development of the vortex method for the Euler equations of fluid mechanics, and should have potential for excellence in research and teaching. Please send resume, and arrange for three letters of recommendation to be sent, to Ralph D. McWilliams, Chairman. Application deadline is October 15, 1988. Florida State University is an EEO/AA employer.

THE UNIVERSITY OF ADELAIDE
SOUTH AUSTRALIA
invites applications from both women and men for the following position:
PROFESSOR OF MATHEMATICAL PHYSICS
(Tenurable)

(Ref: 1516) in the DEPARTMENT OF PHYSICS AND MATHEMATICAL PHYSICS. The appointment follows the retirement of Professors H. S. Green, F. A. A. and C. A. Hurst, F. A. A. and is available from June, 1989. The Department was formed from the Departments of Physics and Mathematical Physics by the amalgamation of the two Departments on 1 January 1988. The new Department is responsible for teaching of physics and theoretical physics in the Faculty of Science and mathematical physics in the Faculty of Mathematical Sciences. The Department teaches undergraduate physics subjects to physics majors and Honours students and has a substantial responsibility for teaching physics to the professional faculties and to other Departments in the Faculties of Science and Mathematical Sciences.

The current research interests of the Department are atmospheric physics, cosmic rays and high energy astrophysics, mathematical physics, physical archaeometry, theoretical nuclear and particle physics and ultra-violet physics. There are two other Professors in the Department, Professors J. R. Prescott and A. W. Thomas.

The new professor will be expected to contribute to the academic leadership of the whole Department but will have a particular responsibility for teaching subjects in the discipline of mathematical physics in second, third and Honours year, leading to degrees in the Faculty of Mathematical Sciences. The new professor will be expected to promote and extend a strong programme of research and postgraduate studies within the new Department, and in cooperation with other Departments, particularly in the Faculty of Mathematical Sciences. A commitment to excellence in teaching and research is expected.

Further information concerning the duties of the position may be obtained from Dr. L. R. Dodd, telephone (618) 228 5113.

It is University policy to encourage women to apply for consideration for appointment to tenurable academic appointments. Holders of full-time tenured or tenurable academic appointments have the opportunity to take leave without pay on a half time basis for a specific period of up to ten years where this is necessary for the care of children.

INFORMATION about the general conditions of appointment may be obtained from the Senior Assistant Registrar (Personnel) at the University.

SALARY per annum: AUS $59,183 per annum (subject to second tier wage increase)

APPLICATIONS, IN DUPLICATE, quoting reference number 1516 and giving full personal particulars (including whether candidates hold Australian permanent residency status), details of academic qualifications and names and addresses of three referees should reach the Senior Assistant Registrar (Personnel) at the University of Adelaide, GPO Box 498, Adelaide, South Australia, 5001, Telex UNIVAD AA 89141/FAX NO. (618) 224 0464 not later than 30 September 1988.

The University reserves the right to make enquiries of any person regarding any candidate's suitability for appointment, not to make an appointment or to appoint by invitation.

THE UNIVERSITY OF ADELAIDE IS AN EQUAL OPPORTUNITY EMPLOYER.

University of Notre Dame
Department of Mathematics
Notre Dame, In. 46556

Applications are invited for a tenure-track or tenured associate professorship in the area of global analysis and differential geometry. Applicants should have substantial teaching ability and an outstanding record of publications in areas related to geodesics and the theory of submanifolds. Send by September 30, 1988, a curriculum vitae, list of publications, a few selected reprints or preprints, and the names of three references to Andrew Sommese, Chairman, at the above address. The University of Notre Dame is an equal opportunity affirmative action employer.

POSITIONS AVAILABLE

UNIVERSITY OF CALIFORNIA,
LOS ANGELES
Department of Mathematics

TEMPORARY POSITIONS

(1) One or two E. R. Hedrick Assistant Professorships. Applicants must show very strong promise in research and teaching. Salary $36,000. Three year appointment. Teaching load: four quarter courses per year, which may include one advanced course in the candidate's field. Preference will be given to applications completed by January 1, 1989.

(2) Two or three Research Assistant Professorships in Computational and Applied Mathematics. Applicants must show very strong promise in research and teaching. Salary $36,000. Three year appointment. Teaching load: four quarter courses per year, which may include one advanced course in the candidate's field. Preference will be given to applications completed by January 1, 1989.

(3) One or two Assistant Professorships in the Program in Computing (PIC). Applicants must show very strong promise in teaching and research, preferably in the general area of Logic, Language and Computation. Teaching load: four quarter programming courses and an advanced quarter course of the candidate's choice per year. Two year appointment, renewable once or twice. Salary range: $36,000-$42,000. Preference will be given to applications completed by January 1, 1989.

(4) One or two Lectureships in the Program in Computing (PIC). Applicants must show very strong promise in the teaching of programming. Teaching load: five quarter programming courses per year. One year appointment, renewable up to four times. Salary depends on experience, begins at $30,300.

(5) Subject to administrative approval, a few adjunct assistant professorships. Two year appointments. Strong research and teaching background required. Salary $31,500-$35,400 per year. Teaching load: five quarter courses per year.

(6) Several positions for visitors and lecturers.

To apply, write to Alfred W. Hales, Chair, Department of Mathematics, University of California, Los Angeles, CA 90024-1555. Attn: Staff Search. UCLA is an equal opportunity/affirmative action employer.

Advertisement

The Jordan University of Science and Technology announces vacancies for staff members in the Faculty of Science in the following areas:

1. Mathematics
2. Computer Science

Candidates must have an earned Ph.D. degree, preferably with some academic experience. The candidate must have a university degree (Bachelor of Science) in the same field.

Applications with full curriculum vitae should be sent to:

Personnel Department
Jordan University of Science and Technology
Irbid P.O. Box (3030)
Jordan

UNIVERSITY OF CALIFORNIA,
LOS ANGELES
Department of Mathematics
REGULAR POSITIONS IN PURE AND APPLIED MATHEMATICS

Six to eight regular positions in pure and applied mathematics. Specific fields of interest include algebra/number theory (including algebraic geometry), analysis, applied and computational mathematics, differential equations, dynamical systems, game theory, logic, mathematical computer science, mathematical physics, probability and statistics. Very strong promise in research and teaching required. Positions initially budgeted at the assistant professor level. Sufficiently outstanding candidates at higher levels will also be considered. Teaching load: Averaging 1.5 courses per Quarter, or 4.5 Quarter courses per year. To apply, write to Alfred W. Hales, Chair, Department of Mathematics, University of California, Los Angeles, CA 90024-1555. Attn: Staff Search. UCLA is an equal opportunity/affirmative action employer.

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Journals from 1961, *American Mathematical Monthly, Bulletin* AMS.

For detailed information write
Professor Bert Ross
Mathematics Dept.
University of New Haven
West Haven, Conn. 06516

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PUBLICATIONS

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Order directly from: Heldermann Verlag, Nassauische Str. 26, D-1000 Berlin-West 31.

ANNOUNCEMENTS

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PRIZE ($1,000) for **PHILOSOPHIA MATHEMATICA** (circulating in some 50 nations since 1964) on such topics as: 1. Ethics and Mathematics (in particular, Morals of Knowledge in general); 2. Sociology or Social Theory of Mathematics; 3. The Topological vs the Algebraic; 4. Others, related to the study on the Nature of Mathematics (definitely not via Logic alone). For details, write to: [Prof.] J. Fang, ODU (Phil), Norfolk, VA 23529-0083.

POSITIONS WANTED

Seeking Full Professorship with tenure at Ph.D. granting institutions where normal teaching load is 0 to 6 cr. hrs. per term. Seeking seniority since Jan. 1st '76. Age: 42, Speciality: Algebraic Topology (Lefschetz Type Fixed Point Theorems), M. Experience: '67 to '83. C. Vora, 1178 Milford Str., Backporch, Johnstown, PA 15905. Available immediately.

Colby College
Mathematics Department
Waterville, Maine 04901

Carter Professor of Mathematics and Chair

Colby invites nominations and applications for the Carter Professor of Mathematics and Chair of the Mathematics Department, effective September 1, 1989. Ph.D. in mathematical sciences required. Desirable qualifications include a distinguished record as teacher and scholar; demonstrated departmental and collegial leadership, including the ability to nurture faculty development and research programs; commitment to liberal arts and undergraduate math education.

Colby is a highly selective college of 1700 students and 165 faculty. Its Mathematics Department, within which are taught computer science and statistics courses, has 9 FTEs. Colby is an affirmative action/equal opportunity employer, and encourages applications from women and minorities.

Send applications (letter of application and resume) and nominations to: H.T. Hayslett, Jr., Chair, Mathematics Department, by December 1, 1988.

THÉORIE DES VARIÉTÉS MINIMALES ET APPLICATIONS (MINIMAL SUBMANIFOLDS) SÉMINAIRE PALAISEAU

(Astérisque, Number 154–155)

The study of minimal submanifolds is by now established as one of the deep and esthetically appealing parts of mathematics. It combines in an exemplary fashion geometric and analytical techniques both of a classical and of a more modern nature. In recent years it became a powerful tool to investigate the internal geometry of manifolds, a subject of interest today to both mathematicians and theoretical physicists.

This volume, devoted to notes of a seminar held from October 1983 to June 1984 under the direction of H. B. Lawson Jr. at Ecole Polytechnique in Palaiseau, presents recent contributions to the theory of minimal submanifolds in their diversity. It starts with an elementary approach to the subject, hence is appropriate as a source book for a graduate seminar.

SOCIÉTÉ MATHÉMATIQUE DE FRANCE, ASTÉRISQUE

The AMS distributes Astérisque only in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF, B.P. 126-05, 75226 Paris Cedex 05, France, or to OFFILIB, 48 rue Gay-Lussac, 75240 Paris Cedex 05, France. Individual members of either AMS or SMF are entitled to the member price. (ISSN 0303-1179)

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