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Calendar of AMS Meetings

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

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

MEETING #	DATE	PLACE	ABSTRACT DEADLINE	ISSUE
832	March 26–28, 1987	Honolulu, Hawaii	EXPIRED	February
833	April 3–4, 1987	Kent, Ohio	EXPIRED	February
834	April 25–26, 1987	Newark, New Jersey	EXPIRED	February
835	June 18–20, 1987	Tacoma, Washington	April 17	June
836	August 5–8, 1987*	Salt Lake City, Utah	May 12	August
837	October 30–November 1, 1987	Lincoln, Nebraska		
838	November 14–15, 1987	Los Angeles, California		
	January 6–9, 1988 (94th Annual Meeting)	Atlanta, Georgia		
	August 8–12, 1988 (AMS Centennial Celebration)	Providence, Rhode Island		
	January 11–14, 1989 (95th Annual Meeting)	Phoenix, Arizona		
	January 17–20, 1990 (96th Annual Meeting)	Louisville, Kentucky		

* Preregistration/Housing deadline is June 1.

DEADLINES

Advertising	(*Apr.* 1987 *Issue*) *Mar.* 23, 1987	(*June* 1987 *Issue*) *Apr.* 29, 1987	(*Aug.* 1987 *Issue*) *June* 10, 1987
News/SMIC	(*Apr.* 1987 *Issue*) *Mar.* 5, 1987	(*June* 1987 *Issue*) *Apr.* 13, 1987	(*Aug.* 1987 *Issue*) *May* 25, 1987

Other Events Sponsored by the Society

April 30–May 7, 1987, AMS-SIAM Summer Seminar on Computational Aspects of VLSI Design with an Emphasis on Semiconductor Device Simulation, University of Minnesota, Minneapolis. Details: This issue.

May 12–16, 1987, Symposium on the Mathematical Heritage of Hermann Weyl, Duke University, Durham, North Carolina. Details: This issue.

June 14–July 25, 1987, Joint Summer Research Conference in the Mathematical Sciences, University of Colorado, Boulder, Colorado. Details: This issue.

July 19–August 15, 1987, Joint Summer Research Conference in the Mathematical Sciences, Cornell University, Ithaca, New York. Details: This issue.

July 6–24, 1987, Summer Research Institute on Theta Functions, Bowdoin College, Brunswick, Maine. Details: This issue.

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Notices
of the American Mathematical Society

Volume 34, Number 2, February 1987

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Notices: highlights

The Steele and Cole Prizes were awarded at the Annual Meeting in San Antonio. The 1986 Steele Prizes were given to Donald Knuth for expository writing, to Rudolf Kalman for a fundamental paper, and to Saunders Mac Lane for his mathematical career. The 1987 Cole Prize in Number Theory, awarded every five years, was shared by Dorian Goldfeld and by Benedict Gross and Don Zagier. Page 227.

The AMS Science Policy Committee reports on items of interest to the mathematical community, including the panel discussion on defense funding held at the Annual Meeting and the two motions presented at the Business Meeting. Page 235.

William R. Graham, the newly-appointed Science Adviser to President Reagan, gives an address at the San Antonio Meeting entitled "Challenges to the Mathematics Community" in which he discusses two issues of vital importance to mathematics and mathematicians. Page 245.

The Second Report of the 30th Annual AMS Survey examines the employment picture in the mathematical sciences by presenting statistics on the employment pattern for new doctorates and a mobility analysis of mathematicians in academia. The report also contains information on course enrollments, department size, and the number of graduate students and undergraduate majors. Page 252.

The Boston Computer Society, in Richard Palais's column, continues its report on Technical Wordprocessors for the IBM PC and Compatibles with an analysis of the available software programs, using tables to draw comparisons and to highlight features. Page 262.

Kenneth Hoffman, in his Washington Outlook column, examines retiring Congressman Don Fuqua's tenure as Chairman of the House Committee on Science and Technology and outlines some of his recommendations for the future. Page 285.

The NSF announces the Presidental Young Investigators awards and the Mathematical Sciences Postdoctoral Research Fellowships. Page 295.

The NSF Budget Request for FY1988 is $1.9 billion, an increase of 16.5% over FY1987, and provides for some new directions and initiatives. Page 297.

1986 Steele Prizes Awarded at Annual Meeting in San Antonio

Three Leroy P. Steele Prizes were awarded at the Society's ninety-third Annual Meeting in San Antonio, Texas.

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 year: 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 1986 are DONALD E. KNUTH for the expository award; RUDOLF E. KALMAN for research work of fundamental importance; and SAUNDERS MAC LANE 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 Richard W. Beals, Jerry L. Bona, Charles W. Curtis, Harold M. Edwards (Chairman), Hermann Flaschka, Frederick W. Gehring, John P. Hempel, Lawrence E. Payne, George B. Seligman, and Patricia Lilaine Sipe.

The text that follows contains the Committee's citations for each award, the recipients' responses to the award, and a brief biographical sketch of each of the recipients. Professors Kalman and Knuth were unable to attend the Annual Meeting to receive the prize in person. They did, however, send written responses.

Expository Writing

Donald E. Knuth

Citation

The 1986 Steele Prize for expository writing is awarded to DONALD E. KNUTH for his book *The Art of Computer Programming* which has made as great a contribution to the teaching of mathematics to the present generation of students as any book on mathematics proper in recent decades. The book is intended to be accessible to readers with very little mathematical background—readers with no more than high school algebra are told to skip the more mathematical sections—but it is hard to imagine an intelligent reader spending much time with the book without markedly improving his or her mathematical background as a result. Problems of real interest and substance in combinatorics, number theory, algebra, asymptotic series, and statistics are posed in compelling ways and handled with clarity, sophistication, and an open-endedness that stimulates further thought and new problems. The carefully thought-out exercises have inspired many papers in journals of mathematics as well as in journals of computer science.

Knuth says in his Preface, "Much of the published mathematics about computer programming has been very faulty, and one of the purposes of this book is to instruct readers in proper mathematical approaches to this subject. Since I myself profess to be a mathematician, it is my duty to maintain mathematical integrity as well as I can." His devotion to mathematical integrity has produced a book of outstanding mathematical quality; in professing to be a mathematician he honors the profession.

Response

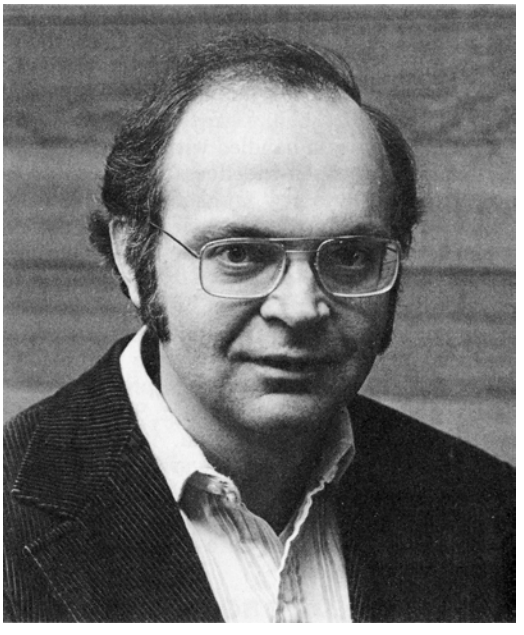
It is wonderful to discover a beautiful corner of mathematics, and even more wonderful to learn later that you have helped others to discover this same beauty. Therefore it was a special pleasure for me to learn that my books on computer programming had been selected for a Steele Prize.

When I began work on *The Art of Computer Programming*, I wanted to find appropriate mathematical underpinnings by which programmers could understand the behavior of important algorithms. This quest opened up a rich vein of new questions that were fascinating both because of their inherently interesting mathematical structure and because of their importance in practical applications.

After 25 years of research on the analysis of algorithms, I still am struck by the "unreasonable effectiveness of mathematics"—by the fact that these new questions almost always have answers that can be formulated in terms of classical concepts. For example, the problem of "largest stack height when traversing a random binary tree" reduces to a calculation involving Euler's gamma function times the square of Riemann's zeta function!

On the other hand, I was not taught much about these "good old" mathematical tools when I was a college student; they had gone out of fashion. For want of a better term, I began

referring to them as 'concrete mathematics', a blending of 'continuous' and 'discrete', and I began teaching a course with this title at Stanford in 1970. Other people independently came to similar conclusions. I'm glad to see that concrete mathematics is once again resuming its rightful place, amid many other beautiful theories, in the affections of modern mathematicians.



Donald E. Knuth

Biographical Sketch

Donald Ervin Knuth was born in Milwaukee, Wisconsin on January 10, 1938. He received both a B.S. and an M.S. in 1960 from Case Institute of Technology, and a Ph.D. in 1963 from the California Institute of Technology. In that year he became an assistant professor of mathematics at the California Institute of Technology, and he advanced to the rank of professor by 1968. He has been a professor of computer science at Stanford University since 1968 and has held the Fletcher Jones chair of computer science since 1977.

He began writing a manuscript in 1962 that has grown into a series of books entitled *The Art of Computer Programming.* Three volumes in this series have been published so far (1968, 1969, 1973); four more volumes are projected. Knuth is also the author of a five-volume series entitled *Computers & Typesetting* (1986); these books describe his TEX and METAFONT systems for computer typesetting, on which he began work in 1977. He published a mathematical novelette, *Surreal Numbers*, in 1974; a monograph in French, *Mariages Stables*, in 1976; and (with Daniel H. Greene) an advanced textbook, *Mathematics for the Analysis of Algorithms*, in 1981. His books have been translated into Chinese, Czech, German, Hungarian, Japanese, Romanian, Russian, and Spanish.

Professor Knuth gave an invited address at the International Congress of Mathematicians in 1970, and he delivered the Josiah William Gibbs lecture of the American Mathematical Society in 1978. He has received the Grace M. Hopper Award (1971), the Alan M. Turing Award (1974), the Computer Science Education Award (1986), and the Software Systems Award (1986) of the Association for Computing Machinery. He is a member of the American Academy of Arts and Sciences (1973), the National Academy of Sciences (1975), and the National Academy of Engineering (1981). President Carter awarded him the National Medal of Science in 1979.

Fundamental Paper

Rudolf E. Kalman

Citation

The 1986 Steele Prize for a paper, whether recent or not, that has proved to be of fundamental or lasting importance in its field, or a model of important research, is awarded to RUDOLF E. KALMAN for his papers:

> *A new approach to linear filtering and prediction problems*, Journal of Basic Engineering, volume **82** (1960), pages 35-45.
>
> *Mathematical description of linear dynamical systems*, SIAM Journal on Control and Optimization, volume **1** (1963), pages 152-192.

and for his contribution to the paper:

> (with R. S. Bucy) *New results in linear filtering and prediction theory*, Journal of Basic Engineering, volume **83D** (1961), pages 95-108.

The ideas presented in these papers are a cornerstone of the modern theory and practice of systems and control. Not only have they led to eminently useful developments, such as the Kalman-Bucy filter, but they have contributed to the rapid progress of systems theory, which today draws upon mathematics ranging from differential equations to algebraic geometry.

Response

To be awarded the STEELE Prize is a totally unexpected honor. I am truly grateful for it. And I regret very much that I cannot be here in person, impeded by commitments that go back, in principle, at least ten years.

I have been aware from the outset (end of January 1959, the birthdate of the second paper in the citation) that the results of the deep analysis of something that is now called *Kalman filtering* were of major importance. But even with this immodesty I did not quite anticipate all the

reactions to this work. Up to now there have been some 10^4 related publications, at least two Citation Classics, etc. There is something to be explained.

To look for an explanation, let me suggest a historical analogy, at the risk of further immodesty. I am thinking of NEWTON, and specifically of his most spectacular achievement, the Law of Gravitation. NEWTON received very ample "recognition" (as it is called today) for this work. It astounded—really floored—all his contemporaries. But I am quite sure, having studied the matter and having added something to it, that nobody then (1700) really understood *what* NEWTON's contribution was.

Indeed, it seemed an absolute miracle to his contemporaries that someone, an Englishman, actually a human being, in some magic and ununderstandable way, could harness mathematics, an impractical and ethereal something, and so use mathematics as to discover with it something fundamental about the Universe. The technical discussion of why and how this was done must be left to a future publication. Right now I want merely to say that NEWTON showed that

mathematics + reality >> zero-sum game.

This is symbiosis between mathematics and physical reality. After Newton mathematics advanced quickly but the symbiosis has gradually vanished. Physics cannot be done today without electronics but mathematics hardly matters. (This is, of course, a purely personal observation.)

Yet there *is* new symbiosis between mathematics and reality. We have a new game and it is nonzero sum. Miraculous, if you like. The new magic is that mathematics helps to conceive machines, systems, before they can be actually built. Unlike at the time of NEWTON, there are many today who understand this process. Perhaps this is why my papers that you have so kindly cited turned out to be so influential.

There has been much noise lately about the "relevance" of mathematics. I do not share this worry and I try to explain why not. NEWTON turned out to be a difficult role model to follow. But then, through the advancement of technology—which is neither mathematics, nor physics, something quite different though not unrelated—a substitute has appeared. Its name is system theory. With system theory there is a new and harmonious relationship of mathematics to reality. Without having to veil any of her unbelievable but delicate intellectual beauty, mathematics has become the much-loved partner of a new kind of relevance.

Thank you again.

Biographical Sketch

Rudolf Emil Kalman was born in Budapest, Hungary on May 19, 1930. He was educated at the Massachusetts Institute of Technology (S.B., 1953; S.M., 1954) and Columbia University (D.Sci., 1957).

Professor Kalman was an instructor at Columbia University (1955–1957), a staff engineer at IBM (1957–1958), and a staff mathematician at the Research Institute for Advanced Studies, Baltimore (1958–1964). At Stanford University he was Professor of Engineering Mechanics and Electrical Engineering (1964–1972). Since 1971, he has been Graduate Research Professor and Director of the Center for Mathematical System Theory at the University of Florida. Since 1973 he is also Professor of Mathematical System Theory at the Swiss Federal Institute of Technology in Zurich.

Professor Kalman's awards include the IEEE Medal of Honor (1974), the ASME Rufus Oldenburger Medal (1976), and the Kyoto Prize (1985).

Career Award

Saunders Mac Lane

Citation

The 1986 Steele Prize for cumulative influence is awarded to SAUNDERS MAC LANE for his many contributions to algebra and algebraic topology, and in particular for his pioneering work in homological and categorical algebra.

Response

First of all, may I express my deep gratitude for the award of this Steele Prize.

This inevitably brings me to think about the advantages which I have enjoyed in the course of my career. I am particularly grateful to all those who helped me. First of all to my family, who instilled in me a love of learning and a sense of independence. Next, to a third grade teacher, who gave me and my classmates a striking diagrammatic introduction to fractions. A high school teacher, Olive Greensfelder, went to great trouble to teach me how to write. When I was a freshman at Yale, Lester Hill, an instructor working for his doctorate, persuaded me that Calculus was more exciting than Chemistry. Later at Yale, Wallace Wilson taught me both rigor and point set topology. Bert Miles showed me how to make the writing of Mathematics clear and persuasive, while Oyestein Ore taught me algebra very well, but could never recover from his dislike of Logic. At Chicago, Eliakim H. Moore was the major influence, while in Göttingen there were Hermann Weyl, Paul Bernays, and Emmy Noether. What a fortunate start!

The ideas of abstract Algebra emphasized again the observation that Mathematics can be clear, precise, and understandable—and this has been reflected in much of my work, both in the agreeable task of training graduate students, beginning with Irving Kaplansky, and in various

books, such as the *Survey of Modern Algebra*, written with Garrett Birkhoff.

My retiring address as President of this Society was entitled "Topology and Logic as a Source of Algebra." These remarkable interconnections continue to fascinate me. Here is topology, beginning with a soup of continuous deformations, which turn out to require all sorts of algebraic concepts, both known ones and new ones which first turn up in the topological situation. For example, it was Otto Schilling who had taught me about class field theory, crossed product algebras, and group extensions. These extensions then turned out to be just the tool needed to express the dependance of cohomology on homology, by a "universal coefficient" theorem. Because Eilenberg and I had to explain the exact sense in which that theorem was "natural," we had to go on to discover categories. On the other hand, Eilenberg had recently brought singular homology theory to an understandable form, by using simplices with ordered vertices. This made it possible to handle those group extensions better, and to get a cohomology of groups which could then apply back to algebra—crossed products and class field theory. These topological ideas also led to homological algebra—Ext, Tor, and resolutions.

On the other hand, those singular simplices had to appear in the homology of a product of spaces, even though a simplex is not naturally a product of lower dimensional simplices. This required a comparison with tensor products, by the Eilenberg-Zilber theorem, crucial to the use of acyclic models and to the study of Spaces with just one Homotopy group (Eilenberg-Mac Lane spaces). That in turn required more algebra—a Bar construction, a W construction, and their comparison. What a wealth of algebra is hidden here in the geometry—for example the Steenrod algebra. I am still trying to better understand that transition from the W to the Bar construction.

But I have not yet formulated in adequate philosophical terms why it is that algebra and topology interpenetrate in this remarkable manner. Much the same sort of interconnection occurs now between other parts of mathematics. I am somewhat saddened to see that some mathematics has become so specialized and some parts of it so isolated that the chance for interconnections and for general conceptual analysis is likely to be lost.

The progress of mathematics does also depend on a better understanding of what our subject really is about. It is not just about empirical facts and the applications, nor is it just about some abstract platonic ideas, full of truth and beauty. No, Mathematics arises rather as the interaction of the empirics and the ideas—in a fashion which I have ventured (in a recent book) to call "Formal functionalism." It seems to me good to combine the pleasure of doing mathematics with the clear and general formulation of what we are doing and what it means. For the preparation of that book, as in the preceding 51 years, my wife, Dorothy Jones Mac Lane, gave me unstinting support.

Thank you again.

Additional Remarks

At the award ceremony, I was reminded how much the AMS did to help the start of my career. The Secretary stated that the Steele prize fund had been established to honor the work of three Harvard professors: William Fogg Osgood, George David Birkhoff, and William Casper Graustein. As it happens, I knew the last two well.

It happened as follows. In the fall of 1933 I had a new Ph.D. and a new wife; I desperately needed a job for the next year. So I did what young Ph.D.'s still do: I went to the winter meeting of the AMS, held that year late in December in Cambridge, Massachusetts. I gave a 10-minute paper (there was then only one session at a time, and everyone attended). Then I met George David Birkhoff and told him about my interests; I am sure that he was aware that I was looking for a job.

After that meeting, I returned home; with no visible prospects for a teaching position in a college or university, I made application for a position as a master at a well-known private preparatory school for boys. (It was then the height of the depression). A few months later William Casper Graustein, Chairman of the Department of Mathematics at Harvard, wrote to offer me a two year appointment as a Benjamin Pierce Instructor at Harvard. I accepted with alacrity; the ensuing two years made an excellent start for my career—a start mediated by the AMS and Professors Birkhoff and Graustein.

I turn again to mathematics, where Homological Algebra still fascinates me. Forty years ago, Samuel Eilenberg and I found and formulated the cohomology of groups in terms of a simple chain complex, the "Bar construction". We found it from a topological model—the minimal singular complex of a space whose only non-trivial homotopy group is a fundamental group π_1; that is an Eilenberg-Mac Lane space $K(\pi_1, 1)$. Since that time that chain complex has been widely used, in algebra and topology. Five years later our complicated but strictly algebraic analysis of the homology of a space $K(\pi, n)$ led us to formulate a much more general bar construction which applied to differential graded algebras, in particular to $K(\pi, n)$ with its shuffle product. This construction has also been widely used, for example to directly construct $K(\pi, n)$—but its boundary formula seemed to have a purely algebraic origin. Just last month (36 years later), I found a natural geometric explanation for this boundary formula in terms of singular prisms in a space $K(\pi, n)$. So I am much pleased to report that algebra and topology, as in this case, still belong together.

Saunders Mac Lane

Biographical Sketch

Saunders Mac Lane was born in Norwich, Connecticut on August 4, 1909. He was educated at Yale University (Ph.B., 1930), the University of Chicago (M.A., 1931), and the University of Göttingen (D.Phil., 1934). In addition, he has received several honorary degrees: the D.Sc. degree from Purdue University (1965); Yale University (1969); Coe College (1974); the University of Pennsylvania (1977); and an LLD from Glasgow University (1971).

At the start of his career, Professor Mac Lane was a Pierce Instructor at Harvard (1934–1936) and an instructor of mathematics at Cornell (1936–1937) and at the University of Chicago (1937–1938). He returned to Harvard in 1938, where he moved from the rank of assistant to full professor between the years of 1938 and 1947. In 1947 he returned to the University of Chicago where, in 1963, he became Max Mason Distinguished Service Professor of Mathematics. He retired in June, 1982.

In addition to his work at these universities, Professor Mac Lane has served as the Director of the Applied Mathematics Group at Columbia University (1944–1945), as a member of the Executive Committee, International Mathematical Union (1954-1958), and as a member of the National Science Board (1974-1980). As a visiting professor, he has taught and studied at the University of Heidelberg (1958, 1965, 1976), at the University of Frankfurt (1960), and at Tulane University (1969). He has been a Guggenheim Fellow in 1947–1948 (Paris and Zurich) and in 1972–1973 (Cambridge, England and Aarhus, Denmark), and a Fulbright Fellow at the Australian National University (1967).

Since 1933 Mac Lane has been a member of the American Mathematical Society. He has served the AMS at various times as a member of the Council (1939–1941), Colloquium Lecturer (1963), Editor of the *Bulletin* (1943–1947), Editor of the *Transactions* (1949–1954), Vice-President (1946–1947), Editor of the *Colloquium Series* (1966–1972), and finally as President (1973–1974). He is also a member of other professional societies, including the Association for Symbolic Logic since about 1935, and the American Association for the Advancement of Science. Professor Mac Lane was also Vice-President (1948) and President (1950) of the Mathematical Association of America (MAA). Among the awards he has received are the Chauvenet Prize of the MAA (1941) and the Distinguished Service Award from the MAA (1975). His research interests include algebra, topology, algebraic topology, logic, and category theory. He has directed forty doctoral dissertations and has written five books, including *Algebra* (with Garrett Birkhoff).

In 1949 Mac Lane was elected to membership in the National Academy of Sciences. He served as an elected member of the Council of that Academy from 1958-1961, and again from 1969-1972. From 1960–1968 he was Chairman of the Editorial Board of the *Proceedings* of the National Academy of Sciences. In 1973 he was elected to a four-year term as Vice-President of the National Academy of Sciences, and in this connection concurrently served as Chairman of the Report Review Committee of that Academy. In 1977 he was reelected to a second four-year term as Vice-President of the Academy.

1987 Cole Prize in Number Theory Awarded in San Antonio

The Frank Nelson Cole Prize in Number Theory is awarded every five years for a notable research memoir in number theory that has appeared during the previous five years. This prize, as well as the Frank Nelson Cole Prize in Algebra, was founded in honor of Professor Frank Nelson Cole on the occasion of his retirement as Secretary of the American Mathematical Society after twenty-five years and as Editor-in-Chief of the Bulletin for twenty-one years. The original fund was donated by Professor Cole from moneys presented to him on his retirement. It has been augmented by contributions from members of the Society, including a gift made in 1929 by Charles A. Cole, Professor Cole's son, which more than doubled the size of the fund. In recent years, the Cole Prizes have been augmented by awards from the Leroy P. Steele Fund and currently amount to $4,000.

The Twenty-Second Cole Prize was awarded jointly to DORIAN M. GOLDFELD, of Columbia University, and to BENEDICT H. GROSS, of Harvard University, and DON B. ZAGIER, of the University of Maryland and the Max Planck Institute. The prize was awarded at the Society's ninety-third Annual Meeting in San Antonio. The Cole Prize was awarded by the Council of the American Mathematical Society, acting through a selection committee consisting of Paul T. Bateman (Chairman), Enrico Bombieri, and Bernard M. Dwork.

The text below includes the Committee's citation, the recipients' responses on presentation of the award, and a brief biographical sketch of the recipients. Professor Zagier was unable to attend the Annual Meeting to receive the prize in person. He did, however, send a written response to the award.

Citation

The 1987 Frank Nelson Cole Prize in Number Theory is awarded jointly to DORIAN M. GOLDFELD and to BENEDICT H. GROSS and DON B. ZAGIER for giving an effective bound for the discriminants of all imaginary quadratic fields with a given class number—thereby solving a problem that goes back to Gauss. This effective bound was developed in the following two papers:

Benedict H. Gross and Don B. Zagier, *Heegner points and derivatives of L-Series*, Inventiones Mathematicae, volume **84** (1986), pages 225-320; and

Dorian M. Goldfeld, *Gauss's class number problem for imaginary quadratic fields*, Bulletin of the American Mathematical Society, volume **13** (1985), pages 23-37

the latter of which summarizes the results of Goldfeld's earlier paper, *The class number of quadratic fields and the conjectures of Birch and Swinnerton-Dyer*, Annali della Scuola Normale Superiore di Pisa, Serie IV, volume **3** (1976), pages 623-663.

Dorian M. Goldfeld

Response

It is a great honor to receive the Cole Prize, and I should like to take this opportunity to thank the American Mathematical Society and the Cole Prize Committee for considering me.

In 1976, I developed an analytic method for solving the long-standing conjecture of Gauss on class numbers of imaginary quadratic fields; to construct an effective algorithm for finding all imaginary quadratic fields with a given class number. The first case of this problem was solved by K. Heegner in 1952 who showed that there are exactly nine imaginary quadratic fields which are unique factorization domains (class number one). His proof, however, had a gap which was later rectified by H. Stark. Subsequently, both H. Stark and A. Baker gave different proofs of this result, and they also solved the class number two problem. The higher class numbers, however, seemed inaccessible by their methods.

In my approach to this problem, I demonstrated that the Gauss conjecture would follow if one could exhibit the existence of a single L-function, $L(s)$, associated to an automorphic form of arithmetic type on $GL(2)$ for which the same L-function over an imaginary quadratic field has at least a fourth order zero at the center of its critical strip. It can be shown that this requirement will be satisfied for suitable $L(s)$ having a triple zero at the center of its critical strip.

In their brilliant and beautiful work, Gross and Zagier proved a special case of the Birch-Swinnerton-Dyer conjecture on the special values of derivatives of L-series associated to elliptic

curves. They were then able to construct an L-function with a triple zero at the center of its critical strip. Combined with my work, this solved the Gauss conjecture.

Let me also take this opportunity to thank B. Gross and D. B. Zagier for their contribution to this problem. It is a delight to share the Cole Prize with them.

In conclusion, I should like to mention the still unsolved conjecture of Chowla; to construct an effective algorithm for finding all real quadratic fields (with discriminant equal to one plus a square) which have a given class number. My method would solve this problem if one could find a suitable L-function with a fourth order zero. Of course, if no condition is put on the discriminant, another famous conjecture of Gauss asserts that class number one occurs infinitely often. This problem appears quite intractible at the moment.

Dorian M. Goldfeld

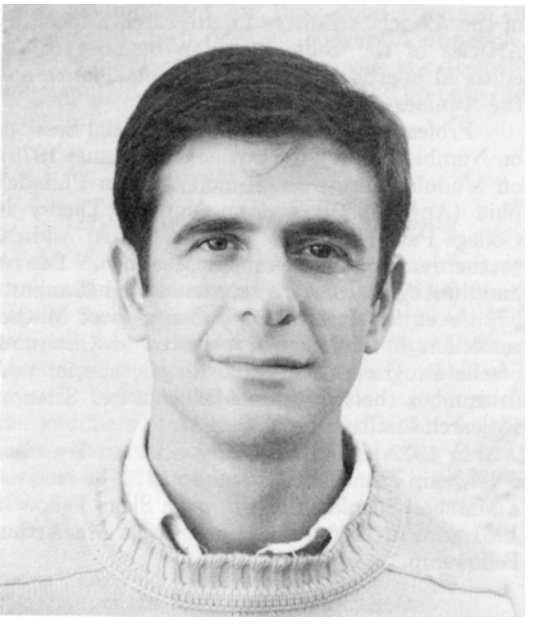
Biographical Sketch

Dorian M. Goldfeld was born January 21, 1947, in Marburg, Germany. He received both his B.S. degree (1967) and his Ph.D. (1969) from Columbia University.

Professor Goldfeld was a Miller Fellow at the University of California, Berkeley (1969–1971), a postdoctoral fellow at Hebrew University, Jerusalem (1971–1972), and a lecturer at Tel-Aviv University, Israel (1972–1973). He spent the 1973–1974 year as a member of the Institute for Advanced Study in Princeton, and the years 1974–1976 as a visiting professor at Scuola Normale Superiore, Pisa. Professor Goldfeld then became assistant professor at the Massachusetts Institute of Technology (1976–1979), advancing to associate professor (1979–1982). He was an associate professor at the University of Texas, Austin, (1983–1985) and a visiting associate professsor at Harvard University (1982–1985). Since 1985, he has been a professor at Columbia University.

Professor Goldfeld spoke at the Special Session on Elliptic Curves and Arithmetic Geometry in Providence (October 1980), on Number Theory in San Francisco (January 1981), and on Number Theory and Related Parts of Analysis in Austin (November 1981). Also, Professor Goldfeld gave an Invited Address at the Annual Meeting in Anaheim (January 1985) and an invited 45-minute address at the International Congress of Mathematicians in Berkeley (August 1986).

Professor Goldfeld was a Sloan Fellow (1977–1979) and, in 1985, received the Vaughn Prize.



Benedict H. Gross

Benedict H. Gross

Response

I would like to thank the American Mathematical Society for this honor. The Cole Prize means a great deal to me, as many of my teachers were former recipients.

The joint paper cited by the committee establishes a new type of limit formula, which connects the canonical heights of special points on modular curves to the first derivatives of L-series at $s = 1$. One application is to give examples of L-series which vanish to order 3, and this has applications to the class number problem via previous work of Dorian Goldfeld.

I was lucky both to find this limit formula and to collaborate with Don Zagier on the proof. The essential miracles underlying our computations are still not well understood; I look forward to the day when some of these secrets will be revealed.

Biographical Sketch

Benedict H. Gross was born on June 22, 1950, in South Orange, New Jersey. He received his B.A. from Harvard University in 1971, his M. Sc. from Oxford University in 1974, and his Ph.D.

from Harvard University in 1978. He began his teaching career at Princeton University in 1978 as an instructor and then as an assistant professor. In 1982, he went to Brown University where he held the positions of associate professor and then professor. Since 1985, he has been a professor of mathematics at Harvard University.

Professor Gross has been a member of the AMS Committee on Postdoctoral Fellowships (1980–1982) and of the AMS Committee on Summer Research Conferences (1982–1985). He is one of the Associate Editors for Research-Expository Articles of the *Bulletin* and a member of the editorial boards of *Compositio Mathematica* and the *Annales de l'Institut Fourier*.

Professor Gross spoke at the Special Sessions on Number Theory in Providence (August 1978), on Modular Forms and L-Functions in Philadelphia (April 1980), and on Number Theory in College Park (1982). He gave an Invited Address at the January 1983 Annual Meeting in Denver and, in August 1986, he gave an invited 45-minute lecture at the International Congress of Mathematicians in Berkeley. He served as Chairman of the Program Committee for the special year in number theory at the Mathematical Sciences Research Institute in 1986–1987.

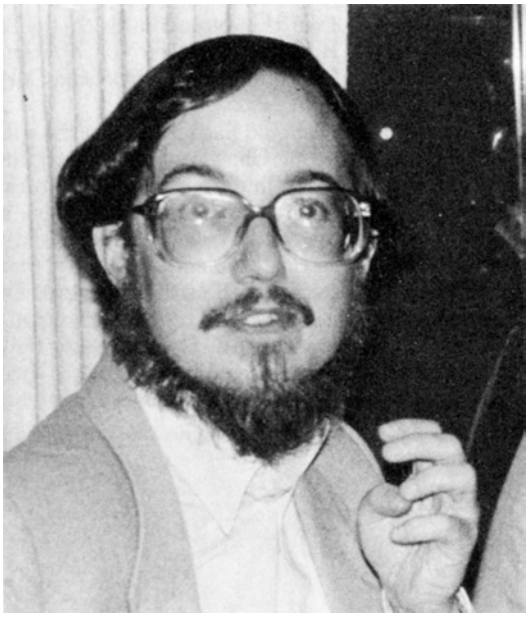
In 1972, Gross received a Sheldon Traveling Fellowship from Harvard and, in 1973, he received a Marshall Scholarship. He was a Sloan Fellow in 1981 and, in 1986, he was awarded a MacArthur Fellowship.

Don B. Zagier

Response

I feel greatly honored to be one of the recipients of the Cole Prize, which has gone in the past to such illustrious number theorists.

Working on the paper which has been cited by the Cole Prize Committee was a tremendously satisfying mathematical experience, for several reasons. First of all, the perhaps most important recent development in number theory has been the realization of the phenomenal interdependence between purely arithmetic questions and the theory of automorphic forms, epitomized by the Langlands program but visible at a more naive level in the conjectures and theorems relating modular curves to elliptic curves and associated with the names of Taniyama, Shimura, Weil, Birch, and Swinnerton-Dyer. It is, however, very rare to find a situation where a diophantine object and a related modular one are both understood so well that they can be calculated, and it was very exciting to be able to work out one such case. Secondly, the actual progress of my collaboration with Dick Gross had a lot of drama, since we were both feeling in the dark and each step of one of us cast just enough light for the other to take one step in turn. And finally, I love to calculate, and this paper let me indulge as never before. The application to Gauss's class number formula via the beautiful prior work of Goldfeld was, of course, a wonderful and undeserved bonus.



Don B. Zagier

Biographical Sketch

Don B. Zagier, an American citizen, was born on June 29, 1951, in Heidelberg, Germany. He finished high school at the age of 13, attended an English public school (Winchester) for one year, and then attended the Massachusetts Institute of Technology, where he received Bachelor's degrees in mathematics and physics two years later. He studied topology under Michael Atiyah (Oxford) and Friedrich Hirzebruch (Bonn), obtaining his D.Phil. degree from Oxford in 1972.

Professor Zagier has been attached to the faculty of the Universitat Bonn since 1971, a professor at the University of Maryland since 1979, and a scientific member of the Max-Planck-Institut für Mathematik (Bonn) since 1984. He has also held visiting appointments at the Eidgenössische Technische Hochschule Zurich (1972–1973), the Institut des Hautes Etudes Scientifiques (1973–1974), Universiteit Leiden (1976), and Harvard University (1977). He has lectured in India, China, Japan and, extensively, in America and Eastern and Western Europe. He was awarded the Carus Prize of the Leopoldina Academy in Germany in 1983 and a special research grant of the French Ministry of Research and Technology in 1985.

Professor Zagier is a member of the editorial boards of *Compositio Mathematica* and the *Journal of Number Theory*. His research interests include number theory and the theory of modular forms.

Report of the Science Policy Committee

New Charge to Science Policy Committee by Council

At the Council Meeting in San Antonio, the Science Policy Committee (SPC) was given two new responsibilities: (1) to publish in the *Notices* information that urgently requires Society members' attention and (2) to arrange a lecture or panel discussion at each annual meeting on some topic concerning an area of social import in which mathematics (broadly interpreted) is used.

This report attempts to respond to the first charge and will contain information in the style of a "newsletter" on matters related to science policy and funding, especially that affecting the mathematical sciences. Although much of the impetus for the additional charge came from departments and individuals wanting early information on federal funding opportunities (such as last year's University Research Initiative (URI) Program), the reports of the SPC will be more broadly conceived. We begin with the San Antonio Meeting. Plans for responding to the second charge will be contained in a future report.

Presidential Science Adviser Attends Meeting

William R. Graham, the new Presidential Science Adviser, attended the San Antonio Meeting and spoke on Two Challenges for the Mathematical Community. First, he challenged mathematicians to continue the process of better articulating and justifying their needs to the public, to federal funding agencies, and to colleges and universities, which was begun in the David Report. His second challenge was for us to take greater responsibility for improving mathematical education at all levels. In particular, he urged that we support and actively participate in the activities of the Mathematical Sciences Education Board to improve mathematics education in the schools. He argued strongly that the health of our community and of mathematics rests on our accepting both challenges. Let me add that this is not a partisan view but one that is shared by most political leaders in Washington and in the states.

Panel Discussion on "Mathematics and the Media"

A panel discussion on "What makes news in mathematics?" was organized by Ken Hoffman and Kathleen Holmay at San Antonio. Three science writers and three mathematicians discussed mathematics reporting and why it is so difficult. All agreed that a science writer's job is neither to publicize events nor to teach mathematics but to report news in mathematics of interest to readers. Moreover, since little that happens in mathematics must be reported, actual coverage will depend on the presence at a newspaper or magazine of an interested writer with access to timely, understandable information. Although the Washington Office is important for this, good coverage of mathematics, be it research, education, or people, depends on all of us and, moreover, is extremely important. A "how-to guide" will be prepared to help.

Discussion on Department of Defense Funding

At the ICM in Berkeley last summer, controversy surrounding Department of Defense (DOD) funding in the mathematical sciences surfaced. In response a panel discussion at the San Antonio Meeting was organized by William Browder and myself. After a brief introduction, I provided the summary data presented in TABLE 1 (the most accurate I could obtain) comparing federal support in the mathematical sciences for 1983 and 1987.

Federal Support of the Mathematical Sciences in Millions of Dollars

Agency	FY 1983	FY 1987
National Science Foundation		
Division of Mathematical Sciences	34.1	59.8
Other Divisions	3.0	5.0
Department of Defense		
AFOSR, AOR, ONR, DARPA	26.5	45.5*
Other Agencies		
DOE, NASA, NIH	4.8	5.2
Total	68.4	115.5

*Including 10.4 million in DARPA funding.

TABLE 1

Then five panelists, Hyman Bass, Ettore Infante, Melvyn Nathanson, William Thurston, and Steven Weintraub each presented a statement. (A position paper that reflects the views of each of the panelists is printed in the *Notices* in an appendix to this report, except for Thurston, whose views are contained in a letter to the editor on page 39 of the January 1987 *Notices*.) Discussion followed involving both the audience and the panelists. Most speakers echoed or reinforced arguments presented in the statements with a majority of the participants from the audience speaking against DOD funding.

Earlier that afternoon at the Business Meeting, two motions related to DOD funding were placed on the Agenda of the Summer Meeting in Salt Lake City. Via the parlimentary stratagem of "meeting as a committee as a whole," some informal discussion took place and favorable "straw votes" were taken by the group which numbered about two hundred. The motions presented were:

Motion 1. Many scientists consider SDI (commonly referred to as Star Wars) incapable of achieving its stated goals and dangerously destabilizing. Participation by universities and professional organizations lends a spurious scientific legitimacy to it. Therefore the AMS will lend no support to the Star Wars program. In particular, no one acting as a representative of the AMS shall participate in efforts to obtain funding for Star Wars research or to mediate between agencies granting Star Wars research money and those seeking to apply for it.

Motion 2. The AMS is concerned about the increasing militarization of support for mathematics research. There is a tendency to distribute this support through narrowly focussed (mission-oriented) programs which circumvent normal peer review procedures. This tendency, unless checked, may skew and ultimately injure mathematics in the United States. Therefore those representing the AMS are requested to direct their efforts towards increasing the fraction of non-military funding for mathematics research, as well as towards increasing total research support.

These motions had been considered earlier at the November Meeting of the SPC and of the Executive Committee of the Council, and at the Council Meeting in San Antonio, where they garnered less than majority support.

The SPC intends to provide further information and to organize discussion on the issues surrounding these motions, both at SPC and AMS Meetings and in future reports. Before concluding this discussion, however, let me provide some background on these issues as seen by me.

Federal funding of mathematics is a post-World War II phenomenon and is based largely on the perceived contributions of mathematics to the national good, especially to the national economy and to the national defense. Of particular importance is the role of mathematics in science and engineering. Although a few mathematicians were involved during the fifties in the political decisions that established DOD and, eventually, NSF funding for mathematics, these decisions were taken mainly by physicists and other scientists, and this pattern persisted for many years. It changed, however, during the past decade, when we decided that mathematics was being greatly underfunded by the federal government as compared to the other sciences. Hard work by a small number of mathematicians eventually convinced the National Research Council to appoint a blue ribbon panel which resulted in the David Committee Report. That Committee found that the mathematical sciences were, indeed, underfunded and recommended a doubling of federal support for the mathematical sciences by all agencies including both the NSF and the DOD. This latter recommendation was specific. Both political and agency leaders, in conversations at the time the report came out and now, made it clear that this recommended plurality of the sources of support, to include both civilian and defense agencies, was not accidental and that we cannot ignore it unless we are prepared to give up the recommendations of the David Report altogether.

Although most of those arguing against DOD funding will dispute the latter statement, it is, I believe, how Washington views matters. Let me try to explain why this is the case.

As I indicated above, federal funding of mathematics by all agencies is a political decision, meaning that it is decided by the political process. After all the discussion and arguments about what mathematics (or mathematicians) should be supported and how, a compromise is reached in Washington on the proper balance between basic and applied, mission-oriented research and how much each agency should support the mathematical sciences. And rightly or wrongly, political leaders believe that this is for them to decide and that allowing federal agencies such as the DOD or even the NSF to decide what mission-oriented research to support *ensures* that mathematicians and scientists are responsive to the national interest. Thus they would see an attempt by mathematicians to systematically boycott funding for mission-oriented research as an attempt at evading "public review," which to them is, at least, as important as "peer review." This is the linkage they see between support from the NSF and the DOD. I hope that this explanation begins to make clear some of the complexities in these issues.

In conclusion, am I suggesting that discussion and debate on these issues should cease or be avoided? On the contrary, the efforts for increased funding via a better understanding of the nature of mathematics and the political nature of its funding need to be expanded. This depends on many more mathematicians educating themselves and then joining the political process. Merely stating that mathematics is different will accomplish little! We must be able to communicate these differences, and if we can't, then we must be able to understand why Washington isn't hearing us. Eventually this may lead us to make some fundamental decisions about our discipline. But for now we must resist easy or quick answers and learn how the political process works. These

paragraphs are not the last word on these issues or even close to it. But that can be good for mathematics!

Funding Opportunities in the 1988 Budget

Although details are few and this is only the Executive Budget, which is always changed by Congress, there are several items in it that mathematicians may want to consider. First, the URI program in DOD may continue with additional centers being awarded. Secondly, much of the projected increase in the NSF Budget for FY 1988 may be targeted for interdisciplinary science centers similar to those in the URI program. Thirdly, the NSF may fund calculus reform as part of a new initiative in Undergraduate Science Education. Finally, the Executive Branch in its budget has endorsed the NSF plan to double the NSF Budget in the next five years. Although this is not binding on future budgets, it is a good omen.

The Science Policy Committee is interested in establishing a dialog with the mathematical community on policy issues that affect mathematics. Individuals are invited to communicate with the chairman of the committee.

Ronald G. Douglas (Chairman)
Science Policy Committee, AMS
State University of New York
Stony Brook, NY 11794

EDITOR'S NOTE: The current members of the Science Policy Committee are:

Hyman Bass
Columbia University

Felix E. Browder
Rutgers University

Carl-Wilhelm R. de Boor
University of Wisconsin

Ronald G. Douglas (Chairman)
State University of New York at Stony Brook

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Judith D. Sally
Northwestern University

David A. Sanchez
Lehigh University

William P. Thurston
Princeton University

Guido L. Weiss
Washington University

APPENDIX

The following statements were prepared in conjunction with the panel discussion on "The effect of Department of Defense funding on mathematics" presented at the Annual Meeting in San Antonio which was organized under the auspices of the Science Policy Committee.

Statement of Hyman Bass

Defense Funding of Mathematics

What brought us here? People have come to today's discussion from two directions, with correspondingly different perspectives on the issue. Some of us arrived via the efforts to restore adequate levels of support for mathematics research. Those efforts met early success at NSF, which John Polking declared to be responsible for 60% of the federal funding of mathematics. However, at the defense agencies, responsible for most of the remaining 40%, efforts were less effective. As a consequence much of the energy of our Washington activity has been directed at defense agencies.

These efforts have been perceived by others present here as a courtship of the military and as a movement toward military preponderance in mathematics support. This perception has provided a number of legitimate concerns and so raised the broad issue of defense funding for public discussion here.

While I share many of these concerns, I feel that the conclusions drawn by opponents of defense funding have been extreme and that these people have not responsibly addressed the grave and urgent funding needs of our profession.

Institutional guidelines. I shall focus my remarks on the question of institutional, as opposed to individual, actions, specifically actions of such organizations as the AMS and the JPBM, which represent us as a professional community. Individuals are free to seek and accept any legal source of funding, and some of us here may wish to offer them moral advice on this matter. I am instead concerned here with what might be appropriate institutional policies guiding the AMS and the JPBM in their dealings with the federal establishment.

Until now the driving force behind these activities has been funding needs, and all available federal sources have been pursued opportunistically and without prior constraint. The experience now gained and the debate here raise the question of formulating some institutional guidelines to govern our Washington activities, guidelines that respond to the concerns that have been expressed

here, yet that do not undermine the legitimate efforts to rejuvenate our profession. I would like to propose some such possible guidelines.

Mathematicians have tended to be rather fatalistic about federal policies. I suggest that mathematicians are well qualified to judge the nation's mathematical needs and that we can start using our Washington presence to alter the federal structures governing our profession to better serve those needs.

My premises. 1. National security, like economic strength and social well-being, is a legitimate national goal, to which scientists can significantly contribute. As such, it deserves appropriate public and scientific support. 2. Basic scientific research, especially as conducted in academic environments, is a national, cultural, and technological resource. Its contribution to serving national goals depends on its continued strength and vitality. These are best sustained by support structures that respect the established intellectual traditions of good science in America. These include: 1. expert and objective evaluation of scientific work and proposals; 2. open scientific communication; 3. allowing the directions of basic research to be governed predominantly by the vision and judgement of our best scientists.

Defense funding. National security programs support research (and development) in two very different modes. In the military mode, which commands the preponderance of their funding, the work is highly mission-oriented. It is secretive (classified or otherwise constrained). Scientific evaluation procedures are of variable reliability, and the work is typically conducted off, but perhaps near, university campuses.

On the other hand, defense programs fund a great deal of basic research in a "civilian mode," similar to that of the NSF. These operate with some reasonable variant of peer review, and the research is not classified. The research areas supported are selected for their perceived general relevance to the missions of the funding agency, but beyond that little direction is imposed on the individual investigators.

Both types of programs can be legitimate. However, it seems obvious to me that the AMS should do nothing to foster a substantial funding of basic mathematical research in the military mode.

Some proposed guidelines. The AMS, largely through the JPBM, is seeking to enhance federal funding of mathematical research in the service of national scientific and educational needs. This involves making a case to the funding agencies, the Congress, and the public.

I would like to propose the following policies guiding these activities.

I. (Immediate term.) Programs from which we, as a community, seek expanded support of mathematical research should meet the following standards of scientific integrity:

A. Peer review, or some creditable substitute;

B. Open scientific communication (no constraint on publications, public access to scientific conferences, etc.);

C. Broad discretion for the principal investigators in guiding the direction of the research;

D. Absence of political abuses. (These include, for example, nonscientific pressures on investigators or political exploitation of their participation without their consent.)

II. (Long term.) We should seek a gradual realignment of the federal funding structures for basic mathematics research. The great preponderance of such funding should come from agencies that share the following characteristics with the NSF:

A. They are not highly mission-oriented;

B. The policies and budgets of their scientific programs are under the effective control of administrators whose main priority and vision is the nation's scientific needs, in a broad sense.

In this regard, the recent proposal to double the NSF budget should be supported.

III. (Immediate term.) The recent initiatives toward interdisciplinary research and team efforts, though valuable, should not be allowed to undermine the vitality of the traditional programs funding individual investigators.

Comments on I. The research offices of the Army, Navy, and Air Force have played a major and laudable role in supporting basic research, with programs of generally high scientific integrity. However, that integrity was somewhat compromised under political pressure during the Vietnam War. Like all military agencies, they are vulnerable, as are the investigators they support, to political pressures at times of broad scientific disaffection with some government policy.

The new mathematics program at DARPA started off with flagrant violations of the standards set above, but it has since largely eliminated its objectionable features.

The case of SDI is more substantial, because of its potential influence on the scientific enterprise and on the nation. A large number of knowledgeable scientists view the stated aims of SDI as scientifically unfeasible. Briefly put, it would fail any honest peer review, were it advanced as a research proposal. Yet these aims are the premise of the political case made for SDI, and participation by scientists in SDI programs has been exploited as giving implicit scientific credibility to its stated purpose. This kind of scientific dishonesty and political abuse of scientific authority is alarming. I personally feel that SDI lacks the scientific integrity that would justify our encouraging mathematicians to participate in SDI programs.

Comments on II. Putting moral and political questions aside, consider the federal support of mathematical research from a purely administrative point of view, taking as a starting point the broad mathematical needs of the country, rather than those of the defense establishment. The support is roughly divided between NSF (60%) and defense agencies, including DOE (40%). At the DOD, mathematical research is fragmented in a variety of mission-oriented programs with rather selective mathematical needs. The program directors have been usually well informed and responsive to conditions affecting mathematics. They cooperate informally to coordinate their programs. They operate under the inherent constraints of their service missions. At the same time, neither they nor other DOD personnel who manage and understand science have much discretion, or influence on scientific policy. Those at DOD who make such policy decisions operate at a level where nonscientific issues are paramount and where the mathematics budget is hardly visible to the naked eye.

I seriously question the rationality of making such a structure the repository of the fate of 40% of the federal support of mathematics research. When the nation's interests call for adjustments in the funding of mathematics, we can talk rationally to Erich Bloch at the NSF. But whom can we address at the DOD who has the power, knowledge, and commitment to the basic sciences to make appropriate changes?

The nation has an important stake in the well-being of mathematics research and education. I submit that the DOD is not an appropriate guardian of 40% of that interest.

Later observations

1. The exchanges at the panel were serious, thoughtful, and almost entirely nonbelligerent. Absent was the sense of a defensive establishment under assault by radical outsiders that has plagued AMS ideological debates in the past. I fully share Thurston's conviction that such honest and public discussion as we enjoyed in San Antonio is healthy and appropriate for AMS sponsorship. My only misgiving was that those not opposed to defense funding were not more amply represented. I look forward to their increased public participation as the discussion continues.

2. It is quite significant (to me) that, for all of the divergences of opinion at San Antonio, there was one substantial proposition to which I heard no voiced objection from any quarter, and for which a majority expressed powerful support. That proposition is that *federal funding of basic mathematics research should be realigned so that a larger proportion comes from civilian agencies.*

Note that this does not automatically imply that defense funding of mathematics should decrease. For example, normal increases in DOD funding accompanied by the extraordinary increases contemplated for the NSF do not violate the above proposition.

3. Civilian agencies are susceptible to many of the same failings with which critics faulted the defense agencies. The more sensitive issue to me is one's attitude toward defense funding that is, in immediate terms, scientifically benign: It is subject to quality review, it imposes no constraints on open communication, it supports work to which you are scientifically committed independently of any defense funding, and even without such funding the defense agency can make full use of your work through its publication. Thurston and others are uneasy with defense funding even under such conditions, because it legitimizes the defense establishment's role as patron and because the benign conditions of support are inherently precarious in such hands.

One can take another view. Large funds are vested in the defense agencies by Congress as an expression of the public will. DOD dollars are taxpayers' dollars (including yours and mine) intended to support a broad sector of the national interest, of which the DOD has been made the trustee. It is therefore appropriate to aid the DOD in putting those public funds to the most enlightened and constructive use. I find some merit in this position, though I confess that it leaves me uneasy in the long term.

Statement of Ettore Infante

What is Wrong with DOD Research Support?

A multiplicity of answers is given, by members of our research community, to this question. To some, the problem is that there is not enough of it; to others, that there is too much. Still others have concerns that the DOD research agencies, as mission agencies, do not support the entire spectrum of the mathematical research enterprise, but concentrate support in specific areas and projects which are funded at much higher levels than the support traditionally provided by NSF. Some claim that the peer review process of the DOD agencies is not what it should be. And many state that DOD research support represents a "militarization" of the universities, that it distorts the discipline, and that it is an "intrusion" which is damaging to the health and well-being of mathematics. Many propose that the Society, through its offices, should encourage a redirection of research funds from the DOD agencies to NSF.

The discussions that have taken place, and are taking place, on this topic are becoming vociferous ones. They are not only vociferous, but they also are confusing. The confusion stems, it seems to some of us, on the unfortunate weaving together of three sets of arguments which should be analyzed separately. These are: the management and style of research support of the DOD agencies; the "intrusion," indeed "militarization,"

of university research; and, finally, a frankly more political argument that acceptance of DOD support implies support for broader strategic policies of the federal government.

There is no doubt that the support policies of the DOD agencies are different from those traditionally used by NSF in the mathematical sciences. There is a concentration of resources in certain areas of mathematics, whereas others are unsupported. The infusion of funds from the new mathematics DARPA program and from the University Research Initiative of DOD in large concentrations is a novelty in the mathematical sciences, although it has been repeatedly used in the past in other disciplines. It is possible, indeed desirable, to discuss the wisdom and appropriateness of these modes of support for mathematics, and alter them accordingly. Neither the mathematics research community nor the taxpayers are well served by programs that are not effective, if that is the conclusion. It would seem, therefore, that a careful examination of DOD research support policies is desirable; what is not desirable, or sensible, is to state *ab initio* that because of doubts and concerns there should be no DOD support. Further, it should be recognized by us that some of the modes of research support, with focusing and "fencing," are being implemented not only at the DOD agencies, but as NSF as well where *Centers* are receiving an increasingly greater proportion of the budget. Indeed, it can be argued that the question to be asked is "How should federal research support for mathematics be improved?" and this question has little to do with whether the funds are channeled through DOD, NSF, or DOE. After all, each of these is an agency of the same patron, the federal government.

The second strand of the argument is centered on the "militarization" of the universities, on the intrusion of the government on academe. It is difficult not to sympathize with this view. However, it is equally difficult to perceive that the taxpayers will agree to invest the level of funds in research which they do simply out of a desire to support scholarly work. Indeed, the large allocation of public funds to research is based on the expectation by taxpayers, and their representatives, that these investments will have a handsome return in increasing the health, industriousness, and security of the nation. This fact is inescapable if we note that the investments by the federal government in support of academic research in the sciences and engineering dwarf, by a factor of thirty, those in the humanities and the arts. There is an intrusion by the government, and the society it represents, into the universities. It is an inescapable intrusion by a society which is increasingly dependent for its competitiveness on the basic research that takes place in our universities. Let us remember that, today, the case for increased funds for research at NSF is made on the argument of "competitiveness" and on the increased emphasis on university-industry-government cooperation in basic research. To speak of "militarization" or "industrialization" of universities is to place a pejorative connotation on an ongoing reality.

More than ever, the university is part of the world, especially so at the research level. The question, therefore, is not if funds for research should come from NSF or DOD, but whether the federal government should intrude in academe with large funding for basic research, and the concomitant relationships and expectations. Some of us believe that mathematics can contribute greatly to the health, well-being, competitiveness, and security of the nation; and that taxpayer funds for mathematics should be provided. Acceptance of these funds implies acceptance of a close relationship with the federal government.

Many of the arguments on the ills of DOD research support seem, to some of us, to use the DOD agencies as whipping boys for the repugnance some of us feel for policies of the federal government that have nothing to do with research. Our foreign policy, our strategies in Central America, the decision to pursue or not to pursue SDI are not made by the DOD research agencies, but by our government, the executive and legislative branches, our civilian-elected representatives. DOD research agencies and NSF (which was, incidentally, established to "... secure the National Defense" among other purposes) are part of the same government. It does not seem sensible, as a protest of national policies, to castigate the defense agencies and to praise the Foundation. It is too facile a protest, and an ineffectual one.

I would argue that it is incumbent on the mathematical research community to carefully examine the patterns and modes of research support it receives, and solicits, from the federal government; and to effectively see to it that they are appropriate and supportive of its needs, and of those of society. I would also argue that we, at this time, are beyond the point where a reasonable argument can be made that universities should be "ivory towers." Lastly, I would state that, as members of the mathematics research community, it is ineffectual and self-defeating for us to use DOD research to castigate broader policies of our government. It is as citizens, and in the political arena, that we must present informed arguments to see to it that our national policies and strategies are sensible, and beneficial to the nation.

Statement of Melvyn B. Nathanson

Military Funding of Mathematics

Mathematicians have begun to debate the issue of Department of Defense (DOD) funding of research. The discussion sometimes indicates a certain naïveté about the politics of govern-

ment support for scientific research, and about the purpose of funding by any mission-oriented agency, whether it is the Environmental Protection Agency (EPA), the National Institutes of Health (NIH), or the military.

A mission agency's purpose is not and should not be to support the best research in a discipline. The purpose is, rather, to obtain results in specific areas that help an agency achieve its goals. Whether the goal is clean air (EPA), a cure for leukemia (NIH), or point defense of Minuteman missile silos (DOD), an agency is buying scientific talent to help solve particular problems. Some mission agencies, such as DOD and NIH, have often allocated part of their research budgets to support pure science, but the justification has been not the beauty of science but the need to strengthen the basic science base on which mission-oriented results are built.

Do mission-oriented research grants alter the direction of research in a discipline? Of course. That is their purpose. If a mathematician goes into a new area of research in order to get a grant, and if the grant includes research assistantships that induce a few graduate students to write dissertations in spatial statistics or dynamical systems instead of in additive number theory or geometric topology, then agency funding is having exactly the effect that the agency intends. This is a proper goal for a mission-oriented agency.

Is this good or bad for mathematics? The answer is not obvious *a priori*. Significant DOD funding will certainly influence the development of mathematics. The NIH, for example, significantly affects the direction of research in the biomedical sciences. NIH money has not yet produced a cure for leukemia, but it has improved the treatment of many diseases and it has created extraordinary advances in biology. The NIH example does not imply that mathematics will leap forward because of big infusions of defense dollars, but neither does it suggest a great leap backward.

Mathematicians are the most independent of scientists. We do not need money to prove theorems. A molecular biologist would be out of business without a big budget to buy equipment and supplies, but a mathematician can do research without any outside funding.

This freedom to prove and conjecture without grants is relevant to the ethical issue of military funding. Some mathematicians oppose all military funding of mathematics research. Others oppose only funding from the Strategic Defense Initiative. In a letter in the January 1987 issue of *Notices*, Bill Thurston wrote, "In many discussions of funding of science and of mathematics, ethical considerations having to do with the wider society or the longer term are dismissed as extraneous, unprofessional, or political.... Those of us who believe military funding is wrong should reconcile our actions to our beliefs." I agree that ethics matter, but I disagree with the statement that military funding is wrong. There is nothing unethical about accepting DOD funds. As a matter of individual conscience, if you believe that the military is bad and that SDI is foolish, and you do not want to support SDI in any way, then do not accept SDI money. Classified research has no place on a college campus, but it is surely a matter for each investigator to decide if he or she wishes to accept a grant for unclassified research from the military or any other mission agency. It would be a violation of academic freedom for a department or university administration or the AMS to put pressure on a mathematician not to apply for such grants.

Other questions have arisen in connection with military funding. Should the American Mathematical Society or the Joint Policy Board for Mathematics (JPBM) actively seek more DOD money for mathematics? This is a policy matter that is being debated within the mathematical community. It would be odd to decide, however, that mathematics' representatives in Washington should do anything other than encourage more research money from all possible agencies, and leave to individual investigators the choice of which research grants to pursue.

There will be two motions on the agenda of the Business Meeting of the AMS in Salt Lake City in August 1987. The first states that "no one acting as a representative of the AMS shall participate in efforts to obtain funding for Star Wars research." For the reasons discussed above, I oppose this motion.

The second motion states, "The AMS is concerned about the increasing militarization of support for mathematics research.... Therefore those representing the AMS are requested to direct their efforts towards increasing the fraction of non-military funding for mathematics research, as well as towards increasing total research support."

I also oppose this motion, but the issue here is more subtle than in the previous one. There is not enough money for research in mathematics. The National Science Foundation (NSF) will support a broader range of research than the DOD, and it would be wonderful if NSF had more money. The AMS should encourage this. In the next few years, however, NSF funds for mathematics will not suddenly double or triple. This is not an axiom, but a political judgement. Moreover, even if the NSF budget did increase, it would still be appropriate for the AMS and JPBM to seek research support from DOD and other mission agencies.

There is a final political point. If the AMS were publicly to renounce military support, and thereby to suggest that it had no sympathy for the national security interests of the United States, then it is unlikely that NSF funds for mathematics would increase to replace the DOD funds that were lost. Instead, a probable political consequence is that NSF funds would be cut.

As Ettore Infante noted at the AMS meeting in San Antonio, the charter of the NSF states that one of the missions of the Foundation is to promote national security. It is hard to imagine that Congress would appropriate more money for mathematics through the NSF at the same time that the AMS was refusing to accept money from the military.

The AMS meeting in San Antonio was the first meeting in many years where serious questions of science policy were argued publicly. The debate has been intense and enlightening. I hope that it will continue.

Statement of Steven Weintraub

I was a participant in the panel discussion of military funding of mathematics sponsored by the Science Policy Committee at the AMS meeting in San Antonio. As a contribution to the long overdue public debate on this important issue facing the Society, I would like to offer my statement there (somewhat revised in light of both the panel session and other events and discussions at the meeting) for publication in *Notices*:

I would like to make it clear that my remarks are directed at actions of the Society and what I consider to be the best interests of the mathematical community as a whole and not at actions of individual mathematicians. I am not trying to impose my views of whom one should or should not apply to for support on my colleagues, and certainly do not feel I have the right to do so.

My argument has two parts. The first is that the solicitation and acceptance of funds from the military constitute political acts by the Society. The second is that reliance on such funds poses a threat to the long-term health of mathematics. I shall discuss these in turn.

Both in theory and in practice the Society has been and is concerned with matters affecting mathematics and mathematicians. What are matters of concern for the Society? To some extent everything affects mathematics. However, in its past actions the Society has consistently adopted a narrow view of what its proper concerns are. It has consistently declined to take positions on broad societal issues, such as whether or not the Department of Defense (DOD) should be supported. In any case, I have not heard any of the proponents of military funding of mathematics arguing their case by saying that the DOD is an institution worthy of our support and we should therefore help it in its activities. Instead, they argue that endorsing and promoting such support and lobbying members of Congress and DOD officers for its increase are apolitical acts, not implying approval of the DOD, and that it is the opponents of military funding who are injecting invalid political considerations into the argument.

I claim that solicitation and acceptance of support from the DOD imply support of that agency and hence are political actions. Let me prove this by showing that its negation—the statement that soliciting and accepting funds from the DOD do not imply support of the DOD—is false. I can't imagine any way of deriving this statement other than as a special case of the theorem "Soliciting and accepting funds from X do not imply support of X," where X is arbitrary. Can anyone really maintain that? Let's let $X =$ the Third Reich. I am sure that there is nobody in this room who would accept a grant of any sort from the Nazis. Why? Because everybody realizes that doing so *would* imply support of them.

Here is another disproof. The David Report [R, p. 612] cites as one of the benefits of mathematical research its contribution to the development of the MX missile. Now let us imagine that a prodisarmament group were to issue a report citing the very same contribution as evidence for its view that, on the whole, mathematical research has been to the detriment of society and that support for it should be cut. I'm sure that many of the same people who now claim that the David Report is apolitical would loudly claim that this other report represents an inadmissable intrusion of politics into the question of support of mathematics. Well, you can't have it both ways. Either neither is political or both are.

In all of the various reports that have appeared in *Notices* in the past few years, there is exactly one mention of the fact that a relationship between mathematics and the military is one that some mathematicians might and do object to. That one instance is due, to his credit, to Mr. David himself. In a speech he made at the annual meeting in 1984, he said, [N, p. 144] "I realize that opinions differ on association with DOD but in my view the situation is doing great harm to both parties." In this regard I must confess that I am angry about the way the Council of the AMS has operated. The AMS is in theory a representative democracy. Yet the Council endorsed the David Report, a report it had to know was in part controversial, in August 1984, *before the membership even had a chance to know what it contained*—it was first published in the August and October 1984 issues of *Notices*.

If the AMS wishes to broaden its perspective and consider more general issues, it is of course free to do so. Indeed, discussions at the meeting seem to indicate that many members of the Society are in favor of a broader perspective. However, what is in my opinion not legitimate is for the Society to maintain its pretense of being apolitical while engaging in implicitly political acts.

The AMS has embarked on a course of actively lobbying for more money for mathematics to be appropriated to and disbursed by the DOD, without any consideration of what the DOD's activities are. I can only characterize as cynical the attitude that one shouldn't care what the source of one's funds is; one should just take the

money and run. The Society has, quite rightly, become concerned with the public perception of mathematics. I feel this cynical attitude can only affect this perception negatively. (Do we want to be seen as just another special interest group that has its hand out for money wherever it can find it?)

Let me now turn to the second half of my argument. It is that the increased reliance on support from an agency whose mission is not the advancement of mathematical research places the mathematical community in the perilous position of being increasingly dependent on that agency, its level of funding and its priorities, and increasingly vulnerable to pressure therefrom.

This argument is worded generally and is meant to apply generally, not just to the DOD. Let us consider the case of some agency A. Suppose that agency A is very interested in X, and is supporting research in mathematics Y which is relevant to X. Consider these (among many) possibilities:

> Agency A continues its interest in X and mathematics Y.
>
> Agency A continues its interest in X but decides that mathematical techniques have been useless in its analysis.
>
> Agency A continues its interest in X and feels that mathematical techniques have been a great success in its analysis, and the knowledge so obtained has set the stage for research in physics Z related to X.
>
> Agency A is still interested in X but decides that something else, X', must have a higher priority.

What is the rational course of action for agency A to pursue? In the first case it is to continue its support of mathematics, but in the last three cases it is to decrease or discontinue support of mathematics. Now suppose that the mathematical community had gotten itself into the position of being heavily reliant on funding from agency A. Question: What would be the result of this reliance? Answer: We would be left high and dry. This is precisely why I feel such reliance is "perilous."

Let us now turn to the case at hand, that of the DOD. I am claiming that increased reliance on the DOD is "perilous" for mathematics. The best evidence I can cite for my claim is in the David Report itself. In the 1960s the mathematical community *was* in the situation of being more dependent on the DOD. Then came cutbacks at both the NSF and DOD, but more sharply at the DOD, and the mathematical community suffered for its former dependency. I refer you to figures 3 and 4 of the David Report [R, p. 449]. They show that, in the decade 1966–1976, support for mathematics at the NSF decreased about 20%, while support of mathematics at the AFOSR (typical of the DOD) decreased over 50%. Why did this especially sharp drop at the DOD occur? The David Report provides the answer. I quote from [R, p. 580], discussing the period 1968–1973:

> A shift in emphasis toward direct mission relevance phased out virtually all support of pure mathematics and limited the support of fundamental applied mathematics as well.

The David Report [R, p. 586] analyzes this development as being due to "the Mansfield Amendment" and "as a result of DOD policy changes emphasizing mission-oriented research more directly." In other words, it is one of the perils cited in my resolution—different priorities, for both internal and external reasons.

Now let us turn to the question of funding. I doubt that anyone would deny that the level of defense funding has been a major political issue in the United States. Do we really want to make the level of support of mathematics hostage to the DOD budget? If defense spending were to be cut, what would be the first to go? Put yourself in the place of the Pentagon. You have to cut somewhere. Would you buy fewer tanks, fewer submarines, fewer aircraft, or fund fewer mathematicians? The answer is obvious.

Defense spending has been sharply increased in the last few years. That was a political decision. Suppose we get dependent on this high level of funding, and a political decision is made to decrease the level of DOD funding. What would happen? Again, we would be left high and dry, and again, this has happened to us in the past. To quote from the David Report [R, p. 586]:

> During the FY 1969–1974 period, Congress and the President reduced the NASA and DOD budgets substantially. The FY 1971 federal budget included a 12% cut for NASA. DOD's outlays were reduced $5.8 million. Space and defense research budgets were hard-hit by these moves. Thousands of technically trained people were affected by this change in federal priorities. An early result was an apparent oversupply of Ph.D. scientists, which motivated OMB and Congress to terminate NSF Institutional Science programs and to approve cutbacks and phase-outs of graduate student support programs.

If one reads *Notices* for the past two years, one sees the same pattern continuing. The Society has been quite successful in increasing NSF funding of mathematics, but great efforts at the DOD have borne little fruit. In addition to generally increasing its support of mathematics, in view of our situation the NSF specifically exempted mathematics from Gramm-Rudman budget cuts, while of course the DOD did nothing of the sort. Indeed, the record shows that despite strenuous efforts to convince the DOD that it should be

supporting basic, long-term research, it persists in being more interested in short-term, mission-oriented research.

To propose increased reliance on a source of funds without worrying about the long-term reliability of that source is short-sighted, and infinitely more so when that source has been unreliable in the past. In first citing this unreliability of the DOD and then proposing increased reliance on it, the David Report is hardly displaying the sort of logical thinking we mathematicians pride ourselves on.

Of course, being supported by the NSF makes us dependent on the level of NSF funding, but at least there the decision about the level of funding of that agency will be made on how much scientific research is valued, not on the value of the activities of some agency whose mission lies elsewhere. (In the case at hand, the NSF budget has been much less a political issue than the DOD budget.)

Now I come to my last point, that of potential pressure. I don't think I have to argue the point that dependence on funds from agency A implies vulnerability to pressure from agency A. What happens if agency A then starts to apply pressure on mathematicians to support the actions and policies of agency A, or makes the level of such support a factor in deciding to whom grants should be awarded? In case you think I am being paranoid, and that no agency would ever operate that way, I've got news for you—it's already been tried, with A = DOD. I quote from a news article in *Science* about Donald Hicks, then Under Secretary of Defense for Research and Engineering [S, p. 444]:

> In a recent interview with *Science*, Hicks was asked if he really meant that only those who agreed with the agency should receive its funds. "Absolutely," he said. "What I'm saying is that the Department of Defense is given money for *defense*. Those who want to accept money to help us with the programs we need, we want to have. But I don't particularly view it as appropriate when somebody says we don't like the way you're running the department but we sure like your money."...
>
> "If they want to get out and use their roles as professors to make statements, that's fine, it's a free country," Hicks said. But "freedom works both ways. They're free to keep their mouths shut...[and] I'm also free not to give the money."

This article created something of a furor, and the DOD issued a statement that Hicks's remarks were not DOD policy [S, p. 929]. True, this instance of pressure was disavowed by the DOD. However, I think it is naïve to view this disavowal as evidence for the proposition that the DOD would never do such a thing in the future. Indeed, the fact that it was tried is evidence that it may well be tried again. The "peril" cited above, of being "increasingly vulnerable to pressure," is a very real one.

In summary, by actively promoting ties with the DOD, and hence implicitly supporting the DOD, the AMS leadership is acting improperly. The attitude that the money is there now, we shouldn't care where it comes from or how long it is likely to last, we should just grab it while we can, is a cynical and short-sighted attitude that we should certainly not adopt. The prospect of an ever greater percentage of mathematical research being funded by the military is not an opportunity—it is a trap, and indeed, one we have fallen into once before. We should not make the same mistake twice.

The AMS has been successful lately in its efforts to increase support of mathematics from the NSF, efforts I applaud. Indeed, there has been a consensus among members of the Society in favor of such actions. On the other hand, there has been widespread disagreement within the Society over the question of pursuing military support. In pursuing the latter, the AMS leadership has stretched this consensus beyond its legitimate bounds and has threatened to divide the Society and weaken its voice in favor of the former.

I believe that it is in the long-term interests of mathematics to have our support concentrated at the NSF. Even many mathematicians who see nothing wrong with military funding of mathematics agree that civilian funding would be preferable. (However, the argument that is sometimes made that for the present we should pursue both but hope in the long run the balance shifts to the latter is a self-contradictory one. The surest way to preclude future change is to work hard for the maintenance of the status quo.)

The AMS should adopt a policy of promoting the transfer of support of mathematics from the military to the NSF. It should refrain from lobbying for increased DOD funding of mathematics but continue its efforts in favor of increased NSF funding. (Pushing on one side of a scale and leaving the other side alone will tend to tip the balance.) This transfer of funding may well be a long-term proposition. The Society's argument for additional federal funding of basic research is that while it may not yield short-term benefits, it will pay off in the long run. The Society should apply this argument to its own activities as well.

References

[N] *Notices of the AMS*, 1984.

[R] "Renewing U.S. Mathematics: Critical Resource for the Future," *Notices of the AMS*, 1984, pages 435–466 and 570–616.

[S] *Science*, vol. 232 (1986).

Challenges to the Mathematics Community

William R. Graham

Tonight I want to talk to you about two subjects, both critical to the health of American science and engineering and both involving mathematics and mathematicians.

The first subject is one that in the past decade has aroused a great deal of passion in many of you. In the past few years, it has also aroused considerable action. That subject is our national investment in mathematics research; in our mathematics of the future. It seems evident now that we've not been fully attentive to research opportunities in mathematics over the past 20 years. As many of you have told me and as I've noted myself, part of the problem stems from the failure of the math community to justify greater national investment.

Tonight I can offer you the perspective of someone who has had the opportunity to listen to and grapple with proposals from the science community for support in areas of high opportunity. Of course there are always more requests than there is support. More requests for support than there are resources available. The left-hand side of this inequality is good news—mathematics is an idea-rich environment. The right-hand side—resources—will always be scarce. In fact, economists say that resources are by definition scarce. But the level of those resources is in the long run up to you.

To a large extent, policymakers in Washington do their job by balancing opportunities and very rarely do they go out and "beat the bushes" to encourage even more pressure for scarce funds. The result, as we've all seen, is that support for mathematics has fallen behind support for many other disciplines.

I've heard an occasional rationalization that it's difficult to engender support for mathematics because at the forefront mathematics is such an arcane set of disciplines and fields. I usually tell people who make that statement to look into something called the gravity probe "B" experiment in physics. It's an experiment to test some of the aspects of general relativity—not the easy ones—like the time valuation and different gravitational potentials that were already checked by gravity probe "A" and everything seemed to work just fine. So far Einstein is right on. Gravity probe "B" is to check some of the general relativistic effects that occur when you have a gravitating mass that's rotating rapidly, and the experiment is designed to use the earth as that rotating mass and a satellite to do the checking. This is an experiment that measures some very arcane terms in general relativity, and the experiment itself has to have accuracies in the vicinity of one part in ten to the tenth. At least that's the right order of magnitude in the exponent to see the kinds of effects they're looking for from 10 to 20 arc seconds of angle in a year of satellite orbital time.

At the invitation of the AMS Committee on Science Policy, William R. Graham, Science Adviser to President Reagan, presented this address at the 1987 Joint Mathematics Meetings, San Antonio, Texas, January 21, 1987.

In Washington when I talk to businessmen, politicians, accountants, people who are interested in the space program but have very little technical background—much less a background in general relativity—I'm pleased to report to you that those people are almost universally in favor of and strongly in support of gravity probe "B". That is not because they have a deep understanding of general relativity, it is because they're interested in technology. And Bill Fairbanks and Francis Everett and other people in Stanford who are working this experiment have gone to considerable care to make sure that people in Washington and elsewhere understood what gravity probe "B" was all about. And I'll just assert that if gravity probe "B" can engender that much interest, anything in mathematics can engender an equal level of interest if you make an equal level of effort to get people interested in it.

Fortunately, some of that has been happening. The pattern in our national investment in mathematics began to change a few years ago in large measure as a consequence of the growing unity of purpose on the part of your community. The Committee on Science, Engineering, and Public Policy, known in Washington as COSEPUP, and their report in 1982 was an important element of that resurgence. So was the David Report chaired by one of my predecessors, Ed David, which helped show the degree to which the gap between opportunity on the one hand and

funding in mathematics on the other threatened progress in science and technology. And please note that I refer to the gap in terms of lost opportunities or at least delayed opportunities which at a given point in time amount to the same thing.

One of the lessons of the '80s has been that the most persuasive arguments for Federal support for research are those that characterize the benefits that will ultimately be returned to the taxpayer, even when those benefits are somewhat diffused and certainly long-term. That approach has been difficult for many scientists, as they've been conditioned by a kind of academic isolationism which has led to the view that any claims to the utility of their work are a potential threat to its integrity or its other scholarly characteristics. That's not true, and happily it's been changing as many of you found it healthy to think about your own work and its reason for deserving public support. It is possible to develop sound, persuasive arguments that are entirely consistent with the rationale for why we do research.

Federal Government support for science itself is changing. In fact, there's an interesting analogy. Mathematics is commonly accepted not only as a discipline in itself but as the universal language of science—a key enabling discipline. I think a professor of mine, Richard Feynman, said it best. He said, "I'm sorry some people find it difficult to learn math, but if you want to understand nature you must be conversant with the language in which nature speaks to us."

In a similar vein, the nation increasingly sees science, particularly basic research, as the enabling element for our national economic competitiveness and for our security as a free and leading nation. That fundamental point has influenced Federal policy in science for much of the '80s, and I can't emphasize that too strongly. It's been the dominant reason for the rapid growth and support for science and technology, especially for science and technology at the universities, where our greatest talent in basic research lies today. And, likewise, persuasive arguments for support for mathematics are both the manifest intrinsic value of the field and its links to the rest of science.

Let me take a few minutes to describe the overall situation because I think it's important to understand both the forces and the directions evident in the Administration's science policy in order to see how mathematics fits in.

First, I hope it's no longer necessary to convince the scientific community of this Administration's strong commitment to basic research, which it has consistently backed up with increasing levels of funding for the last six years.

Just two weeks ago, the President sent his fiscal year 1988 budget to Congress. The President made it clear, probably clearer than ever, that he sees his strong program for support of science as a key element in restoring American industrial competitiveness. You'll hear more about this in the State of the Union address. He continues his insistence that the best way to compete is to take advantage of our inherent technical and other strengths, not to look to short-term political solutions, and not to pursue the fantasy that we can protect and isolate our industries and our markets from foreign competition without doing ourselves grave long-term harm.

For 1988, we're requesting more than $9 billion for basic research. That represents more than a 50 percent increase in Federal support for basic research since 1982. And when we consider that inflation has been held relatively low during that time, we get a sense of the impact that support has been having. Without a doubt, basic research remains one of the highest priorities of this Administration.

I would call particular attention to the National Science Foundation, which not only embodies Federal support for basic research, but which has also been a primary focus for mathematics. For 1988, the President has proposed an increase of nearly 18 percent for the National Science Foundation—the latest in a series of consistently large annual increases during the 1980s. Moreover, the President stated his intention to request support for NSF that would, by 1992, only five years from now, triple the 1980 level of our annual investment for basic research. And while, short of a Constitutional amendment, the President that we have now won't be in office in 1992, there is a budget process which projects each year the budget out in five years, and we will incorporate that increase in the five-year budget and pass it on to the President's successor. On the basis of recent history, I believe that such a tripling can and will happen. If there's any sign that they're not staying the course, talk to the next President's Science Adviser.

Support for mathematics will continue to grow as well, although the detailed numbers for 1988 haven't been released yet, it looks as if we're seeing more than a doubling of NSF support for math since 1982. That far exceeds the growth rate even for basic research in general.

In addition, and this is an important point, the Defense Department is finally coming up to speed in providing its own independent support for university research. I would point at particular to DARPA, the Defense Advanced Research Project Agency's new mathematics program, as an example of renewed DOD commitment to basic science. And I'd add that this is a healthy sign—recognition by the DOD that national security depends to a large extent on the quality of U.S. science and technology and on the quality of

people who are trained in science and technology, and that certainly includes mathematics. DOD has been pulling less than its share of support for basic research and universities in recent years, and I'm glad to see a movement in the right direction.

As you know, there have been a couple of very visible programs at NSF that have grown quickly in recent years, and I refer particularly to the mechanisms developed to reflect the growing potency of multidisciplinary research to attack problems that transcend any one area of science. In 1988, NSF is planning to spend $48 million for continuing support to eleven existing engineering research centers and to permit four or five more to begin. And that's not the full economic measure of the support to these centers because the NSF provides the minority of center support—the majority coming from a combination of local and regional governments and private industry and foundations. At the same time, NSF plans to spend $50 million in 1988 on new science and technology centers. That should result in at least five to ten of those new research centers, and they too will emphasize multidisciplinary research and they will involve cooperation of industry, regional government, and other funding organizations.

When the engineering research centers were first started, it was already clear that similar mechanisms were needed in science as well, and that's what we're proposing in the science and technology centers in 1988.

I want to emphasize, however, that support for interdisciplinary activities should not be at the expense of resources for basic research in the fundamental sciences. But I'd also like to emphasize that the mathematics community should play an increasing role in the activities of these interdisciplinary research centers. Certainly mathematics, as the enabling science for many activities, should be deeply involved in these multidisciplinary activities. And I think you'll find professionally many of your colleagues in other disciplines interesting and stimulating to work with.

I said at the outset of my remarks that I wanted to address two issues. The second is not so much the state of mathematics research in this country as it is the state of mathematics itself. My feeling is that as long as we sustain the growing emphasis on basic research, now in its sixth year, and as long as the math community remembers to speak up for itself, then we should be able to expect a steady restoration of research resources for mathematics. I don't mean to minimize this problem, but we now have a momentum and we should be able to maintain it if you're diligent.

The other problem is more difficult, and it's one that we can't solve through Federal programs. There are two kinds of mathematics—they're coupled certainly—but one is the science of mathematics, the kind of research effort that many of you here are engaged in. The other is mathematics as the sophisticated instrument whose applications are nearly universal. I would argue that the health of your science is going to be dependent, to a larger extent than we might think, on how successful you are in bringing the tools of mathematics to other people—other than professional mathematicians and professional mathematics educators. Because frankly the way things stand now, the vast public, even many in the sciences, don't perceive mathematics as a dynamic, evolving, powerful intellectual pursuit and scientific instrument. Why is that? Because still today, while we recognize the value of trying to motivate and teach grade school children and secondary school children with descriptions of physicists' black holes, engineers' supercomputers and aerospace planes, and biologists' genetic engineering, math is often taught abysmally—the curricula can be outdated, timid, and often boring. And many of our primary and secondary school teachers still treat math as a minefield to tiptoe through.

Worse yet, we've inherited a woefully limited set of expectations of what schools and students can accomplish. For the most part, we've been simply standing by and watching our upcoming generation of students fall further and further behind their counterparts in Europe and in Japan and elsewhere, well aware that something is seriously wrong yet unable to galvanize action to correct it.

Now, having said that, let me note some positive things that are happening. Because something important has happened in the past year and I'm delighted to say that the impetus for that action has come from your community. I viewed the establishment a year ago of a Mathematical Sciences Education Board, under the auspices of the National Research Council, as a potentially far-reaching step. To understand its importance, we have to consider what it's going to take to rework education in math in this country.

Remember that precollege education in America is a collective output of more than 15,000 independent, often fiercely independent, school districts. Overlying that structure are state governments that, to varying degrees, are able to impose broad instructional standards on their local schools. But we're dealing with 15,000 independent bodies, each with its own idea of what constitutes quality education and each heavily embroiled in the politics of education. The Federal Government provides funding for innovation and science teacher enrichment, but properly stays away from trying to run our educational system. While there can be great strength in our diversity, we, you and I and our colleagues, have obligations to ensure a sense of national expectations for progress.

Our structure for education grew as the country did, and it was essentially in place before the modern scientific era. But our own decentralized authority does not automatically link rapid changes in education to rapid changes in knowledge. It's worth taking a look at what happened in the wake of Sputnik in the '60s, because many of our resources at that time showed that we could pull together national responses that worked well. Faced with the perception of a crisis, and in fact a real crisis in some areas, leaders in science, working with teachers in schools, were able to produce and implement new curricula in a variety of sciences. And as a result, at the very least, we realized significant improvement in the preparation of high school students in physics, chemistry, and biology.

The post-Sputnik reforms offer a few lessons that we shouldn't have to learn again. First, we can devise an effective partnership between national education leadership and the Federal Government—it can be done. The government won't write curricula and won't suggest how they should be written, but the government can, as NSF did in the 1960s, encourage our national leaders in education and research to provide the kind of vision that will give the weight we need to have a coherent, intellectually unified approach to education. And certainly Federal efforts can help to identify successes and in some cases create them, successes that can then be applied by these 15,000 different districts, or some substantial part of them, in a widespread way—leverage. And states are beginning to realize how important it is to have a sound educational base if they're going to have a sound economy. That's one of the incentives that some states give to foreign manufacturers, as well as domestic ones, to move to their states, and it has certainly worked. Tennessee is a prime example of that.

Second, we should use broadly based leadership to hammer home to everyone the importance of quality in education—the importance of reflecting the changes in science and mathematics that make them dynamic fields, the importance of demanding more from our students and by extension from our schools and our parents, and the importance of putting our money where our mouths are. That is, every one of those 15,000 school districts has to decide that it's going to find good teachers, and that it's going to hold the education schools responsible for preparing their graduates to teach substance—and they're going to have to be inventive about getting these teachers. Even with the best efforts there, we're going to have to increase the productivity of our teachers as well, because we're running into demographic problems even faster with our teachers than we are with our student population.

Third, this time we shouldn't allow ourselves to think of educational reform as a crisis to be solved, because the solutions then are seen as one-time fixes. Maybe we're better off than in 1957, because we've had a decade-long sensitization in this country to our faltering schools. And if the stories about how little Pierre could do geometry in the sixth grade or about how little Kenji was spending six days a week in school studying algebra were seen as curiosities in the 1970s, they're seen as direct corollaries to our imbalance in foreign trade today. I think this country is just about ready to undertake sustained reform and upgrading of education, based primarily on the specter of economic decline. But if our reforms are based on a ten-year unease, then there's hope that we'll have the resolve to maintain a multiyear effort to cure these same problems.

And that brings me back to the subject of national leadership in the Mathematical Sciences Education Board. I see that as exactly the right kind of mechanism to work on this problem. First of all, it provides a focus for those in the mathematics community who need a channel for working on the problem of mathematics education. Second, it establishes at the outset a similar avenue for school leaders to focus efforts on reform where they're likely to be successful. Composition of the Board—which includes professors of mathematics, superintendents of education, school teachers, education school professors, and community leaders—is not, like too many such groups in the past, designed to be cosmetically representational but basically ineffective. Instead, the Board can build on the strength of that group to develop a consensus that's essential for reform.

The Board's effectiveness in catalyzing improvement in math education is going to depend on the degree of participation of the rest of us. I'm afraid that too often in the past we've either assumed that others, supposedly more expert than we in the ways of school and education or the great political geniuses in Washington, would make sure things were done right. I can't help but remember a description by the teacher of mine whom I mentioned earlier, Richard Feynman. In his book *Surely You're Joking, Mr. Feynman*, which I recommend to all of you over the age of 12 at least, he relates his experiences as a reviewer of proposed mathematics textbooks for the State of California. He found reviewing all these math books to be not only a time-consuming activity, but frustrating as well. Nevertheless, he took it seriously. He tells how he showed up at one committee meeting with his ratings in hand of a big set of books that he had reviewed. When one particular text was discussed, I believe it was a 6th or 7th grade math text, he was amazed to find that it received ratings that more or less set in the middle of the pack. How, he wondered, did that square with the fact that the copies of the book that had been sent out to the reviewers contained only pages that were completely blank—nothing

in the book. Not having enough time to run off the proofs, the publishers sent a handsomely bound version of nothing with the explanation that the text would be available soon. To Feynman's astonishment, he was the only one of the reviewers who had bothered to open the book. In fact, as it turned out, most of the reviewers didn't read the books at all. They simply rounded up other people to review them and pass along their comments. Surely if Feynman could find the time to review these books, the others could have done so too. Just think of the impact if every textbook reviewing group had someone with his kind of dedication, experience, knowledge, and insight—or your kind of dedication, experience, knowledge, and insight.

That's one place where you come in. My point is that you, as members of the scholarly community, can and should become active in this emerging push to turn around school math, in primary and secondary schools and all the way up—certainly undergraduate education as well. At all steps in the process from the first grade on, we lose enormous numbers of students who are interested in science and technology. We lose something like a factor of two or three in the number of people who claim science as their most interesting area of study, and that goes on virtually from the start. I think if you ask first graders, you find that 30 to 40 percent of them claim some area of science as the area they are most interested in. And by the time they get to the sixth grade, it's down substantially from that. And the number just keeps falling as you go through college.

It seems to me that the approach that's going to be successful in this is one that builds on both the intellectual beauty of math, which you appreciate, and on its profound applicability. Students are bored with the repetitive, traditional computational mathematics. My guess is that as parents we've all had the same kind of experience. Why is it that we have to work so hard to convince our children, or try to convince them, that math is going to be important to almost anything they undertake in later life? One reason is that the curriculum is often so divorced from the application, so they have little assurance that they're not learning some variant of Egyptian hieroglyphics—interesting to a few perhaps, but a dead language without much utility except for interpreting other dead things. Surely we can do better.

The topic "school math" is a little bit a Rorschach test. We each have our pet analyses of the problems and our pet solutions, but the problems are difficult enough that it will take many people to solve them. They won't be solved without new ideas and a lot of long-term effort. So what is needed is the participation of bright and knowledgeable people who understand hard intellectual work.

How should we use the new computers in the classroom? How should we prepare youngsters for the world that uses more abstraction, simulation, and modeling? After I became sufficiently frustrated in trying to teach one of my children fractions, in a state somewhat close to desperation, I went out and bought for our personal computer a floppy disk that claimed to talk about fractions. I gave it to her and put her in front of the computer. By golly, she learned fractions—it worked. And that wasn't a very sophisticated piece of machinery or a very sophisticated piece of software, but it was very interactive and very illustrative of what was going on.

If any single trend has characterized science and technology in this century, it has been the remarkable increase in productivity brought about by the incorporation of new tools—both physical and mental. You can't meet a scientist who doesn't have his favorite story about how some task that took him three months when he was in graduate school can now be done in thirty minutes by some combination of sensors, computers, and undergraduate capabilities.

I keep a calculator in my desk and I carry one in my briefcase as well, and when I want to compute numbers I use it. But when I want to estimate numbers which I tend to do much more of the time, I do it in my head. It seems to be a pretty good division of labor, and I don't see why we can't be preparing our students to use resources in comparable ways.

I suspect that using those means to get beyond the rote processes that still dominate math education today will also produce important benefits in allowing students to become more creative in their use of math and to discover relationships for themselves.

A friend of mine who was in the third grade was learning some of the more sophisticated aspects of addition and was being asked to add 5 to more or less all of the useful larger numbers—which in her view were 6, 7, 8, 9. The way to do that, explained my young friend, is to *subtract* 5 from the big number, then put a 1 in front of the difference. Kids like to discover.

All in all, the timing for a major effort in math reform is very good now and over the next few years. That reform becomes even more important when we remember that the number of students is dropping with each succeeding year and will continue to do so for a decade.

The impact on the field of mathematics is significant, in part because of that increasing cross-over between math and other fields that I mentioned before. People trained in math are increasingly in demand elsewhere, and that makes

it harder not just to snare the best of them for mathematics teaching and research, but also compounds the already serious problem of finding trained teachers for schools. Unless we make the teaching of math a more attractive career for well-trained people, we'll have an even greater shortage of well-trained math teachers in the 1990s. And, without question, reforms will have no chance of success without trained and enthusiastic people in the classroom to carry them out.

Here's another way you can make a real difference. Each year, 54 mathematics teachers receive the Presidential Award for Excellence in Mathematics Teaching. Find out who the winners are in your state, talk with them. You will find that they are dedicated, highly competent, and enthusiastic. And find the best ones to select next year.

I challenge you to create a range of mathematics curricula that are up-to-date in content, innovative in approach, well integrated, and highly sophisticated—but above all interesting. Let me challenge you to provide opportunities for classroom teachers to continue their own mathematics education; to become role models for our students. And most fundamentally, I challenge you to become a part of our local, state, and national policymaking process.

In short, I ask you to give some of that sacred fourth dimension—time—to a cause from which we'll all benefit.

As a community, you have taken a big first step by creating the Mathematical Sciences Education Board; now it's essential that as individuals you participate in the future of our next generation and beyond.

MATHEMATICAL REVIEWS

ASSOCIATE EDITORS

The *Mathematical Reviews* Editorial Committee invites applications and recommendations for two-year appointments as Associate Editor of **MR**, to commence as soon as possible, but no later than the summer of 1987. Applications will be welcomed from persons taking leave from other positions, and in particular from tenured faculty members who could take leave to come to **MR** for two years.

The **MR** office is located in Ann Arbor, Michigan, adjacent to the campus of the University of Michigan, and the editors enjoy many faculty privileges at the university. At present, **MR** employs eleven editors, about a dozen consultants, and over fifty noneditorial personnel. It produces *Mathematical Reviews* and *Current Mathematical Publications* and various indexes, as well as the online service *Math\Sci*. The responsibilities of Associate Editors fall primarily in the day-to-day operations of classifying articles and books, assigning these items to reviewers, and editing the reviews when they are returned. Other responsibilities evolve in accordance with the individual's experience and capabilities. At this time, no particular area of mathematical specialization is sought, although strength in applied areas is desirable. Considerable breadth in mathematics, rather than special skill, is sought. A reading knowledge of two main foreign languages is important, but not essential. (Russian and Chinese are especially desirable.)

Those interested in combining a sabbatical or other leave with a part-time or full-time appointment as an Associate Editor should write for further details. The twelve-month salary is negotiable, and will be commensurate with the experience applicants bring to the position. Retirement, insurance plans, and other fringe benefits are similar to those in universities. Of special importance is a policy providing a study leave after at least two years. This amounts to three months of full pay for each two years spent as Editor.

Applications (including curriculum vitae, bibliography, data on experience, and names and addresses of three references) and recommendations should be sent to Dr. R. G. Bartle, Executive Editor, *Mathematical Reviews*, P. O. Box 8604, Ann Arbor, MI 48107. Telephone 313-996-5250. Those interested in applying for this position are urged to inquire immediately.

Mathematical Reviews is an equal opportunity employer.

Second Report

A first report of the 1986 Survey appeared in the November 1986 *Notices*, pages 910–938. It included a report of the survey of faculty salaries, tenure, and women, a first report of the survey of new 1985–1986 doctorates, and a list of the names and thesis titles of the 1985–1986 doctorates included in the Survey. This second report includes an update of the fall 1986 employment status of new doctorates, an analysis of faculty mobility, and a report on fall 1986 enrollments and class sizes.

The 30th Annual AMS Survey was made under the direction of the Society's Committee on Employment and Educational Policy (CEEP), whose members in 1986 were Stefan A. Burr, Edward A. Connors, Philip C. Curtis, Jr., Gerald J. Janusz, and Donald C. Rung (chairman). A Data Subcommittee of CEEP, consisting of Lida K. Barrett, Edward A. Connors (chairman), Lincoln K. Durst, James W. Maxwell (ex officio), Donald E. McClure, and Donald C. Rung, designed the questionnaires with which the data were collected. The committee is grateful to members of the AMS staff, especially Marcia C. Almeida, for the diligence and efficiency with which the data were collected and compiled. Comments or suggestions regarding this program may be directed to the subcommittee.

Employment of New Mathematical Science Doctorates Faculty Mobility, Employment Trends, Enrollments and Departmental Size, Fall 1986

by Edward A. Connors

I. Introduction and Overview

We present patterns of employment for new doctorates in the mathematical sciences (commencing with an update of the employment status of the 1985–1986 class) and we analyze trends in the academic job market based on the 1986 AMS Survey of Faculty Mobility (30th Annual). We also provide estimates for course enrollments, majors, graduate students, and faculty in the mathematical sciences as extrapolated from the data gathered from returns of the 1986 AMS Survey on Enrollments and Departmental Size. Our extrapolation methodology is described below in the section headed "A Comment on our Extrapolation Methodology." The Mobility and Enrollments Surveys requested data for fall 1985 and fall 1986, so we have data for consecutive years from the same population. We attempt to survey all four-year college and university departments in the mathematical sciences (see below for the response rates in the various groupings). The Mobility section of the survey has three parts (Size of Faculty, Faculty Entering Department, and Faculty Leaving Department) and we use the data reported only if all three responses are useable. However, the Enrollments and Departmental Size survey form has four parts (Course Enrollments, Majors, Departmental Size, and Graduate Students) and we treat each of the parts as a separate entity as to its useability. Note that useable responses to the Mobility Survey came from 75% of Groups I–III combined, 64% of Group IV, 49% of Group M, and 37% of Group B.

Groups I and **II** include the leading departments of mathematics in the U.S. according to the 1982 assessment of Research-Doctorate Programs conducted by the Conference Board of Associated Research Councils in which departments were rated according to the quality of their graduate faculty.[1]

Group I is composed of 39 departments with scores in the 3.0–5.0 range.

Group II is composed of 43 departments with scores in the 2.0–2.9 range.

Group III contains the remaining U.S. departments reporting a doctoral program.

Group IV contains U.S. departments (or programs) of statistics, biostatistics and biometrics reporting a doctoral program.

Group V contains U.S. departments (or programs) in applied mathematics/applied science, operations research and management science which report a doctoral program.

Group Va is applied mathematics/applied science; **Group Vb** is operations research and management science.

Group VI contains doctorate-granting departments (or programs) in the mathematical sciences in Canadian universities.

Group M contains U.S. departments granting a master's degree as the highest graduate degree.

Group B contains U.S. departments granting a baccalaureate degree only.

[1]These findings were published in *An Assessment of Research-Doctorate Programs in the United States: Mathematical and Physical Sciences*, edited by Lyle V. Jones, Gardner Lindzey, and Porter E. Coggeshall, National Academy Press, Washington, D.C., 1982. The information on mathematics, statistics and computer science was presented in digest form in the April 1983 issue of *Notices*, pages 257–267, and an analysis of the above classifications was given in the June 1983 *Notices*, pages 392–393.

We regard as significant the relative increase of new women doctorates hired by the doctorate-granting institutions in Groups I–III. More specifically, 18% of all hires of new doctorates in Groups I–III were from the class of new women doctorates—this compares to 13% last year and, approximately, 10% for each of the three previous years. In fact, among all U. S. doctorate-granting institutions in the mathematical sciences (Groups I–V) new women doctorates represent 19% (40/208) of all new doctorates hired. Women doctorates comprise 17% of the new doctorates (140/801).

Useable Responses

	I	II	III	IV	V	VI	M	B
Enrollments and Departmental Size*	29	34	62	48	9	19	148	350
Faculty Mobility	29	33	54	44	9	14	129	361

*There are 4 parts to the Enrollments and Departmental Size Form (Enrollments, Majors, Departmental Size, and Graduate Students). The number given is the number of returns with a useable response on the departmental size.

Useable Responses (Percentage of Population)

	I	II	III	IV	V	VI	M	B
Enrollments and Departmental Size*	74	79	85	70	15	66	56	36
Faculty Mobility	74	77	74	64	15	48	49	37

*As Above.

New Doctorates
Fall and Spring Counts

	1982-1983	1983-1984	1984-1985	1985-1986
Fall	792	789	769	801
Spring	840	827	807	827

New Doctorates
U.S. Institutions Spring Count

1982-1983	1983-1984	1984-1985	1985-1986
796	775	765	782

New Doctorates
Awarded by Groups I–Va, VI Spring Count

1982-1983	1983-1984	1984-1985	1985-1986
767	735	755	743

Table 1A: 1985-1986 Employment Status of New Doctorates in the Mathematical Sciences

Type of Employer	PURE MATHEMATICS: Algebra and Number Theory	Analysis and Functional Analysis	Geometry and Topology	Logic	Probability	Statistics	Computer Science	Operations Research	Applied Mathematics	Mathematics Education	Other	Total
Group I	19	20	23	1	1	3	2	0	16	0	4	89
Group II	5	4	8	0	2	1	0	0	11	0	3	34
Group III	4	9	8	3	1	7	1	1	10	1	2	47
Group IV	0	0	0	0	4	29	0	0	0	0	3	36
Group V	0	2	0	0	1	4	1	4	6	0	1	19
Masters	10	8	9	3	0	10	2	2	14	0	4	62
Bachelors	11	16	8	8	3	5	2	2	9	0	2	66
Two-year College or High School	1	1	0	0	0	0	0	1	0	1	1	5
Other Academic Departments	1	3	1	1	2	19	2	15	12	0	11	67
Research Institutes	4	3	0	0	0	5	0	1	2	0	1	16
Government	1	0	2	1	0	9	0	3	6	0	5	27
Business and Industry	4	7	1	1	2	32	4	15	22	0	21	109
Canada, Academic	4	5	2	1	0	4	0	1	6	0	1	24
Canada, Nonacademic	1	0	1	0	0	1	0	0	2	0	0	5
Foreign, Academic	17	20	6	2	3	19	0	4	14	0	6	91
Foreign, Nonacademic	6	6	3	2	5	14	2	11	9	0	7	65
Not seeking employ.	1	1	1	0	0	5	0	0	1	0	0	9
Not yet employed	5	0	2	0	1	3	0	1	5	0	0	17
Unknown	3	2	1	0	1	1	0	1	4	0	0	13
Total	97	107	76	23	26	171	16	62	149	2	72	801

For the first time our survey asked for data on citizenship of graduate students. We requested data for fall 1985 and fall 1986 on citizenship of all graduate students and first-year graduate students, with answer options given as U.S., Canada, other, and unknown. In Groups I–III combined, U.S. citizens comprise 53% of all graduate students, and of first-year graduate students, whose citizenship was reported as known for fall 1986 (see Table 8). The raw data show an increase of U.S. citizens from fall 1985 to fall 1986 in both the first-year and total graduate student populations.

For the second consecutive year we report a decrease in total enrollments in courses taught by mathematical science departments, with a good share of the decrease resulting from a drastic decline in computer science courses. Graduate student numbers are up both for first-year and all graduate students across the board, but the number of junior-senior majors is down (see Tables 5, 6, and 7). The decline in computer science enrollments (within mathematical science departments) can be explained, we feel, by the continued creation of separate computer science departments, and the continued decline in interest in computer science careers and concentrations among entering freshmen. For example, the Higher Education Research Institute's survey of over 200,000 freshmen at 372 institutions reports that 3.5% of all surveyed reported an interest in pursuing computer careers as compared to 8.8% who so reported in 1982 (*Chronicle of Higher Education*, January 14, 1987, vol. XXXIII, no. 18, page 38).

Summing over columns of the updated employment matrix shows that of the 801 new doctorates (fall count), 171 (21%) specialized in statistics, 149 (19%) specialized in applied mathematics, 62 (8%) specialized in operations research, and 16 (2%) specialized in computer science. All told, 398 (50%) of the new doctorates are in statistics, applied mathematics, operations research, or computer science. (See Table 1B for the comparable data for the last four surveys.)

Government employment of new doctorates is nearly double that reported last year (27 compared to 14), while the total number employed by business or industry is virtually identical (109 to 108).

Part-time faculty continue their significant role in undergraduate instruction in departments in Groups M and B at roughly the same level of participation as last year. Here we have an estimated 5,270 part-time faculty (909 doctorate holding, 4,361 nondoctorate holding). In contrast, 966 part-time faculty are utilized by Groups I, II, and III combined, and approximately half of these are in Group III. If we examine the total faculty staff reported, we find that Groups B and M both report 29% part-time faculty. In contrast, Group I reports 9%, Group II reports 13%, and Group III reports 21%. We alert the reader to a forthcoming report of the MAA Committee on Teaching Assistants and Part-Time Instructors, chaired by Professor Bettye Anne Case of Florida State University, and to the CBMS 1985 Survey, chaired by Professor R. D. Anderson of Louisiana State University.

Estimates based on AMS Survey data suggest a shortfall in the number of doctorates needed for academic positions in the mathematical sciences. This shortage is most felt by the Group M and B institutions where we estimate that, of 560 new positions filled by nondoctorates, the departments would have preferred to fill 337 with doctorate-holding faculty. Of the 609 new positions filled by nondoctorate faculty in all U.S. colleges and universities (excluding Group V), the department would have preferred to fill 357 with doctorate-holding faculty.

We estimate the full-time faculty in Groups M and B combined to be 13,324 (an increase of 272 from fall 1985). Groups I–IV combined contain, we estimate, 6,719 full-time faculty (an increase of 93 over fall 1985). Tables 1A–1C provide the doctorate-nondoctorate breakdown. Thus, exclusive of Group V, we estimate the total U.S. mathematical sciences faculty to be approximately 20,000, of which approximately 15,600 hold doctorates.

Continuing the policy enunciated in the first report of the 1983 Survey, the survey no longer contains data from departments of computer science. The limited response from these departments made reliable estimates difficult. For the third year, returns from Group V departments were too small to be included. This survey, then, is an analysis of what might be called the traditional mathematics and statistics community. Because the response rate in the remaining groups continues at a high level, this year's survey gives a fairly accurate picture of faculty mobil-

Table 1B: Fields of New Doctorates*

	Year surveyed			
	1982–1983	1983–1984	1984–1985	1985–1986
Number (Full Count)	792	789	769	801
Specialty:				
Applied Math	103 (13%)	110 (14%)	115 (15%)	149 (19%)
Statistics	188 (24%)	173 (22%)	189 (25%)	171 (21%)
Operations Research	63 (8%)	66 (8%)	41 (5%)	62 (8%)
Computer Science	18 (2%)	20 (3%)	15 (2%)	16 (2%)
Total	372 (47%)	369 (47%)	360 (47%)	398 (50%)

ity, enrollments, etc., within this community. It should be noted that while departments of computer science are not included in the survey, many departments of mathematics in Groups M and B teach computer science.

II. A Comment on Our Extrapolation Methodology

The numbers in Tables 2–8 were obtained by extrapolation from the AMS Surveys and are not actual counts. The various reported totals for each group were multiplied by the ratio of the size of the faculty in that group (obtained by adjusting the comparable number given in the 1980 CBMS Report) to the number of faculty members in the responding departments, as provided on the forms submitted. We illustrate with some examples of computations and estimates from this year's survey.

We begin with our estimate of the number of full-time faculty in Groups I, II, and III combined. This number was estimated to be 5,845 in fall 1985, based on the 1980 CBMS number and adjusting yearly with AMS Survey data as follows. We received useable answers to the Faculty Mobility Survey from Groups I, II, and III, reporting 4,307 full-time faculty for fall 1985. The ratio of 5,845 to 4,307, or 1.36, is our extrapolation index for Groups I, II, and III on the mobility issues of this report. For example, they reported 131 new doctorate faculty as coming directly from graduate school, so we extrapolate to 178 (as reported

Table 2A: Faculty Flow 1985-1986 To 1986-1987

Full-Time Doctorate-Holding Faculty in 155 Doctorate-Granting Mathematics Departments in the U.S. (Groups I, II, III)

Sources of New Faculty

From	Nontenured	Tenured
Graduate school	178	
Faculty position in another U.S. or Canadian college or univ. dept.	140	39
Business, industry, or government in the U.S. or Canada	4	
Outside the U.S. or Canada	52	5
Other sources (e.g., part-time in same dept.)	7	8
Total in	381	52

Faculty Leaving

	Nontenured	Tenured
To ACADEMIC employment in the U.S. or Canada in:		
Depts. granting doctorate in math. sciences	110	33
Other four-year college or university position	48	15
Two year college	4	
Other	15	7
Total Academic	177	55

Faculty Leaving (continued)

	Nontenured	Tenured
To NONACADEMIC employment in the U.S. or Canada:		
In the math. sciences, in other science, or in engineering	30	7
Other	3	4
Total Nonacademic	33	11
To OTHER:		
Currently seeking professional employment	7	
Obtained a position outside the U.S or Canada	16	3
Either retired (and do not seek employment) or have died	4	52
Returned to graduate or professional school	3	
Status unknown/other	5	3
Total Other	35	58
Total out	245	124

Received doctorate and not moving	12 (tenure status unknown)
Received tenure and not moving	110

Estimated size of full-time faculty, Fall 1986 Groups I–III

Doctorate, Tenure status unknown	12	
Doctorate, Nontenured	1281	(+26 from Fall 1985)
Doctorate, Tenured	4242	(+38 from Fall 1985)
Total Doctorate Faculty	5533	(+76 from Fall 1985)
Nondoctorate faculty	396	(+10 from Fall 1985)
Total full-time faculty	5931	(+86 from Fall 1985)

in Table 2A, Faculty Flow for Groups I, II, III). As a check we observe that the updated employment matrix (Table 1A) reports that 170 of the new doctorates were employed by Groups I, II, and III. However, our knowledge of a few institutions that did not respond to the new doctorate survey leads us to suspect that the employment matrix total would almost exactly match the extrapolated total if responses were complete.

Useable responses on the departmental size portion of the Enrollments and Departmental Size Survey report 4,695 full-time faculty in Groups I, II, and III, and hence an index of 5,845/4,695, or 1.24. However, there were 125 useable responses to the enrollments portion. Thus, we extrapolate the reported enrollment data for Groups I, II, III by multiplying the raw data reported by the product of 1.24 and 125/121. Similarly, for the majors portion of the survey (119 useable responses) and for the graduate students portion (97 useable responses).

III. Comments and Observations on the Fall 1986 Employment Status of 1985–1986 New Doctorates

Table 1A contains the fall 1986 employment status by type of employer and field of degree for 801 new mathematical sciences doctorates who received the degree between July 1, 1985, and June 30, 1986. The names of these 801 new doctorates and the titles of their doctoral theses were published in the November 1986 *Notices*, pages 924 to 938. Table 1A updates the corresponding table on page 920 of the November 1986 *Notices*, using more

Table 2B: Faculty Flow 1985-1986 To 1986-1987

Full-Time Doctorate-Holding Faculty in Group IV

Sources of New Faculty

From	Nontenured	Tenured
Graduate school	22	
Faculty position in another U.S. or Canadian college or univ. dept.	19	7
Business, industry, or government in the U.S. or Canada	5	
Outside the U.S. or Canada	2	2
Other sources (e.g., part-time in same dept.)	1	
Total in	49	9

Faculty Leaving

	Nontenured	Tenured
To ACADEMIC employment in the U.S. or Canada in:		
Depts. granting doctorate in math. sciences	14	3
Other four-year college or university position	6	
Two year college		
Other	1	
Total Academic	21	3

Faculty Leaving (continued)

	Nontenured	Tenured
To NONACADEMIC employment in the U.S. or Canada:		
In the math. sciences, in other science, or in engineering	7	2
Other	1	
Total Nonacademic	8	2
To OTHER:		
Currently seeking professional employment	1	
Obtained a position outside the U.S or Canada	6	
Either retired (and do not seek employment) or have died	0	9
Returned to graduate or professional school	0	
Status unknown/other	0	
Total Other	7	9
Total out	36	14

Received doctorate and not moving	1
Received tenure and not moving	20

Estimated size of full-time faculty, Fall 1986 Group IV

Doctorate, Tenure status unknown	1	
Doctorate, Nontenured	240	(− 7 from Fall 1985)
Doctorate, Tenured	528	(+15 from Fall 1985)
Total Doctorate Faculty	769	
Nondoctorate faculty	19	(− 2 from Fall 1985)
Total full-time faculty	788	(+ 7 from Fall 1985)

recent information provided by departments and the recipients of the degrees. Note that 801 is the fall count for 1985–1986 and does not include the additional recipients who were reported too late to gather employment information for these reports, but who are included in the spring count for 1985–1986. (A supplementary list of recipients appears in this issue of *Notices*.)

The first five rows in Table 1A refer to those 1985–1986 new doctorates employed by doctorate-granting departments in the U.S. The next two rows refer to those employed by U.S. mathematical sciences departments which grant master's and bachelor's degrees as the highest degree, respectively. The remaining row designations are self-explanatory.

Academic Employment

There was an increase over last year in the hiring of new doctorates by U.S. doctorate-granting departments (225 versus 206) with a marked increase in Group IV (36 versus 19). The decline in hiring of new doctorates by Group III (47, down from 59) is tempered by the realization that only 39 were hired two years ago. Note that these comparisons are derived from the updated employment matrices which appear annually in the February or March issue of these *Notices*. Fewer new doctorates were hired by Groups M and B than last year (128 versus 138) but approximately 337 positions that M and B departments intended for doctorate holders were filled by nondoctorate faculty. It seems that job prospects for new

Table 2C: Faculty Flow 1985-1986 To 1986-1987

Full-Time Mathematical Sciences Faculty in Groups M and B

Sources of New Faculty

From	Doctorate	Nondoctorate
Graduate school	151	236
Faculty position in another U.S. or Canadian college or univ. dept.	394	126
Business, industry, or government in the U.S. or Canada	47	57
Outside the U.S. or Canada	35	5
Other sources (e.g., part-time in same dept.)	62	136
Total in	689	560

Faculty Leaving

	Doctorate	Nondoctorate
To ACADEMIC employment in the U.S. or Canada in:		
Depts. granting doctorate in math. sciences	50	12
Other four-year college or university position	173	109
Two year college	7	15
Other	17	62
Total Academic	247	198

Faculty Leaving (continued)

	Doctorate	Nondoctorate
To NONACADEMIC employment in the U.S. or Canada:		
In the math. sciences, in other science, or in engineering	47	69
Other	10	10
Total Nonacademic	57	79
To OTHER:		
Currently seeking professional employment	17	30
Obtained a position outside the U.S or Canada	10	7
Either retired (and do not seek employment) or have died	67	102
Returned to graduate or professional school	7	69
Status unknown/other	32	55
Total Other	133	263
Total out	437	540

Received doctorate and not moving	99
Received tenure and not moving	
Doctorate	270
Nondoctorate	47

Estimated size of full-time faculty, Fall 1986 Groups M and B

Doctorate holding	9295	(+351 from Fall 1985)
Nondoctorate faculty	4029	(− 79 from Fall 1985)
Total full-time faculty*	13324	(+272 from Fall 1985)

* Last year's total of 13,052 is reported correctly in the table, but it is misprinted as 13,502 in the text on p. 293.

doctorates in the mathematical sciences are very good in Groups M and B, especially if academic and teaching strengths are complemented by an ability to teach statistics and computer science.

As reported earlier, new women doctorates comprise 18% of the new doctorates employed by Groups I–III (compared to only 13% last year and 10% each of the three previous years). Among all U. S. doctorate-granting institutions (departments or programs) 19% of new mathematical science doctorates were women. Although the percentage of women among all new doctorates is 17%, we caution that the apparent gain is relative only—only 140 of 801 new doctorates were awarded to women. In Groups I–IV, M, and B, the percentage of new women doctorates to all new doctorates hired is: Group I (13%), Group II (26%), Group III (21%), Group IV (25%), Group M (19%), and Group B (21%).

The number of new doctorates accepting Canadian academic positions increased slightly over last year (24 versus 22), whereas the number accepting foreign, non-Canadian academic positions decreased (91 from 96).

Faculty Mobility

This part of the Annual Survey is concerned with the numbers and sources of newly hired faculty and the employment status of the recently departed. We monitor trends in tenure and doctorate recipients. The response to the 1986 Faculty Mobility Survey was considerably larger than last year and larger than two years ago. The responding departments account for more than half (52%) of all mathematical sciences faculty members. Roughly 75% of the faculty in the doctorate-granting mathematics departments (Groups I–III) are represented in the responses. The relevant tables are 2A, 2B, and 2C.

Tables 2A, 2B, and 2C show estimated faculty flow between 1985–1986 and 1986–1987 for U. S. departments. A composite number for all U. S. departments, excluding Group V, may be obtained by adding corresponding rows. The left side of each table shows the estimated numbers of new full-time faculty members hired from the sources indicated between fall 1985 and fall 1986. The right side of each table shows the fall 1986 employment status of those full-time faculty members (as of fall 1985) who had permanently left their departments by fall 1986.

Combining Tables 2A, 2B, and 2C, we show an estimated increase of 423 in the size of the doctorate-holding faculty and a decrease of 71 in the nondoctorate faculty, for an overall increase of 352. Last year's net increase was 469 and the previous year's was 681. We estimate that of 606 positions filled by nondoctorates in Groups III, M, and B, doctorate-holding faculty were preferred for 355. Thus we have a pattern of replacement and/or utilization of nondoctorate faculty in lieu of doctorate-holding faculty among the vast majority of our mathematical sciences departments.

Attrition because of death and retirement was 1.2%, down from last year's 1.4% but equal to the previous year. Retirements and deaths seem to hover near 1%.

Nonacademic Employment

Table 3 presents a summary of AMS Survey data on nonacademic employment in the U.S. of new doctorates from 1979–1980 to 1985–1986. Note that the percentage of new doctorates in government/business/industry had held constant at 22% (of all new doctorates) for three years, but jumped to 24% on the strength of increased government hiring. This year 27 new doctorates

Table 3: New Mathematical Sciences Doctorates Taking Nonacademic Positions in U.S.

	1979 -80	1980 -81	1981 -82	1982 -83	1983 -84	1984 -85	1985 -86
In government	37	28	22	24	23	14	27
In business/ industry	165	169	141	105	110	108	109
Total	202	197	163	129	133	122	136
Total new doctorates employed in U.S.	691	732	659	583	597	557	577
% in govt./ bus./ind.	29%	27%	25%	22%	22%	22%	24%

Table 4: Estimated Net Outflow of Doctorate-Holding Faculty Members to Nonacademic Employment

	1979 -80	1980 -81	1981 -82	1982 -83	1983 -84	1984 -85	1985 -86
Net outflow	168	116	94	46	125	22	55

took employment with government compared to 14 last year.

Table 4 presents the estimated annual net outflow of doctorate-holding faculty to nonacademic positions since 1979. The number 55 is obtained from Tables 2A, 2B, and 2C, with the breakdown as follows. Groups I, II, III combined (net outflow of 40); Group IV (net outflow of 5); Groups M and B (net outflow of 10). The net outflow is much more than twice that of a year ago but less than half of two years ago.

Enrollments

Undergraduate enrollments declined for the second straight year but a considerable portion of the decline is tied to the shift in computer science courses taught in mathematics departments. Several of the computer science courses previously taught in mathematics departments are now being taught in rather recently created computer science departments. At the same time, there is a precipitous decline in interest in computer science as a major, especially among freshmen (see the *Chronicle* article cited earlier). There is an increase in graduate enrollments and another increase in "courses below calculus" (excluding computer science and statistics). The increase in these so-called "precalculus" and, often, remedial courses is most felt in Group B (+3%). It does seem, however, that the hitherto rapid rate of increase of precalculus and remedial courses has lessened somewhat.

IV. Summary

In summary, we report an increase over last year in the number of new doctorates in the mathematical sciences—the first such increase in several years. The percentage and absolute number of U.S. citizens among the doctoral recipients from U.S. institutions continued to decline (see the First Report of the 30th Annual AMS Survey in the November 1986 *Notices*, pages 922–923). The percentage of women among the new doctorates (including Canadian degrees) is 17% (fall count—used for consistency in comparison utilizing updated employed matrix, Table 1A). The percentage of women among the new doctorates hired by U.S. doctorate-granting institutions is 19%. The percentage of women among the new doctorates hired by Groups M and B is 20%. A significant percentage (60%) of nondoctorate faculty were hired in Groups M and B for positions for which the department indicated a preference for a doctorate holder. We project that 337 positions were so filled. In U.S. doctorate-granting departments U.S. citizens account for approximately 53% of the graduate students whose citizenship is reported as known. In Groups I, II, and III, the number of U.S. citizens among first-year graduate students is up by 6% over last year (reporting institutions are the same for fall 1985 and fall 1986). Fifty percent of the new doctorates are in the fields of statistics (21%), applied mathematics (19%), operations research (8%), or computer science (2%). We note that the percentages and the absolute numbers in applied mathematics itself are substantially up from our surveys in the early 1980s. Overall course enrollments are down slightly, but a good part of the decline is because of decreased teaching of computer science courses in mathematics departments. In Groups M and B enrollments in remedial and/or "precalculus" courses increased over fall 1985 but the rate of increase is not as great as it has been in recent years. Graduate enrollments are up in all groups and undergraduate enrollments in statistics rose by 2% in Group M.

Table 5: Total Course Enrollments for Fall 1986 (in Thousands)
(Percent increase from fall 1985 in parentheses)*

Type of Course	Groups							
	I, II, III		IV		VI		M, B	
Below calculus	285	(0%)			10	(+1%)	637	(+2%)
First year calculus	214	(−4%)			43	(+3%)	232	(−4%)
Statistics	26	(−2%)	52	(−3%)	28	(+8%)	109	(+1%)
Computer Science	13	(−27%)			4	(−10%)	174	(−11%)
Other undergraduate mathematics courses	172	(−3%)			45	(−4%)	203	(−3%)
Total Undergraduate	710	(−3%)			130	(+1%)	1355	(−2%)
Graduate courses	27	(+1%)	14	(+11%)	1	(+29%)	21	(+9%)
All courses	737	(−3%)	66	(0%)	131	(+1%)	1376	(−3%)

*This percentage is obtained from the raw data as reported for the two years on this 30th Annual Survey. It is not based on last year's estimates.

Table 6: Majors

(Percent increase over fall 1985 in parentheses)*

Fall 1986

	I, II, III	IV	VI	M, B
Total junior-senior majors	19215 (−2%)	1060 (+13%)	5660 (+7%)	62797 (−2%)

*See footnote for Table 5.

Table 7: Graduate Students

(Percent increase over fall 1985 in parentheses)

Fall 1986

	I, II, III	IV	VI	M + B
First Year	2959 (+6%)	653 (+12%)	246 (+1%)	1261 (+9%)
All	9013 (+6%)	1925 (+5%)	700 (+16%)	3265 (+1%)

Table 8: Citizenship of Graduate Students

(Percentage of U.S. citizens of graduate students whose citizenship is reported as known)

	Fall 1985		Fall 1986	
Group	First Year	All Years	First Year	All Years
I	55	54	54	54
II	53	55	54	53
III	52	54	52	51
I,II,III	53	54	53	53
IV	56	53	59	53
M	72	63	66	69

Table 9: Average Class Size Fall 1986

(Fall 1985 size as also reported in this year's survey is in parentheses)

	Groups											
Type of Course	I		II		III		IV		M		B	
Below calculus (excluding statistics and computer science)	35	(36)	41	(42)	49	(47)	—	—	38	(38)	30	(30)
First year calculus	36	(37)	44	(44)	41	(41)	—	—	32	(33)	26	(26)
Undergraduate statistics	30	(31)	27	(27)	37	(39)	42	(43)	33	(34)	27	(27)
Undergraduate computer science	32	(36)	27	(27)	28	(31)	—	—	24	(25)	20	(21)
Other Undergraduate mathematics	30	(31)	32	(33)	32	(32)	—	—	24	(25)	17	(17)
All graduate	10	(10)	11	(11)	10	(10)	16	(15)	10	(11)		
Total	30	(32)	36	(36)	37	(37)	32	(32)	30	(31)	24	(25)

Doctoral Degrees Conferred in 1985–1986 (Supplementary List)

The following list supplements the list of thesis titles published in the November 1986 issue of *Notices* (see page 924 for an explanation of the numbers in parentheses).

ARIZONA

University of Arizona
(8;2,0,0,0,6,0,0)

APPLIED MATHEMATICS

Clough, Anne, *A mathematical model of single photon emission computed tomography.*

Dagan, Arie, *Some aspects of vortex line reconnection.*

Hammel, Steven, *A dissipative map of the plane—a model for optical bistability.*

Shelley, Michael, *The application of boundary integral techniques to multiply connected domains.*

Tonellato, Peter, *Critical behavior of an ignition model in chemical combustion.*

Weyker, Robert, *Resonance and asymptotic series based identification of an acoustically rigid sphere.*

MATHEMATICS

Sade, Martin, *Variational principles for field variables subject to group actions.*

Wang, Kwang-Shang, *Finite groups for which every complex representation is realizable.*

ILLINOIS

University of Chicago
(3;2,0,0,0,1,0,0)

MATHEMATICS

Crane, Louis, *Action of the loop group on the self-dual Yang-Mills equation.*

Harris, John, *Stable splittings of classifying spaces.*

Squeff, Christina, *Super-convergence of mixed finite element methods for parabolic equations.*

NEW YORK

CUNY, Graduate Center
(2;1,0,0,0,1,0,0)

MATHEMATICS

Benardete, Diego, *Topological equivalence of flows on homogeneous spaces, divergence of subgroups, and asymptotic homotopy classes.*

Kim, Myong-Hi, *Complexity of Newton-Euler type algorithms.*

PENNSYLVANIA

Carnegie-Mellon University
(4;1,0,0,0,2,0,1)

MATHEMATICS

Chang, Ching Lung, *Finite element approximations for first order linear elliptic systems.*

Hodgdon, Marion Louise, *Solutions of the Field relations in a theory of shear bands.*

Strojwas, Malina, *Tangential approximations.*

Turner, James Clarence, *A finite element analysis of a zero equation model of turbulence.*

Lehigh University
(2;1,0,0,0,0,0,1)

MATHEMATICS

Bailey, Carmine Michael, *On the optimum design of piston rings.*

Schaffer, Matthew John, *Permanence and universal family theorems for conull FK spaces.*

SOUTH CAROLINA

Clemson University
(7;1,1,1,0,1,0,3)

MATHEMATICAL SCIENCES

Chien, Victor, *Parameter estimation for a diffusion problem in a semi-infinite interval.*

Kovalcik, William, *A lumped parameter model of evaporation-condensation driven convective flows in atmospheric environments.*

Padua, Roberto, *Some robust estimates of the regression coefficients.*

Peters, Kenneth, *Theoretical and algorithmic results on domination and connectivity.*

Piazza, Barry, *Hamiltonian and connectivity properties of permutation graphs.*

Portier, Frederick J., *An integrated approach to discrete simulation: Theory, methodology, and computer aided program generation.*

Stueckle, Samuel, *Algebraic and isomorphism properties of permutation graphs.*

Mathematical Text Processing

Richard S. Palais

This month's column is a continuation of the Boston Computer Society's report on "Technical Wordprocessors for the IBM PC and Compatibles." Part I appeared in the January 1987 issue of *Notices*, pages 15–32. The final portion of this report, dealing with reviews of specific software packages, has been divided into two parts. Part IIA, which is presented below, gives a collection of summary tables for comparing individual programs, and Part IIB, which will appear in the next issue of *Notices*, will give individual reviews of each program.

Technical Wordprocessors for the IBM PC and Compatibles Report by the Boston Computer Society Part IIA – TWP Summary Tables

Richard Goldstein, James Loomis, and Avram Tetewsky

Background–Part I

Part I of this report described Technical Wordprocessor (TWP) capabilities, People Needs, and the current implementation technology.

TWP capabilities were broken into four categories: equation, manuscript/organizational, layout, and graphics.

People Needs were defined in terms of target documents to be produced, type of users, and users' preferred working mode. Target documents were informal memos, short reports, journal articles, long technical proposals, and technical books. Types of users included clerical, microcomputer support personnel, technical, technical-and-willing-to-program, managers of technical professionals, and committee personnel. The preferred working modes consisted of brainstorming at the tube, inputting, revising, team effort, and final printing.

Implementation included the human-to-software interface (command-driven, menu-driven, mouse-driven, hybrid and customization options), human-to-TWP capabilities (What You See Is What You Get [WYSIWYG], Markup Language [ML], and hybrids), and the hardware-to-TWP interface (keyboard, mice, and printer hardware).

Introduction–Part II

Parts IIA and IIB review currently available products, with a wide range of features from simple memos to typesetting systems. Specifically, Part IIA contains tables with textual description and Part IIB (to be published in the April 1987 issue of *Notices*) will include 19 separate reviews. Prices and hardware requirements, both low cost and high, are compared and ranked. In this report, every attempt has been made to compare products with other products that target the same TWP capabilities and human-to-TWP interfaces.

Final product recommendations are given in each review for up to three cases: individual use, corporate use of a product to be integrated with other products, and corporate use that could potentially satisfy all department needs. No review is perfect, and we acknowledge all the hard work that goes into every product. Writing a TWP for today's hardware is nontrivial. Every attempt has been made to check for accuracy, including vendor feedback. We thank the following vendors for participating in this review and for submitting the requested benchmarks. All vendors supplied all requested information plus comments except for Lexisoft, Inc. (Spellbinder Scientific).

Product	Vendor Name, Address, Phone
ChiWriter	Horstmann Software Design P.O. Box 4544 Ann Arbor, MI 48106 (313) 663-4049
Exact	Technical Support Software, Inc. 72 Kent Street Brookline, MA 02146 (617) 734-4130
EXP	Wadsworth Advanced Books and Software 555 Abrego Street Monterey, CA 93940-3286 (408) 373-0728
The Egg	Peregrine Falcon Co. 2330 Marinship Way Suite 307 Sausalito, CA 94965

	(415) 331-8131
forMath	Shantha Software, Inc. 50 West 97th St. 11N New York, NY 10025 (212) 222-7647
Manuscript	Lotus Development Corp. 55 Cambridge Parkway Cambridge, MA 02142 (617) 577-8500
MASS-11	Microsystems Engineering Corp. 2400 W Hassell Suite 400 Hoffman Estates, IL 60195 (312) 882-0111
MicroTEX	Addison-Wesley Publishing Co. 1 Jacob Way Reading, MA 01867 (617) 944-3700
PCTEX	Personal TEX, Inc. 12 Madrona Avenue Mill Valley, CA 94941 (415) 388-8853
PS	Scroll Systems 5530 N Camino Escuela Tucson, AZ 85718 (602) 299-8087
Samna IV	Samna Corp. 2700 NE Expressway Suite C700 Atlanta, GA 30345-1807 (800) 831-9679
Spellbinder Scientific	Lexisoft Inc. PO Box 1950 Davis, CA 95617 (916) 758-3630
SWP Enhancements to WordPerfect	SWP Enhancements 8320 N Lockwood Ave Skokie, IL 60077 (312) 677-4270
T3	TCI Software Research, Inc. 1190-B Foster Road Las Cruces, NM 88001 (800) 874-2383
TechPrint II	Stony Brook MicroSystems 45 William Penn Drive Stony Brook, NY 11790 (516) 689-3085
TechWriter	Computer Mart Inc. 1395 Main Street Waltham, MA 02154 (617) 899-4540
TECH/STAR	The Computer Linguist PO 7064 Eugene Oregon 97401-9989 (503) 345-1494
TECH/WORD	Goldstein Software, Inc. 12520 Prosperity Drive Suite 340 Silver Spring, MD 20904 (301) 622-9020
TurboFonts	Image Processing Systems 6409 Appalachian Way PO Box 5016 Madison, WI 53705 (608) 233-5033
WordMarc Composer	MARC Software Int'l, Inc. 260 Sheridan Ave Palo Alto, CA 94306 (415) 326-1971

Not all vendors who participated last year were invited to participate this year, since some were clearly not TWPs. Other vendors who were invited to participate, but did not, include:

Brit Scientex–this English company changed U.S. distributors during the review period. Both old and new distributors said they would send copies, but we never received any.

MathCad–not a word processor at present.

Pelada Text Engineer–although, as happened last year, interest was expressed during phone conversations, the package was never sent.

Statistical Wordprocessor–Niakawa Management Systems told us they do not participate in this type of project, but they did send some information. Although their product is called a "statistical" wordprocessor, it is clearly meant for accountants, not for technical writers.

TechniWord (Economic Insights)–has not been actively marketed or updated for several years, and the company has no plans for the program at this time.

TechType (Green Mountain Radio Research)–told us they sent a version to the main office of the Boston Computer Society after last year's report and we should use that since there were no changes. The BCS office told us they had no record of having received the program. Green Mountain decided not to send us another copy.

Volkswriter Scientific (Lifetree Software)–current version is not a full wordprocessing package. The company expects to release a greatly updated version during the spring of 1987.

XyWrite III (XyQuest)–they felt that they were not really a TWP in our sense.

Review Strategy and Benchmarks

The review strategy consisted of 3 major tasks: running test suites, constructing summary tables, and writing a review about the product.

There were two test suites. The first test suite comprised ten benchmarks (*Notices*, January 1986), the results of which are summarized in Table 2C below. The first suite tested the ability of the system to handle equations from physics, chemistry, mathematics, and engineering, as well as testing correct pagination of equations. Each vendor was asked to do these 10 benchmarks, mail us hard copy output from one dot matrix and one laser printer, and to supply us with input files on disk.

The second test suite consisted of a modified journal article testing the TWPs organization/manuscript, page-layout, text and equations, text and graphics, and customization capabilities. Some of the more difficult tests were:

- simultaneous yet distinct numbering scheme styles for pages, equations, figures, tables, footnotes, endnotes, sections, bibliographic references, and list items; each automatically numbered;
- three automatic multi-level indexes, with some entries emphasized;
- automatic table of contents composed partly of chapter/section headings, and partly of special entries;
- automatic table of equations, table of tables, and table of figures;
- box graphics done internally, and mathematical curves imported from another program;
- automatic numbering of equations, using two different numbering schemes;
- a multi-line header that varied across odd and even pages;
- a footer, including left-justified, right-justified and centered text;
- automatic reference (bibliography) list;
- "floating" material (see Part I);
- separately numbered and paginated appendices;
- forward and backward symbolic references.

Note that it is impossible for any system to supply defaults for all possible layout/organizational schemes. But by asking for many specific features, each TWP could be tested for its ability to do the benchmark as well as any required programming/customizing.

While it is certainly true that many documents would not require all features included in Test Suite II, some documents will require all, and many will require even more. Further discussion may be found in Part I of this year's report. There is no special table for this year's benchmark. Instead, the items are spread throughout the tables in what we believe are the most logical places for each item. A more detailed description of the benchmark and a 7-bit ASCII file of the text is available to anyone who sends a formatted IBM-type floppy diskette and a stamped, self-addressed mailer to Richard Goldstein, Ph.D., 87 Bennett St., Brighton, MA 02135.

Summary Tables

Please note that no set of tables nor any review, no matter how detailed, could possibly tell whether a product is right for you. TRY THE PRODUCT WITH YOUR EQUIPMENT BEFORE BUYING, and ask yourself several questions: (1) does it work with your equipment; (2) is it easy to learn; (3) is it easy to use; (4) is the documentation at least tolerable; (5) do you like looking at its screen for hours at a time? Obviously, preview privilege requires a "loan and try" policy or a lower-priced demonstration version. All publishers should offer a preview opportunity.

Other points to keep in mind when reviewing various TWPs include: (1) if the program uses function keys heavily, is a plastic overlay, a template, for each of the major keyboards available? A printed copy of the IBM XT keyboard setup is not sufficient, and neither is a collection of stick-on labels. Your keyboard may look quite different from the XTs, and you may want to use other programs. (2) If the program uses the graphics mode of the screen for everything (or even just for previewing) be sure to try it on a CGA (Color Graphics Adapter), if that's all you have. The low resolution of this screen (640 by 200) may be quite bothersome. (3) Several programs do not send either bit-patterns or vector (outline) graphics to printers. Instead, they either rely on your having a printer that accepts downloadable fonts and using such fonts, or they rely on the user to build their own bit-patterns to be sent to the printer. There are several problems here: (a) you will not be able to print special characters if your printer does not accept downloaded fonts (unless you build your own bit-patterns); (b) if the program provides an alternate keyboard, e.g., a mapping of Alt-key combinations to special characters, it is unlikely that it will match your downloadable font, and you will probably not be able to use the alternate keyboard; (c) even if the package claims to be a WYSIWYG, you will not get the right characters on the screen unless their alternate keyboard matches your downloaded font. Some programs may send bit-patterns to only a few, select, very popular printers, so check this out.

Finally, remember that it is impossible for any vendor to conceive of all possible things that users may want to do, therefore, flexibility and power are very important to look for in a prospective program.

Table 1 presents a summary of each product. The first five columns are: product name, whether copy protected, single copy price, version number, and maximum target document the product can comfortably handle. Products are alphabetically listed within each maximum target document category: journal article, technical text book, or add-on. Although a technical text book can be created with almost any product, doing table of contents, indexes and equation numbering by hand is tedious and error-prone. Products that lacked these features were given journal rankings. Add-ons that work with only one product are listed by the capability of that one product. For SWP Enhancements (WordPerfect add-on) and Tech/Star (WordStar add-on), the tables are filled on the basis of both the add-on and the underlying product. Add-ons that work with several different products are listed at the bottom of each table. The entry DOUW signifies (D)epends (O)n (U)nderlying (W)ordprocessor.

The remainder of Table 1 presents an overview of: the user interface, the products' capabilities, minimum tolerable CPU/disk hardware, and video support.

In terms of user interface, these products offer varying capabilities for equations, organization/manuscript, page-layout, and graphics. Thus, separate information for each category is required. Interface is ranked as either WYSIWYG, ML, or a mixture. Under the ML category, ML-P, ML-SP, and ML-PP signify minimal (P)review, (SP)lit-screen preview, and full-(P)age (P)review, respectively. Capability was ranked as either basic or advanced. (The criteria for basic and advanced were defined in Part I of this article, pp. 19-22, for each category.) Note that a rating of "BASIC" under Equation Capabilities still means that the product has quite a lot of equation-writing ability. Because the technology for mixing texts and graphics is still immature for the IBM mainframe and PC world, graphics was ranked on both internal built-in graphics capability and ability to automatically include externally generated graphs.

Besides the obvious "leave room and paste in by hand," external graphics could consist of:

- embedding the DOS copy command within the document so the printer driver could copy a graphics file to the printer at print time (COPY/B);
- using a page description language to generate custom plots (PDL);
- having an open architecture so that third party vendors could create products compatible with the TWP (specs);
- having the ability to easily incorporate graphics from another program sold by the same developer (own).

Although a manual cut-and-paste would appear to be fine for a first printing, when revisions are made for the figures, the repeated pastings could become tiring. It is interesting to note that although the Macintosh is outstanding at graphics cut-and-paste, it can't remember the cut-and-paste when updating figures.

Minimum tolerable CPU hardware was: 8088 for the original 4.77 MHz PC, and 8086/80286 for high speed PCs or PC-ATs. Although some IBM-compatible computers use an 8 MHz 8088-3, it was discovered that the 16/24 bit buses for the 8086/80286 products were more useful than the 8 bit 8088 buses running at 8 MHz.

An '-S' appended to the disk rating meant that purchasing a fast disk (40 msec or faster) would be worth the extra investment. Necessary hard disk space was difficult to determine because the amount of room needed depends on how many fonts are to be accessible at once, and on the memory capability of the printer.

Five popular graphics cards were listed: Monochrome Display Adaptor (MDA), Color Graphics Adaptor (CGA), Enhanced Graphics Adaptor (EGA), Hercules Graphics (HGA) and Hercules Graphics Plus (HGA+). This final column contained a 'Y' only if the RamFont mode of the Hercules Graphics Card Plus was supported. Sometimes, the user must replace the character generator ROM chip. Please note that some of these programs work entirely in graphics mode. For these programs, users should test the program on a CGA before purchasing if the program is to be used with CGA. These programs are much easier to use with an EGA or HGA.

Not all TWP vendors support the RamFont mode of the Hercules Graphics Card Plus. In particular, a couple of vendors pointed out that using the graphics mode of the Hercules card may be more powerful than RamFont mode: you have more control over vertical and horizontal spacing; you are not constrained in character placement; and you have fine control of formulas and figures. At least one vendor would like a change that allows the entire 64k to be used for a single graphics page (to allow highlighting or blinking of each dot), rather than forcing the use of two graphics pages. Of course, programs that put everything in text mode, and would otherwise require a ROM chip, can put the RamFont mode to good use.

Printers were not listed in this table because all vendors supported at least one laser printer and most dot matrix printers. Some programs do not download special symbols into dot matrix printers in bit-pattern or vector (outline) format, hence bit-patterns must be written before using them. That is, these programs require printers with the ability to download fonts, if one is to print the special characters offered, rather than downloading bit-patterns, or outlines, directly through the program, as other TWPs do. The individual reviews note this where appropriate. Daisywheel printers were not reviewed.

Tables 2A, 2B, and 2C summarize equation capabilities. Table 2A presents an overview of raw equation features. The first part of Table 2A covers special symbols, attributes, font sizes, and styles. The columns are:

- upper/lower case greek;
- special symbols for calculus, partial differential equations, and set theory;
- large symbols for summation, product, integral, surface (contour) integral, union, and intersection;
- large enclosures;
- character block graphics including lines in 45 degree increments;
- chemistry;
- attributes including:

underline
overline
strike-out
over-strike
italics
bold

foreign/other diacritics needed for foreign languages

(Note that strike-out is a special case of over-striking using just one particular character such as a dash. Over-striking refers to an arbitrary number of characters being printed in the same position on the paper.)

• the ability to mix all attributes (e.g., a bold underlined italic character), mix all attributes with any symbol (e.g., a bold underlined italic alpha), mix all attributes and symbols and vary the font (e.g., italic), and mix all attributes and symbols and fonts as well as varying the sizes of the characters.

In general, these are Yes/No entries. Sometimes, 'Y-' is used to show that the feature is included, but that it is restricted to certain symbols. In other cases, 'add' has been used to show that there is an additional cost for this feature.

Each vendor defines symbol sets, font sizes, and font styles differently. There can be considerable overlap in:

• the character sets;

• the number of: characters per symbol set, supplied symbol sets, and symbol sets that can be co-resident in the same document (on the screen and in a printed page);

• whether users can define their own symbols;

• the number of possible font sizes and styles for text and equations.

For these reasons, these features are not table entries, but are described in various reviews.

The last two columns note whether a program allows one to define individual symbols or entire fonts. Since various programs achieve this feature in various ways, the reviews discuss how this is achieved if there are either particularly good or particularly bad elements to the process.

Table 2B summarizes the ability to coordinate special symbols, font sizes, font styles, and text into equations that are offset from text as well as equations that are in-line (within a paragraph of text). The first half of Table 2B tabulates whether a TWP will automatically change the size of enclosures and selected special symbols, or if the user must manually enter the symbol size (A=Automatic, or S=user selectable or manually assembled size; N means there is no large version of the symbol or enclosure). The automatic or selectable enclosure entries cover parentheses, braces, brackets, vertical bars, left/right floor corners, left/right ceiling corners, angle brackets, and null enclosures. (Null enclosures are invisible boxes used by those who prefer their matrices, etc., to be open.) Automatic or user-selectable special symbols include summation characters with limits on the top or on the side, integrals, surface integrals (integrals with a counter/clockwise circle), products, set theory (union/intersection), logic (there exists/for all, etc.), and radicals (square roots with power operators). The remainder of Table 2B summarizes the in-line and off-set equation capabilities: ability to support one level super/subscripts, one level simultaneous super/subscript, multi-level super/subscripts, multi-level simultaneous super/subscripts, and the entry method.

For the entry method, the possible choices are markup language, nested fill-in, or paint-by-level. A typical nested fill-in would work by selecting a set of enclosures (for example, a summation sign) and having the system prompt for the inner material (such as the upper and lower limits and/or size of the symbol). Nested fill-in can also refer to systems that allow users to enter a special editing mode (e.g., press a key to enter a superscript), enter data, then exit the superscript mode (e.g., press a special key to end superscript mode). Typical paint-by-level systems allow users to work in 1/2 or 1/4 line mode, and enter the equation level by level. Note that many paint-by-level systems have less capability when an equation is included in a paragraph of text because, when 1/2 or 1/4 line spacing is used, the user loses ability to wordwrap text that contain equations.

Table 2C summarizes the results of test suite 1. The ten benchmarks were:

(1) multi-level simultaneous super/subscript equation from electromagnetic research;

(2) set theory test;

(3) table with calculus entries and physics symbols with diagonal over-strikes;

(4) control theory block diagram with integrator/op-amp symbols;

(5) mathematical matrix analysis theorem;

(6) physics equation;

(7) Feynman quantum physics diagram;

(8) organic chemistry benchmark;

(9) simple underlined subscript test;

(10) test of whether benchmarks 1-9 could be placed in one file and paginated correctly, with more than one benchmark per page, where appropriate.

The entry codes are (N)o, (Y)es, or (mod)ified somewhat (N, Y, mod). Some programs are only able to print such constructs monospaced regardless of the printer. Some programs can print with exact page layout on all printers, while others offer exact page layout control on only some printers. If this is considered an important feature, be sure to investigate before purchasing. A full discussion of this test suite can be found in last year's report (*Notices*, January 1986).

Manuscript/Organizational Features are covered in Tables 3A and 3B. The first columns of 3A cover page numbering: does the product support automatic page numbering, and does it have the ability to restart page numbering anyplace in the document? Headers and footers are broken into subcategories of: can both be done, can one have multi-line headers, the ability to specify a page number in the header or footer,

the ability to left/right/center justify the pieces of the header/footer, whether you can have different headers/footers based on an even/odd page number, and whether new headers/footers can be defined midway through a document. Reference Notes are divided into footnotes, section notes, and endnotes. Two other questions are whether you can have both footnotes and section/endnotes, and whether you can restart the automatic numbering of these notes. Marker options of using numbers, letters, or symbols to label the foot/section/endnotes is the final element in this part of the table.

The second part of Table 3A covers automatic generation of numbering schemes (in addition to pages and footnotes), including: equations, tables, figures, references, chapters/sections, and lists, plus a final category of the number of general purpose counters. The number of counters shown includes those used for pages and footnotes. The number is followed by a 'D' if all counters are dedicated to particular uses, such as pagination. For some products you are given 'n' counters that allow you to number up to 'n' different quantities such as equations, tables, and figures.

In terms of table of contents, the Table 3B subcategories include the ability to handle front-matter (abstract, preface, acknowledgements, introduction, foreword, list of tables, list of equations, etc.); the body of the report; and the back-matter (appendices, references, indexes, etc.). "Other" refers to whether one may also have a Table of Tables, Table of Equations, etc. Automatic Index generation is summarized by the number of simultaneous indexes, the number of levels allowed for each index, and whether the index material is automatically sorted alphabetically. TWPs should be able to create bibliographic references that are sorted by author, by journal, by alphabetical subject, by order of appearance, by author and year of publication, etc. Given the wide variation in preference across disciplines, the program should provide the user with flexibility.

Many advanced TWPs have the ability to do forward and backward symbolic referencing. (See page 18 of Part I of this report). The symbolic references can either report by page number, chapter, section, list item, note number, or other methods. The user should be able to reference a particular equation, table, footnote, etc., without knowing the correct equation number, etc. That is, when entering the text, one might put a symbol at a certain place (to be referenced) and the program, when it automatically numbers the item to be referenced, should substitute the correct number for this symbol. If the material is then moved, the new correct material should automatically replace the former reference. For longer documents this is important. Please note that some entries in these columns are "C's": these tell you that the program has all the above abilities except that the original reference must include the correct number—a symbol cannot be used. However, if the material is moved, these programs will correct the cross-reference.

The next part of Table 3B covers lists: These are discussed in Part I of this report. We ask whether one can have both ordered (e.g., numbered) lists, and unordered (e.g., bulleted or unmarked) lists, and how many levels. Here, numerous levels are not necessarily of great importance, since many users want each successive level to be indented from the preceding level. These indentations rapidly use up one's page width space. If one does not indent, then it is hard for the reader to determine the level of the list unless each item is marked with its own level plus all higher levels. For example, a sixth level might look like: I.A.1.i.a.3. "list element." Even six levels of this may be too much, and more than nine is awkward looking, and even worse to read. However, certain government regulations may require this mode with even more than 9 levels.

Table 3B concludes with boxes and tables. Here we consider a box to be just an enclosed table. Regarding the material inside a table, we list possible justification modes for each table element: right, left, center, by character (such as decimal or comma tabs), and by printer unit (called "raster" in the table). Raster justification means that if your printer can move as fine as 1/180th of an inch (or 1/300th...), then the program takes advantage of this within tables. Note that all these forms of justification refer to horizontal justification; some programs also allow vertical justification of table elements (e.g., top, bottom, center).

Tables 4A and 4B discuss Layout Control: how does the final product look on paper?

The first section deals with Page Layout, including control over: page size and margins; vertical spacing (e.g., lines per inch); lines per page; horizontal character spacing (interpreted loosely for typesetting programs); choice of fonts; and choice of amount of indentation (including none) for paragraphs, headings, etc.

Next is Spacing Control: horizontal, vertical, and justification. Under horizontal and vertical, the possible entries are "F" and "C": C stands for continuous and means that control is available to the level of resolution of the printer (e.g., 1/180th or 1/300th of an inch), while F stands for fixed or discrete and means the spacing is in character widths or some other set minimum (e.g., 1/48th of an inch, one-quarter the width of a character, etc.).

"Even/Odd layouts": does the program offer the user the chance to set different page layouts for even and odd pages? Possibly the most important use of this feature is in setting the margins for a document that is to be bound.

"Override Globals" asks whether the user can override any global layout option in the middle of a document.

"Multi-Column" asks whether the program can automatically produce multi-column documents. There are three types of multi-column modes: snaking, parallel, and unrelated. Snaking is newspaper, IEEE, or AMS style. Parallel is like a script (e.g., questions in the left column and answers, often much longer, in the right column). Unrelated might be used to allow comments of the text to be placed in a special column next to what is being commented, or to allow text in one column and a graphic in the other. The difference between snaking (or parallel) mode and unrelated mode is that for either snaking or parallel, the program must keep certain relationships between the columns straight, while for unrelated there is no necessity of even having an entry in a column.

The next section deals with issues of the program overriding its own style to make the document look better: hyphenation, widow/orphan control, and space for "figures." Any file may be manually hyphenated, but a few programs offer "soft" hyphens which the program will use if the word would be the last word on a line. We considered the latter to be of so little importance that we did not provide a column for it. The three hyphenation columns are whether hyphenation is automatic, whether the user can override particular instances, and whether the user can amend the hyphenation rules (these are discussed in Part I of this report).

Widow/orphan control refers to blocking the split of text such that one line appears on one page and the remainder appears on the following/preceding page, and whether this can generalize to arbitrary blocks of characters. Finally, figure space refers to whether one can have space left for an imported figure or graphic. The first of the three columns refers to forcing the program to leave white space so the figure will not be split across pages. Column two refers to the ability to float textual material around a block (see Part I). Column three refers to the ability to inhibit the splitting of any block of material so that, for example, a table would not be split across two pages.

The first section of Table 4B deals with hardware customization: can the user install a new printer driver through some procedure (such as a menu-driven questionnaire); is documentation available to allow the user to write a new printer driver; can the user write a new video driver; when new versions of the operating system appear, can the user upgrade the program to take advantage of new abilities; and, can the user write a driver to take advantage of Expanded Memory Systems, such as Intel's "Above Board"?

Analogously, we deal with Style Sheets or software customization in the sense of layout default setups. Can one put ALL commands in such a style sheet? Can the user locally override the style sheet at anyplace within the document? If one can have style sheets, are they available within a particular document, in special files that apply to all documents, or both, with the user having a choice? If they can exist in a special "style sheet" file, how many can one have? Can one choose between style sheets conditionally based on output device or on type of document (memo, letter, article, multi-chapter report, etc.)? For example, a style for the screen, another for drafts, and another for "final." Finally, how many "style sheets" are supplied with the program?

The final section deals with MACROS. First, Keyboard macros, either one key to many, or many keys to many. Next are Command macros, the ability to add new commands to a program. For each type, if available, are these stored in ASCII format? Are comments allowed so you can recall what the macros are supposed to do? Are conditionals allowed? Are both local and global commands allowed, and are replaceable parameters (or stacks) available? If macros are available, can they be kept in their own file, with comments, do they apply to individual documents, to all documents, or does one have a choice of whether they will apply to all documents?

Tables 5A and 5B encompass various forms of interaction between the TWP and other programs/files. Table 5A covers data interchange and document management. First is Data Interchange: importing, exporting, page description languages, and final output files. Regarding importing: can one import a 7-bit ASCII file; a formatted file while retaining the formatting; a mark-up language type file with translation of the mark-up commands? What types of files can be exported? Is the internal format of the file documented so that someone can import it even if this requires writing a brief program? Does the program support any of the three main page description languages: PostScript (Adobe, used in the Apple LaserWriter for example), DDL (Imagen, used in the new Hewlett-Packards for example), and InterPress (Xerox, used in larger, faster printers, such as 200 page per minute printers)? Is the format documented enough so the user could write a driver for a page description language? Can one send the final output to a file instead of a printer?

The next section deals with Document Management, related to what software developers call configuration management. The first of three columns is headed, "Include Separate Files": that is, can one break one's document into several pieces (e.g., one file per chapter) and automatically incorporate the pieces into the overall document while maintaining the consistency of, for example, page and footnote numbers? The second column ("Long File Names") refers to some procedure allowing the user to associate a long (say, 30 characters) descriptive name with a particular

file to ease the organization of one's files. The third column asks whether there is an automatic procedure allowing one to print the filename in the header (or footer) of the document at print time. This is particularly important (1) before completing a document with multiple authors, so that all contributors can know what the file name is, or (2) when there are long breaks between times of working on the document.

RAM-resident programs can sometimes function as computer management facilities and can conflict with applications programs. We asked about keyboard and screen programs. Keyboard programs include both keyboard macro programs (e.g., Newkey, ProKey, SuperKey) and programs to either speed up the keyboard or to increase the type-ahead buffer (e.g., KBFIX2). Screen programs include replacements for ANSI.SYS (e.g., Fansi-Console, which also has keyboard control capabilities) and RAM-resident programs (e.g., SideKick), as well as multi-tasking programs (e.g., WINDOWS, DesqView).

Table 5B starts with "add-ons"; things not necessarily part of a wordprocessor but that can be helpful, such as: spell checking; format checking (all WYSIWYGs are given an "n/a" here); calculator; symbolic calculator; spreadsheet; mail merge; data base management; and an outliner. These were discussed in Part I of this report.

Next is Revision Control, discussed in Part I of this report. Notice that although a program could have all five forms of control listed, it is more common to find either the first four (or some subset), or just the last one. The first form of control refers to whether one can have some form of "audit trail" of the history of the document: can one determine what was added (deleted) and in what order? The second form of control asks whether one can go back and print any particular version of a document from the beginning. Next, can one print material from just a particular author, or material aimed at just a particular type of reader? This form of control might be particularly important when a subset of the document is considered complete enough for non-technical readers. These forms of revision control are most usefully implemented by maintaining all material in one file with various kinds of "change" markers. The final column asks whether a file comparison utility is included in the package so that users can compare different versions of the same document, and prepare a new copy of the document that shows the specific differences between the two versions.

The final section of Table 5B deals with previewing the document. First, can one preview entire pages in compressed mode? This would allow one to check on layout features quickly, though crudely (since nothing will be legible). Next are three columns under the heading "Zoom": can one look, in a readable way, at all aspects of the document, including both textual and technical (equation) material in an integrated way? Although many WYSIWYG systems cannot show the full material as it will approximately appear on paper (e.g., many hide footnotes), for this table we considered that these three columns were Not Applicable (n/a) to WYSIWYG systems. The final column is whether, when previewing, one can jump both backward and forward through the document to any page.

Table 6 primarily deals with issues of consideration of the user by the vendor. The first section deals with the quality of the documentation: is there a quick start section; how is the documentation organized; how clear is the documentation; does the documentation include Technical Appendices, an Index, and examples of using the product to produce something? The final column in this section asks whether the documentation was produced by the product itself, or did the vendor use some other wordprocessing product to produce the documentation?

Section two asks whether one can abort or undo procedures. For the Mark-up languages, there is, of course, nothing to undo, so they receive a Not Applicable (n/a).

The final section deals with vendor support. First, what is the warranty like? To receive an excellent rating here, the vendor must warrant that the product is in substantial conformance with the documentation, AND must either offer to fix all bugs for free (forMath), or refund your money in total (Manuscript, Tech/Star) if the product does not substantially conform to the documentation. forMath warrants that the program will perform fully to the specifications in the manual. A good warranty only differs from an excellent one in the shorter time period involved (EXP has a 30 day warranty). The next column asks whether bug-fixes are free. We firmly believe that fixing a bug in a program does not qualify as an "upgrade," and there should be no charge to any registered user for fixing program errors. The last column asks specifically about technical support to owners of the program: is there any charge for this support? If there is, when does it start? We decided not to include columns on the "quality" or "speed" of the support offered since we had too little experience, most of which was biased by our, usually, known status as reviewers.

Table Notes

General notes, for all tables

add — Can do with add-on product at additional cost; not necessarily available from same vendor.
arb — Arbitrary number of sizes (etc.); essentially any size desired.
(C) — Coming.
D — Depends on underlying wordprocessor or add-ons.
L — Limited.
M — Manually.
ML — Markup language.
n/a — Not applicable.
P — Printer dependent.
prog — Program via macros.
S — Some(times).
WYSI — WYSIWYG.

Notes for Table 1

* — Optional additional products.
\+ — Must purchase an additional product (e.g., printer driver or special font).
COPY/B — Use DOS COPY/B command within file to copy a graphic to the printer.
DOUW — Depends on underlying word processor.
hard-S or flop-S — Needs fast disk access.
ML-P — Mark-up with preview.
ML-PP — Mark-up with full-page preview.
ML-SP — Mark-up with simultaneous preview.
own — Graphics from programs owned by the same company.
PDL — Graphics from a page description language, such as PostScript.
prom — Prom needed in addition to display card.
specs — Will provide program specs to developers so they can write interfaces.

Notes for Table 2

A — Coordination and/or sizing are done automatically relative to the remainder of the construct.
IGC — Do with internal graphics commands.
MF — Can do with METAFONT.
Mod — Modified somewhat.
Overstrike — Any one or more characters can be overstruck on normal characters.
S — Sizes are selectable (within limits) by the user; the user may have to build these up.
Strikeout — One special character can be overstruck on normal characters (e.g., dash through a character to show it has been deleted).
WP-M — WordPerfect macros.

See the reviews for discussions of Product Fonts (both styles and sizes) and for the ability to Mix attributes, large symbols, etc.

Notes for Table 3

B — Backward only.
C — Non-symbolic cross-reference.
Counter — Number of counters available, including for page numbers, footnotes, equations, etc.; we assume that the first two will generally be used for page numbers and for footnotes/endnotes, though the user generally may override this and use them for other things; a hyphen means that the product can do that one, but not all requested at once, and that the user can choose which elements to number.
E — External sort required.
F, T, etc. — List of Figures, Tables, etc.
*n*D — *n* dedicated counters; the first is typically for pagination.
SI — Simple lists, but not bulleted lists.
2P — 2 levels with no programming; need to program to get more.

Notes for Table 4

Under Horiz. and Vert. Spacing Control:
C — Continuous; i.e., control spacing to limit of printer.
F — Fixed; e.g., space by character widths only, or by some other fixed amount ($1/48''$ or $1/4$ char. width, for example).

Under Multi-Column:
P — Parallel, as in a script.
S — Snaking, as in newspapers.
U — Unrelated (e.g., space for comments on the text in the main column).

The column on the far right of both keyboard and command macros in Table 4B (Doc vs. all vs. choice) asks whether one's macros are applicable only to particular documents, or to all documents, or whether the user has a choice of what they apply to. A/D means either all documents or all in a directory, but not any given document.

Notes for Table 5

BIB — BibTeX has this capability.
IP — Internal parameters only.

Notes for Table 6

PW — Produced with ProofWriter, another TWP from the same company; see last year's report for a review of ProofWriter.

Table 1 — Product Summary (2/1/87)

Product	Copy protected	Price	Version	Maximum target document	User interface			Capabilities					Minimum tolerable hardware		Display cards				
					Eqn.	Man.	Layout	Eqn.	Man.	Layout	Internal graphic	External graphic	CPU	Disk	MDA	CGA	EGA	HGA	HGA+
ChiWriter	N	$79.95*	2.05	journal	WYSI	WYSI	WYSI	adv	basic	basic	basic	none	8088	flop	N	Y	Y	Y	N
The Egg	Y	$495.00*	4.2	journal	WYSI	ML	mix	adv	basic	basic	none	none	8088	flop	N	Y	Y	Y	Y
EXP	N	$99.95	1.0	journal	ML-SP	WYSI	WYSI	adv	basic	basic	basic–	none	8088	flop	N	Y	Y	Y	N
Spellbinder Scientific	N	$790.00	6.03	journal	WYSI	ML-P	ML-P	basic	basic	basic	basic	none	8088	flop	N	N	N	Y	N
T^3	N	$595.00	2.2	journal	WYSI	WYSI	WYSI	adv	basic	basic	basic	PDL	8088	hard	N	Y	Y	Y	N
TECH/STAR	N	$195.00	1.0	journal	WYSI	ML-P	mix	basic	basic	basic	none	none	8086	flop	prom	(C)	Y	Y	Y
TECH/WORD	N	$245.00	1.09	journal	WYSI	ML	mix	adv	basic	basic	none	none	8086	flop-S	Y	Y	Y	Y	Y
forMath	N	$400.00	2.2	textbook	ML-P	ML-P	ML-P	adv	adv	adv	basic	COPY/B	8088	flop-S	Y	Y	Y	Y	N
MicroTEX	N	$295+*	1.5	textbook	ML-PP	ML-PP	ML-PP	adv	adv	adv	basic	PDL	8088	hard-S	Y	Y	Y	Y	Y
PCTEX	N	$249+*	2.0	textbook	ML-PP	ML-PP	ML-PP	adv	adv	adv	basic	PDL	8088	hard-S	Y	Y	Y	Y	Y
Manuscript	N	$495.00	1.0	textbook	ML-P	WYSI	WYSI	adv	adv	adv	none	specs/own	8086	hard	N	Y	Y	Y	Y
MASS-11	N	$395.00	6.B	textbook	WYSI	ML-P	ML-P	basic	adv	adv–	adv–	COPY/B	8086	hard	N	N	Y	Y	N
PS	N	$495.00*	1.3	textbook	mix-P	ML-P	ML-P	adv	adv	adv	basic	yes	8088	flop	N	prom	Y	Y	Y
SAMNA WORD IV	N	$595.00	1.0	textbook	WYSI	WYSI	WYSI	basic	adv	adv	none	own,COPY/B	8086	hard-S	Y	Y	Y	Y	Y
SWP Enhancement to WordPerfect	N	$75.00		textbook	WYSI	mix	mix	basic	adv	adv–	none	none	8086	hard	prom	Y	Y	Y	N
TechWriter	N	$395.00	3.0	textbook	WYSI	ML	mix	adv	adv	basic	none	none	8086	flop	Y	Y	Y	Y	Y
WordMarc Composer	N	$249.00*	86.09. 08.C	textbook	WYSI	WYSI	WYSI	basic	adv	adv	basic	none	8086	hard-S	Y	Y	Y	Y	Y
EXACT	N	$475.00	2.5	DOUW	ML-SP	n/a	n/a	adv	DOUW	DOUW	DOUW	none	8088	DOUW	N	Y	Y	Y	Y
TechPrint II	N	$35.00*	2.0	DOUW	ML	n/a	n/a	basic	DOUW	DOUW	DOUW	none	8088	DOUW	prom	prom	prom	prom	N
TURBOFONTS	N	$149.00*	1.1	DOUW	WYSI	n/a	n/a	adv	DOUW	DOUW	DOUW	yes	8088	DOUW	prom	prom	Y	Y	Y

The notations used in this table are defined in "Table Notes" preceding these tables.

Table 2A — Overview of EQN Capabilities (2/1/87)

Product	U/L Greek	Special symbols: Calculus PDEs, Set Theory, etc.	Special symbols: Large symbols	Special symbols: Large enclosures	Char Block Graph	Chemistry	Attributes and style: Under line	Over line	Strike out	Over strike	Italic	Bold	Foreign and diacritics	Mix: Mix all att's	Mix: Symbols too	Mix: Vary fonts also	Mix: Vary sizes also	Define symbols	Define global fonts
ChiWriter	Y	Y	Y	Y	N	add	Y	Y	N	N	Y	Y	Y	S	Y	Y	N	Y	Y
The Egg	Y	Y	Y	Y	N	add	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N
EXP	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Spellbinder Scientific	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	L	N	N	N	N	Y	Y
T^3	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
TECH/STAR	Y	Y	Y	Y	N	N	Y	N	Y	Y	Y	Y	add	Y	Y	N	N	(C)	N
TECH/WORD	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y	N	Y	N
forMath	Y	Y	Y	Y	Y	IGC	Y	Y	Y	Y	P	P	Y	Y	Y	Y	Y	Y	N
MicroTEX	Y	Y	Y	Y	Y	IGC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	MF	MF
PCTEX	Y	Y	Y	Y	Y	IGC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	MF	MF
Manuscript	Y	Y	Y	Y	add	N	Y	Y	N	N	Y	N	Y	Y	Y	Y	N	N	N
MASS-11	Y	Y	Y	Y	Y–	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	P	N	N	N
PS	Y	P	Y	Y	Y	IGC	Y	Y	Y	Y	P	Y	P	Y	Y	P	P	P	P
SAMNA	P	P	P	P	Y	N	Y	N	Y	Y	P	P	Y	P	P	P	P	N	N
SWP Enhancement to WordPerfect	Y	Y	WP-M	WP-M	N	N	Y	Y	Y	Y	P	Y	S	Y	N	P	N	Y	Y
TechWriter	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	S	Y	P	P	P	Y	Y
WordMarc Composer	Y	Y	Y	Y	Y–	Y–	Y	N	Y	Y	N	Y	Y	Y	Y	P	P	Y	Y
EXACT	Y	Y	Y	Y	N	N	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
TechPrint II	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	add	Y	Y	add	N	add	add
TURBOFONTS	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	N

The notations used in this table are defined in "Table Notes" preceding these tables.

Table 2B — Technical Constructs (2/1/87)

Product	Coordination and relative sizing of entire equation																In-line equations					Off-set equations				
	Enclosures								Large symbols								Subs & supers					Subs & supers				
	Paren	Brace	Brack	Vert	Floor	Ceil	Angle	Null	Sum Top	Sum Side	Int	S-Int	Prod	Set	Logic	Sqrt	One level	Simul	Multi level	Simul multi	Entry method	One level	Simul	Multi level	Simul multi	Entry method
ChiWriter	S	S	S	S	S	S	S	S	S	S	S	S	S	S	N	S	Y	Y	Y	Y	paint	Y	Y	Y	Y	paint
The Egg	S	S	S	S	S	S	S	S	S	S	S	S	S	S	N	S	Y	Y	Y	Y	paint	Y	Y	Y	Y	paint
EXP	A	A	A	A	A	A	S	A	S	S	S	S	S	S	S	A	Y	Y	Y	Y	markup	Y	Y	Y	Y	markup
Spellbinder Scientific	N	S	S	S	S	S	S	S	S	S	S	S	N	N	N	S	Y	N	N	N	markup	Y	Y	Y	Y	paint
T^3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	Y	Y	Y	Y	paint	Y	Y	Y	Y	paint
TECH/STAR	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	Y	N	N	N	fill-in	Y	Y	Y	Y	paint
TECH/WORD	A	A	A	A	A	A	A	A	S	S	S	S	S	S	N	A	Y	Y	Y	Y	fill-in	Y	Y	Y	Y	fill-in
forMath	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	Y	Y	Y	Y	markup	Y	Y	Y	Y	markup
MicroTEX	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	Y	Y	Y	Y	markup	Y	Y	Y	Y	markup
PCTEX	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	Y	Y	Y	Y	markup	Y	Y	Y	Y	markup
Manuscript	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	Y	Y	Y	Y	markup	Y	Y	Y	Y	markup
MASS-11	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	Y	Y	N	N	fill-in	Y	Y	Y	Y	paint
PS	A	A	A	A	A	A	A	A	A	PR	A	A	A	N	N	A	Y	Y	Y	Y	markup	Y	Y	Y	Y	markup
SAMNA	S	S	S	S	S	S	S	S	S	S	S	S	S	N	N	S	Y	Y	Y	N	paint	Y	N	Y	N	paint
SWP Enhancement to WordPerfect	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	Y	Y	Y	Y	markup	Y	Y	Y	Y	paint
TechWriter	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	Y	Y	Y	Y	fill-in	Y	Y	Y	Y	paint
WordMarc Composer	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	Y	Y	Y	Y	paint	Y	Y	Y	Y	paint
EXACT	A	A	A	A	N	N	S	A	A	A	A	A	A	A	A	A	Y	Y	Y	Y	markup	Y	Y	Y	Y	markup
TechPrint II	S	S	S	S	S	S	S	S	S	S	S	S	S	N	N	S	Y	Y	Y	Y	markup	Y	Y	Y	Y	markup
TURBOFONTS	S	S	S	S	S	S	S	S	S	S	S	S	S	N	N	S	Y	Y	Y	Y	paint	Y	Y	Y	Y	paint

The notations used in this table are defined in "Table Notes" preceding these tables.

Table 2C — Equation-Type Benchmarks (2/1/87)

Product	1	2	3	4	5	6	7	8	9	10
ChiWriter	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
The Egg	Y	Y	Y	N	Y	Y	N	Y	Y	Y
EXP	Y	Y	Y	N	Y	Y	N	N	Y	Y
Spellbinder Scientific	Y	Y	Y	N	Y	Y	N	Y	Y	
T^3	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
TECH/STAR	Y	Y	Y	N	Y	Y	N	N	Y	Y
TECH/WORD	Y	Y	Y	Y	Y	Y	Y	Y	Y	
forMath	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
MicroTEX	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
PCTEX	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Manuscript	Y	Y	Y	N	Y	Y	N	N	Y	Y
MASS-11	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
PS	Y	Y	Y	N	Y	Y	N	N	Y	Y
SAMNA	Y	Y	Y	N	Y	Y	N	N	Y	Y
SWP Enhancement to WordPerfect	mod	Y	mod	N	Y	Y	N	N	Y	Y
TechWriter	Y	Y	Y	Y	Y	Y	Y	Y	Y	
WordMarc Composer	mod	N	mod	N	mod	mod	mod	mod	Y	
EXACT	Y	Y	Y	N	Y	Y	Y	N	Y	Y
TechPrint II	Y	Y	N	N	Y	Y	N	N	Y	Y
TURBOFONTS	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

The notations used in this table are defined in "Table Notes" preceding these tables.

Table 3A — Manuscript/Organizational Features (2/1/87)

Product	Page numbering		Headers and footers						Reference notes					Note markers			Automatic numbering						
	Auto	Restart	Both	Multi line	Page number	Justify	Odd/ even	Restart	Foot	Section	End	Simul	Restart	Number	Alpha	Symbol	Eqn's	Tables	Figures	Refs	Chaps etc.	Lists	Counters
ChiWriter	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	N	Y	N	N	N	N	N	N	2
The Egg	Y	Y	Y	Y	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	1D
EXP	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	Y	N	N	Y	Y	Y	Y	Y	Y	10
Spellbinder Scientific	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	2D
T^3	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N	Y	Y	Y	N	N	N	N	N	N	2D
TECH/STAR	Y	Y	Y	N	Y	N	N	N	add	add	add	add	add	add	add	add	add	add	add	add	add	add	0
TECH/WORD	Y	Y	Y	N	Y	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	1D
forMath	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	>50
MicroTEX	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	256
PCTEX	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	256
Manuscript	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	N	Y	Y	Y	Y	N	6D
MASS-11	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	-	-	-	-	-	-	5
PS	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	prog	prog	prog	prog	prog	prog	100
SAMNA	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	-	-	-	-	-	-	3
SWP Enhancement to WordPerfect	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	-	-	-	-	-	-	4
TechWriter	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y	Y	N	Y	Y	Y	Y	Y	N	12
WordMarc Composer	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	-	-	-	-	-	-	11
EXACT	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	N	N	D	D	D	D	0
TechPrint II	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	N	N	D	D	D	D	0
TURBOFONTS	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	N	N	N	D	D	D	0

The notations used in this table are defined in "Table Notes" preceding these tables.

Table 3B — Manuscript/Organizational Features (2/1/87)

Product	Automatic T of C				Indexes			Bibliographic references				Symbolic references							Lists			Boxes	Justify tables				
	Front	Body	Back	Other	Number	Levels	Sorts	Auto	Appear	Alpha	Other	Forw'd	Back	Page	Chap Section etc.	List	Note	Other	Ordered	Bullet/ simple	Levels		Right	Left	Center	Char	Raster
ChiWriter	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N
The Egg	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N
EXP	N	N	N	N	N	N	N	N	N	N	N	L	L	L	L	L	L	L	N	N	N	Y	Y	Y	Y	Y	N
Spellbinder Scientific	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	M	Y	Y	N	Y	N
T^3	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	arb	Y	Y	Y	Y	Y	N
TECH/STAR	add	add	add	add	add	add	add	add	add	add	add	N	N	N	N	N	N	N	add	add	add	M	N	N	N	N	N
TECH/WORD	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N
forMath	Y	Y	Y	26	8	9	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	9	Y	Y	Y	Y	Y	Y
MicroTEX	prog	prog	prog	prog	E	E	E	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	2P	Y	Y	Y	Y	Y	Y
PCTEX	prog	prog	prog	prog	E	E	E	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	2P	Y	Y	Y	Y	Y	Y
Manuscript	N	Y	N	FT	1	1	Y	N	N	N	N	C	C	C	C	N	N	N	N	N	N	Y	Y	Y	Y	Y	N
MASS-11	Y	Y	Y	N	20	6	Y	N	N	N	N	N	N	N	N	N	N	N	Y	SI	5	Y	Y	Y	Y	Y	Y
PS	N	N	N	N	N	N	N	N	N	N	N	N	Y	B	B	B	B	B	prog	Y	prog	Y	Y	Y	Y	Y	Y
SAMNA	Y	Y	Y	N	1	3	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N
SWP Enhancement to WordPerfect	Y	Y	Y	Y	1	2	Y	N	N	N	N	N	N	N	N	N	N	N	Y	N	1	N	N	N	N	Y	N
TechWriter	Y	Y	Y	Y	10	arb	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	N	Y	N
WordMarc Composer	Y	Y	Y	99	1	8	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	N	Y	N	9	Y	N	N	N	Y	N
EXACT	D	D	D	D	D	D	D	D	D	D	D	N	N	N	D	D	D	D	D	D	D	Y	N	N	Y	N	N
TechPrint II	D	D	D	D	D	D	D	D	D	D	D	N	N	N	D	D	D	D	D	D	D	D	D	D	D	D	D
TURBOFONTS	D	D	D	D	D	D	D	D	D	D	D	N	N	N	D	D	D	D	D	D	D	D	D	D	D	D	D

The notations used in this table are defined in "Table Notes" preceding these tables.

Table 4A — Layout Control (2/1/87)

Product	Page layout												Hyphenation			Widow/orphan control		Figure space		
	Size & margin	Vert. space	Lines/ page	Char. space	Font choice	Indent choice	Spacing Control Horiz.	Vert.	R,L,C	Even/ odd layouts	Override globals	Multi-column	Auto	User override	User rules	Within pars	Arb. blocks	Leave white	Float	Block splits
ChiWriter	Y	L	Y	N	Y	Y	F	F	Y	N	Y	N	N	N	N	N	N	Y	N	Y
The Egg	Y	Y	Y	Y	Y	N	F	F	Y	N	Y	S	N	N	N	Y	N	Y	N	N
EXP	Y	L	Y	Y	Y	Y	F	F	Y	N	Y	S	N	N	N	N	N	Y	N	Y
Spellbinder Scientific	Y	L	Y	Y	L	N	F	F	N	Y	Y	S,P	Y	Y	N	Y	N	N	N	N
T^3	Y	Y	Y	Y	Y	Y	C	C	Y	Y	Y	S,U	N	N	N	N	N	Y	N	Y
TECH/STAR	Y	Y	Y	Y	Y	Y	F	F	Y	N	Y	N	N	N	N	Y	N	Y	N	Y
TECH/WORD	Y	Y	Y	Y	Y	N	F	F	Y	N	Y	N	N	N	N	Y	N	Y	N	N
forMath	Y	Y	Y	Y	Y	Y	C	C	Y	Y	Y	S,P	Y	Y	Y	Y	Y	Y	Y	Y
MicroTEX	Y	Y	Y	Y	Y	Y	C	C	Y	Y	Y	S,P,U	Y	Y	Y	Y	Y	Y	Y	Y
PCTEX	Y	Y	Y	Y	Y	Y	C	C	Y	Y	Y	S,P,U	Y	Y	Y	Y	Y	Y	Y	Y
Manuscript	Y	Y	Y	Y	Y	Y	F	F	Y	Y	Y	P,U	Y	Y	N	Y	N	Y	N	Y
MASS-11	Y	Y	Y	Y	Y	Y	F	F	Y	Y	Y	S,P,U	Y	Y	Y	Y	Y	Y	N	Y
PS	Y	Y	Y	Y	Y	Y	C	C	Y	Y	Y	S	Y	Y	Y	W	W	Y	Y	Y
SAMNA	Y	Y	Y	Y	Y	Y	F	F	Y	Y	Y	Y	Y	Y	L	Y	Y	Y	N	Y
SWP Enhancement to WordPerfect	Y	Y	Y	Y	Y	Y	F	F	Y	N	Y	S,P	Y	Y	N	Y	Y	Y	N	Y
TechWriter	Y	Y	Y	Y	Y	Y	F	F	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y
WordMarc Composer	Y	Y	Y	Y	Y	Y	F	F	Y	N	Y	N	Y	Y	Y	Y	Y	Y	N	N
EXACT	D	D	D	D	D	D	F	F	D	D	D	D	D	D	D	D	D	D	D	D
TechPrint II	D	D	D	D	D	D	F	F	D	D	D	D	D	D	D	D	D	D	D	D
TURBOFONTS	D	D	D	D	D	D	F	F	D	D	D	D	D	D	D	D	D	D	D	D

The notations used in this table are defined in "Table Notes" preceding these tables.

Table 4B — Layout Control (2/1/87)

Product	Hardware customization					Style sheets									Keyboard macros								Command macros					
								Where			If own file:											In file						In file
	Install printer	Doc to write driver	Install video	Upgrade via DOS	EMS driver	All commands	Local override	In doc	Own file	Choice	No.	Cond'l	Choice	Supplied	One to many	Many to many	Store ASCII	Comment	Conds	Local and global	Params	Doc vs all vs choice	Store ASCII	Comment	Conds	Local and global	Params	Doc vs all vs choice
ChiWriter	Y	N	Y	N	N	Some	Y	Y	Y	C	1	N	N	0	N	Y	Y	N	N	N	N	C	Y	N	N	N	N	C
The Egg	Y	N	N	N	N	N	N		n/a			n/a		0	Y	N	N	N	N	N	N	n/a	N	N	N	N	N	n/a
EXP	N	N	N	N	N	Y	Y	N	Y	N		n/a		0	Y	N	N	N	N	N	N	n/a	N	N	N	N	N	n/a
Spellbinder Scientific	Y	N	Y	N	N	N	Y		n/a			n/a		0	N	N	N	N	N	N	N	n/a	N	N	N	N	N	n/a
T^3	N	Y	N	N	N	Y	Y	Y	Y	C	arb	N	Y	4	Y	Y	Y	Y	N	N	N	A	Y	Y	N	N	N	A
TECH/STAR	N	N	N	N	N	N	Y		n/a			n/a		0	N	N	N	N	N	N	N	n/a	N	N	N	N	N	n/a
TECH/WORD	Y	N	N	N	N	Y	N	N	Y	N	arb	N	Y	0	N	N	N	N	N	N	N	n/a	N	N	N	N	N	n/a
forMath	N	N	N	N	N	Y	Y	Y	Y	C	arb	Y	Y	0	Y	Y	Y	Y	Y	Y	Y	C	Y	Y	Y	Y	Y	C
MicroTEX	N	Y	Y	N	N	Y	Y	Y	Y	C	arb	Y	Y	25	Y	Y	Y	Y	Y	Y	Y	C	Y	Y	Y	Y	Y	C
PCTEX	N	Y	Y	N	N	Y	Y	Y	Y	C	arb	Y	Y	25	Y	Y	Y	Y	Y	Y	Y	C	Y	Y	Y	Y	Y	C
Manuscript	N	N	N	N	Y	Y	Y	Y	Y	Y	arb	N	N	3	N	N	N	N	N	N	N	n/a	N	N	N	N	N	n/a
MASS-11	Y	Y	N	N	N	Y	Y	Y	Y	C	1	N	N	1	Y	N	N	N	N	Y	Y	C	N	N	N	N	N	n/a
PS	N	N	N	N	N	Y	Y	Y	N	N		n/a		0	Y	Y	Y	Y	Y	Y	Y	C	Y	Y	Y	Y	Y	C
SAMNA	N	(C)	S	N	N	Some	Y	Y	N	N		n/a		1	Y	Y	N	N	N	N	N	C	Y	Y	N	N	N	C
SWP Enhancement to WordPerfect	N	N	N	N	N	Y	Y	Y	Y	C	arb	N	Y	1	Y	Y	N	N	S	Y	N	C	N	N	S	Y	N	C
TechWriter	N	N	N	N	N	Y	Y	N	Y	N	1	N	N	0	Y	N	N	N	Y	Y	Y	C	N	N	Y	Y	Y	C
WordMarc Composer	N	Y	Y	N	N	Y	Y	Y	Y	C	1	N	N	23	Y	Y	Y	Y	S	Y	Y	A/D	Y	Y	S	Y	Y	C
EXACT	Y	N	Y	N	N	D	D	D	D	D	D	D	D	D	N	N	N	N	N	N	N	N	N	N	N	N	N	N
TechPrint II	N	N	N	N	N	D	D	D	D	D	D	D	D	D	N	N	N	N	N	N	N	N	N	N	N	N	N	N
TURBOFONTS	N	Y	N	N	N	D	D	D	D	D	D	D	D	D	N	N	N	N	N	N	N	N	N	N	N	N	N	N

The notations used in this table are defined in "Table Notes" preceding these tables.

Table 5A — Utilities (e.g., Communications, Add-ons) (2/1/87)

Product	Data interchange: Import: ASCII	Import: Format	Import: Trans mark-up	Export	Internal format doc'd?	Intermediate output: PDL?: Post Script (Adobe)	PDL?: DDL (Imagen)	PDL?: Inter press (Xerox)	Doc'd format to write own driver?	Final output: to file?	Document management: Sep. files w/ include	Long file names	Print file name	RAM-resident compatible: Key	Screen
ChiWriter	Y	N	N	ASCII+	Y	N	N	N	Y	Y	Y	N	N	Y	Y
The Egg	Y	N	N	N	N	N	N	N	N	N	N	N	Y	N	N
EXP	Y	N	N	ASCII,Bin	N	N	N	N	N	N	N	N	N	Y	Y
Spellbinder Scientific	Y	N	N	ASCII	Y	N	N	N	N	Y	Y	N	N		
T^3	Y	N	N	ASCII,Bin	N	Y	(C)	N	Y	Y	Y	N	N	N	Y
TECH/STAR	Y	N	N	N	N	N	N	N	N	Y	n/a	n/a	n/a	N	N
TECH/WORD	Y	N	N	ASCII	N	N	N	N	N	Y	N	N	N	N	N
forMath	Y	N	N	Bin/Hex	N	N	N	N	N	Y	Y	N	Y	Y	Y
MicroTEX	Y	Some	N	DVI	Y	Y	N	N	Y	Y	Y	N	Y	Y	Y
PCTEX	Y	Some	N	DVI	Y	Y	N	N	Y	Y	Y	N	Y	Y	Y
Manuscript	Y	Some	N	ASCII	N	Y	N	N	N	Y	Y	N	Y	Y	Y
MASS-11	Y	N	N	ASCII	N	N	N	N	N	Y	Y	Y	N	Y	Y
PS	Y	Some	Y	ASCII	Y	N	N	N	Y	Y	Y	N	PR	Y	N
SAMNA	Y	Some	Y	ASCII	N	Y	N	N	Y	Y	Y	N	N	Y	Y
SWP Enhancement to WordPerfect	Y	S	N	ASCII	N	N	N	N	N	Y	N	N	N	Y	Y
TechWriter	Y	N	N	ASCII+	Y	N	N	N	N	Y	Y	N	Y	N	Y
WordMarc Composer	Y	N	N	ASCII+	N	Y	N	N	Y	Y	Y	Y	N	Y	Y
EXACT	Y	D	D	Bin	D	D	D	D	D	D	n/a	n/a	n/a	Y	Y
TechPrint II	Y	D	D	D	D	D	D	D	D	D	n/a	n/a	n/a	Y	Y
TURBOFONTS	D	D	D	D	D	D	D	D	D	D	n/a	n/a	n/a	Y	S

The notations used in this table are defined in "Table Notes" preceding these tables.

Table 5B — Utilities (e.g., Communications, Add-ons) (2/1/87)

	Add-ons								Revision Control					Preview				
															Zoom			
Product	Spell check	Format check	Calc	Symbol calc	Spread sheet	Mail merge	Data base	Out-liner	History	Version	Author	Reader	Compare	Compress page	Text	Graphics	Both	Jump f/b by page
ChiWriter	N	n/a	N	N	N	N	N	N	N	N	N	N	N	N	n/a	n/a	n/a	N
The Egg	N	n/a	N	N	N	N	N	N	N	N	N	N	N	N	n/a	n/a	n/a	N
EXP	N	n/a	N	N	N	N	N	N	N	N	N	N	N	N	n/a	n/a	n/a	Y
Spellbinder Scientific	Y	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
T^3	Y	n/a	N	N	N	Y	N	N	N	N	N	N	N	N	n/a	n/a	n/a	Y
TECH/STAR	add	Y	n/a	n/a	n/a	n/a	n/a	n/a	N	N	N	N	N	N	n/a	n/a	n/a	Y
TECH/WORD	N	N	N	N	N	N	N	N	N	N	N	N	N	N	n/a	n/a	n/a	N
forMath	N	Some	IP	IP	N	Y	N	N	Y	Y	Y	Y	N	N	Y	Y	Y	N
MicroTEX	N	Some	IP	IP	N	prog	BIB	N	N	N	N	N	N	N	Y	Y	Y	Y
PCTEX	N	Some	IP	IP	N	prog	BIB	N	N	N	N	N	N	N	Y	Y	Y	Y
Manuscript	Y	Some	N	N	N	Y	N	Y	N	N	N	N	Y	Y	Y	Y	Y	N
MASS-11	Y	n/a	Y	N	N	Y	Y	N	N	N	N	N	N	N	n/a	n/a	n/a	N
PS	N	prog	IP	IP	N	Y	N	N	N	N	N	N	prog	N	Y	Y	Y	N
SAMNA	Y	n/a	Y	N	N	Y	N	N	N	N	N	N	N	Y	n/a	n/a	n/a	Y
SWP Enhancement to WordPerfect	Y	N	Y	N	N	Y	N	N	N	N	N	N	N	N	n/a	n/a	n/a	Y
TechWriter	Y	n/a	N	N	N	Y	N	N	Y–	N	N	N	N	N	n/a	n/a	n/a	Y
WordMarc Composer	Y	n/a	N	N	N	Y	N	N	Y	N	N	N	N	N	Y	N	N	Y
EXACT	n/a	N	n/a	n/a	n/a	n/a	n/a	n/a	D	D	D	D	D	Y	n/a	N	n/a	D
TechPrint II	n/a	N	n/a	n/a	n/a	n/a	n/a	n/a	D	D	D	D	D	N	n/a	N	n/a	D
TURBOFONTS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	D	D	D	D	D	N	n/a	N	n/a	D

The notations used in this table are defined in "Table Notes" preceding these tables.

Table 6 — Documentation, Ease of Use, and Support (2/1/87)

Product	Documentation Quality							Ease of Use		Vendor Support		
	Quick start section	Organization	Clarity	Technical appendices	Index	Examples	Produce doc. via product?	Abort	Undo	Warranty	Bug fixes free?	Charge?
ChiWriter	Y	Func./tut.	Fair	Y	Y	Y	Y	Y	N	Poor	Y	N
The Egg	Y	Func./tut.	Fair	N	Y	Y	Y	Y	Sometimes	Excellent	Sometimes	N
EXP	Y	Functional	Very good	Y	Y	Y	Y	Y	Sometimes	Good	Sometimes	N
Spellbinder Scientific	Y	Functional	Fair	Y	Y	Y		N	N	Poor		N
T^3	Y	Func./tut.	Fair	Y	Y	Y	Y	Y	Y	Poor	Sometimes	N
TECH/STAR	Y	Tutorial	Good	Y	N	Y	Y	Y	n/a	Excellent	Y	N
TECH/WORD	Y	Alpha/tut.	Fair	N	Y	Y	N	N	N	Poor	Y	N
forMath	Y	Functional	Fair	Y	four	Y	Y	Y	n/a	Excellent	1 year	N
MicroTEX	N	Functional	Good	Y	Y	Y	Y	Y	n/a	Poor	N	N
PCTEX	N	Functional	Good	Y	Y	Y	Y	Y	n/a	Poor	Y	N
Manuscript	N	Func./tut.	Good	Y	Y	Y	Y	Y	n/a	Excellent	N	N
MASS-11	N	Func./tut.	Very good	Y	Y	Y	Y	Y	Sometimes	Good	Y	Y
PS	N	Functional	Poor	Y	Y	Y	Y	Y	Y	Excellent	N	N
SAMNA	Y	Alpha	Fair	N	Y	Y	Y	Sometimes	Y	Poor	N	after 30 days
SWP Enhancement to WordPerfect	N	Functional	Fair	N	N	N	Y	Sometimes	N	Poor	Y	N
TechWriter	Y	Functional	Very good	Y	two	Y	Y	Y	Sometimes	Excellent	60 days	after 60 days
WordMarc Composer	Y	Functional	Very good	Y	Y	Y	Y	N	N	Poor	N	Y
EXACT	Y	Func./tut.	Fair	Y	Y	Y	Y	Y	n/a	Poor	Y	N
TechPrint II	N	Func./tut.	Good	Y	N	Y	n/a	Y	n/a	Excellent	Sometimes	N
TURBOFONTS	Y	Functional	Very good	Y	Y	Y	PW	N	n/a	Poor	N	N

The notations used in this table are defined in "Table Notes" preceding these tables.

International Comparisons of Mathematics Education: Problems and Insights

On January 15–16, 1987, the Mathematical Sciences Education Board (MSEB) sponsored a symposium entitled "International Comparisons of Mathematics Education: Policy Implications for the United States." At the symposium, held at the National Academy of Sciences in Washington, D.C., researchers presented new studies pointing to a by now familiar problem: American students are trailing in mathematics, while the Japanese are leading.

The studies all found American students to rank consistently at or below average on standardized achievement tests, while Japan consistently ranked at or near the top. One of the reports, "The Underachieving Curriculum: Assessing U.S. School Mathematics from an International Perspective," represents the findings of the Second International Mathematics Study; the first one was conducted in 1964. Even since that first study, which ranked the United States "slightly below the mean," eighth grade mathematics classes showed a "modest decline in achievement," and "somewhat greater [declines] for more demanding comprehension and application items." The new study found that eighth grade American students were "slightly above the international average in computational arithmetic (calculation) and well below the international average in noncomputational arithmetic (e.g., problem-solving)." In some of the tests the study used, American twelfth graders were ranked "the lowest of the advanced industrialized countries." The study is the largest cross-cultural analysis of mathematics achievement ever conducted. It compared the mathematics ability of American eighth and twelfth graders with that of their counterparts in 20 other countries, including Japan, France, Finland, Hungary, Israel, New Zealand, and Swaziland.

Another new study, "Mathematics Achievement of Chinese, Japanese, and American Children," by Harold W. Stevenson of the University of Michigan, Shin-ying Lee of the University of Michigan, and James W. Stigler of the University of Chicago (all of whom spoke at the symposium), presents data from mathematics achievement tests administered to over 1,400 randomly selected Japanese, Taiwanese, and American children in kindergarten and grades 1 and 5. In examining the progress of the students from kindergarten to fifth grade, the study notes the "consistently superior performance of the Japanese children and rapid improvement in the scores of the Chinese children," and the steady decline of the scores of the American children. In addition, "the highest average score of an American fifth grade classroom was below that of the Japanese fifth grade classroom with the lowest average score."

This same study also presents an array of data showing that American students spend less classroom time engaged in academic activities, less time on mathematics than on other subjects, and less time on homework. They even spend less time physically in the classroom: 18.4% of the time any American fifth grader was observed during the study, he or she would be in the school office, in another classroom, in the library, or doing an errand for the teacher. In Taiwan and Japan, the figure was only .2%.

While all of the studies painted the same bleak picture of the American students' low achievement, each study pursued different means of identifying the causes of the problem. "The Underachieving Curriculum" points to the American mathematics curriculum as the "culprit." One feature of mathematics education in this country is the "spiral curriculum," in which topics are revisited year after year, each time presumably with a more sophisticated treatment and a deeper understanding. But the report found that these goals seem to have been "sacrificed to demands for content suitable for rote reception learning," and that the "curricula are driven and shaped by still-unmastered mathematical content begun years before."

By contrast, the study shows, the mathematics curricula of Japan are much more focused, and Japanese students progress more rapidly. For example, at the beginning of a school year, 22% of the American and 19% of the Japanese eighth graders in the study could simplify $-6-(-8)$. This skill was taught in 94% of the American and 98% of the Japanese classrooms, but by the end of the year only 41% of the American students could correctly simplify that same expression, compared to 72% of the Japanese.

The Japanese curricula also tend to emphasize a more sophisticated understanding of mathematical concepts. For example, Stigler said that in Japan, a teacher may spend an entire class period discussing the meaning of a simple calculation such as $2+4$, approaching

the problem in several different ways. Kenneth Travers, Professor of Mathematics Education at the University of Illinois at Urbana-Champaign and joint international coordinator for "The Underachieving Curriculum," remarked during the symposium that in Japan mathematical concepts are so often presented as applications to problems that the Japanese teachers participating in the study did not understand the term "word problem." In American mathematics classrooms, "word problems" are treated as a separate topic, like logarithms or graphing.

"The Underachieving Curriculum" also questions the practice, common in American schools, of "tracking," or sorting students into mathematics classes of varying levels. The study examined this practice in eighth grade classes and found that, instead of matching students' background and abilities to the appropriate class, tracking simply limits opportunities for learning and sets "boundaries on what each individual can achieve by his or her own efforts." The report also found that the sorting was not efficiently done. For example, the lowest scoring students in the highest level class had lower arithmetic scores than 75% of the students in the lowest level class.

The attitudes of parents and teachers seem to be another factor in the difference in achievement. At the symposium, Stevenson and Lee presented results of their comparative study of fifth graders and their mothers in the United States, Japan, and Taiwan. (Interviewing only mothers was purely a practical decision: At the symposium, Stevenson said that it had turned out to be quite difficult to schedule interviews around the demanding work schedules of the Japanese fathers. However, the researchers are planning future studies which will examine both parents' attitudes.) The study found that, with regard to mathematics, American mothers seem to be much less demanding of their children and of the schools. They tend to have "more favorable evaluations of their children's abilities than did Chinese and Japanese mothers," and were "the most satisfied with their children's academic performance." "American children have to be performing very poorly for their mothers not to be satisfied with their performance," the study remarks, "and they do not have to be much above average for their mothers to be very satisfied." American mothers appear to be generally satisfied with the job the school is doing in educating their children, for 81% of them gave the school a rating of "excellent" or "good," compared with 40% of the Chinese and 36% of the Japanese mothers.

In the study by Stevenson, Lee, and Stigler, mothers were asked to assign a total of 10 points to 4 factors of academic success—effort, ability, luck, and difficulty of the work—to indicate the relative importance of each factor. Of the mothers from the three countries, the Japanese gave the most points to effort and the fewest to ability, while the Americans did just the opposite. The study concludes, "the willingness of Japanese and Chinese children to work so hard in school may be due, in part, to the stronger belief on the part of their mothers in the value of hard work."

The attitudes of American and Japanese teachers also differ markedly. Data from "The Underachieving Curriculum" show that 66% of American eighth grade teachers reported that mathematics is "very easy" or "easy" to teach, compared with only 10% of their Japanese counterparts. In addition, Japanese teachers tend to accept much of the responsiblity for a student's low achievement, while American teachers tend to cite causes beyond their control, such as lack of student ability. While poor teacher preparation and lack of experience are often assumed to contribute to American students' low mathematics achievement, the study found that the experience and training of the American teachers did not differ much from that of their international counterparts, although on average the Americans had taken fewer pedagogy courses than the Japanese.

The studies found that in the United States, parents and teachers tend to believe that reading is more important than mathematics and science. In Japan and Taiwan, fifth grade classes spend more hours per week on both mathematics and language arts than American classes, and that time is more evenly divided between the two subjects. In American fifth grade classes, more than twice as much time is spent on reading than on mathematics. Even given this unequal emphasis, both parents and teachers when questioned said that they felt even greater proportions of time should be devoted to reading. The study by Stevenson, Lee, and Stigler concludes that American parents and teachers believe that "education in elementary school is synonymous with learning to read," and that "mathematics and science play a small role in Americans' conception of elementary education."

However, the commonly suggested remedy of increasing the total number of hours of mathematics instruction would not necessarily boost achievement. Indeed, one of the studies shows that in the three countries with the highest achievement in eighth grade mathematics—Japan, the Netherlands, and Hungary—the number of hours devoted to mathematics instruction per year are 101, 112, and 96, respectively, while in the United States the figure is 144. The nation devoting the greatest number of hours to mathematics instruction (158) is Nigeria, which ranked nineteenth among the twenty countries in the study.

Another remedy commonly proposed is reducing class size. However, one of the studies points out that a typical eighth grade Japanese class has 41 students, compared with 26 in the United States. In addition, in Hong Kong, which is ranked above the United States in achievement, the number is 43, while for Thailand and Swaziland, both ranked below the United States, the

numbers are 43 and 41. The study concludes that "no simple relationship between class size and achievement is evidenced."

As the disturbing data were revealed and reiterated at the symposium, the audience of teachers, administrators, college professors, and government officers could occasionally be heard gasping and groaning. Lee's presentation of comparisons of mothers' attitudes and beliefs elicited many laughs, and Travers was applauded for pointing out that Japanese teachers have far fewer classes than American teachers (16-17 hours of teaching per week in Japan, compared with 23–25 hours in the United States). The audience's involvement extended to the open discussion period, during which members of the audience lined up at four microphones placed around the auditorium waiting to ask a question or make a comment.

The MSEB was established by the National Research Council in October 1985 to provide national leadership in mathematics education. One of their first goals is to focus national attention on the problems of American mathematics education in order to stimulate a national dialogue about possible solutions. It appears that this symposium was a successful first step toward meeting those goals. News of the studies and the symposium appeared in many newspapers and magazines, and even prompted the appearance of MSEB Chairman Shirley Hill on "Good Morning America." The problems of mathematics education need this kind of widespread attention to insure that the nation as a whole, and particularly parents, understands the necessity for the sweeping reforms that must take place.

In addition to the speakers already mentioned, the symposium included a speech by William R. Graham, Science Advisor to the President; a media panel, during which reporters from the *New York Times*, *United Press International*, the *Chronicle of Higher Education*, and the *Washington Post* questioned the researchers; and discussions of the implications of the studies for presecondary and secondary mathematics curricula. One of the speakers, Izaak Wirszup, Professor Emeritus of Mathematics at the University of Chicago, brought up the subject of the role of research mathematicians in elementary mathematics education. In describing how the Soviet Union has revamped its mathematics and science curricula, he remarked that Soviet mathematicians are involved in writing elementary textbooks and formulating curricula. He also pointed out that some great European mathematicians—among them Klein, Hilbert, Hadamard, and Banach—took an active interest in elementary mathematics education, but that most American mathematicians have shown little interest in this area, especially during the last 15 years.

Allyn Jackson
Staff Writer

PARTICLE SYSTEMS, RANDOM MEDIA AND LARGE DEVIATIONS

Richard Durrett, Editor

"The book is an excellent introduction to the exciting recent developments which combine ideas from physics with mathematical techniques from the theory of probability."

– Frank L. Spitzer
Cornell University

This volume of proceedings of the 1984 AMS Summer Research Conference *The Mathematics of Phase Transitions* provides a handy summary of results from some of the most exciting areas in probability theory today: interacting particle systems, percolation, random media (bulk properties and hydrodynamics), the Ising model and large deviations. Thirty-seven mathematicians, many of them well-known probabilists, collaborated to produce this readable introduction to the main results and unsolved problems in the field. In fact, it is one of the very few collections of articles yet to be published on these topics. To appreciate many of the articles, an undergraduate course in probability is sufficient. The book will be valuable to probabilists, especially those interested in mathematical physics and to physicists interested in statistical mechanics or disordered systems.

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Washington Outlook

Kenneth M. Hoffman

Chairman Fuqua's Legacy

When the 100th Congress convened in January, absent was one of the staunchest and most effective supporters of scientific research and education on Capitol Hill, Congressman Don Fuqua (D-FL). Some controversy did surround Representative Fuqua near the end of his reign as Chairman of the House Committee on Science and Technology (HST) when his influence was used to land a supercomputer for Florida State University. On balance, however, we in mathematics stand, as do all other scientific fields, deeply in his debt. He and his staff strongly supported the NSF budget increases we have received; they were instrumental in helping create National Mathematics Awareness Week last year; and they were the first to promulgate the encapsulation "Mathematics as a Foundation Discipline" (in remarks to the Mathematical Sciences Education Board, October 1985).

The Chairman's retirement after 23 years in the House coincided with the final report of the Science Policy Task Force, established by HST in 1984 to focus attention on the issues involved in maintaining America's leadership in science. The lengthy report based on two years of hearings and testimony has been summarized by Representative Fuqua and enriched by 62 specific proposal recommendations, which constitute a formidable agenda. What his successor as chairman, likely to be Representative Robert Roe (D-NJ), or the broader House Committee on Science and Technology will do with the recommendations remains to be seen, but they make important reading. The first three sentences convey very clearly the general message:

> Science is the keystone of our nation's progress and the backbone of our military security. America's science enterprise is a national treasure and an investment in our future. Science warrants strong financial support from the federal government, even in times of deficit reduction.

Some of the more specific recommendations are described briefly below. Parts of the paraphrasing are taken from the NSF's monthly Congressional Report, October–November, 1986.

Basic Research

Support. Increase federal support for basic research to no less than 1% of the federal budget; increase federal support for basic research at universities to .2% of the GNP. Create a functional multi-year authorization/appropriations mechanism to ensure continuity and stability. Grants should be of longer duration with renewal based primarily on visible, published results. Discontinue support of marginally productive researchers and help young investigators launch their careers. Encourage the support of interdisciplinary research, supercomputers and networking, the collection of reliable data for social science research, and the exploration and production of critical and strategic materials.

Big science. Support by the federal government of big science must not be given to the exclusion of small science. Undertake those efforts that represent the most sound investment for the nation. Order priorities and accept reasonable timetables. Consider support for the Superconducting Super Collider (SSC) only after Fermilab and the Stanford Linear Accelerator have been fully exploited, and when funding is available.

Peer review. Granting agencies should reexamine policies to determine if the geographical distribution of grants is consistent with the best interests of the nation.

Federal laboratories. Encourage technology transfer programs and permit researchers to work on individual projects in addition to those assigned by the laboratory director. No new government laboratory should be started without closing one elsewhere.

Organization. Remedy neglect of the basic research portion of the military R&D budget, possibly with NSF assisting DOD in expending its basic research funds. Correct the fragmented approach of categorizing, counting, and considering the totality of federal funds designated for basic research.

Regulation. Monitor the climate in which science is performed and ensure the public's safety in the general use of biotechnology.

Infrastructure

Facilities. Minimize congressional involvement at the project level. Address problem even if support for individual researchers has to be curtailed. A possible solution could be through programs requiring matching funds.

University operations. Develop a long-term solution for support, possibly through ancillary payments based on a fixed percentage of all direct costs, or on a formula grant system similar to that for agriculture.

University system. Foster and maintain a first-rank research university system by developing a program whereby the Department of Education and the NSF would jointly target the need for development of a new university and/or modernization of an existing one. Encourage specialization among universities to foster abilities to excel in specific areas, and effectively utilize funding, facilities, and talent.

Science Education

Programs. Provide financial inducements for the best science and math students through fellowships, scholarships, and research assistantships. Provide proper storage facilities and computer capability for museums to organize material and make it available for research. Provide effective computer based instruction for all students. Determine whether the precollege educational responsibilities of NSF should be transferred to the Department of Education.

Scientific literacy. Hold hearings to stimulate awareness of the importance of the scientific literacy of the general public.

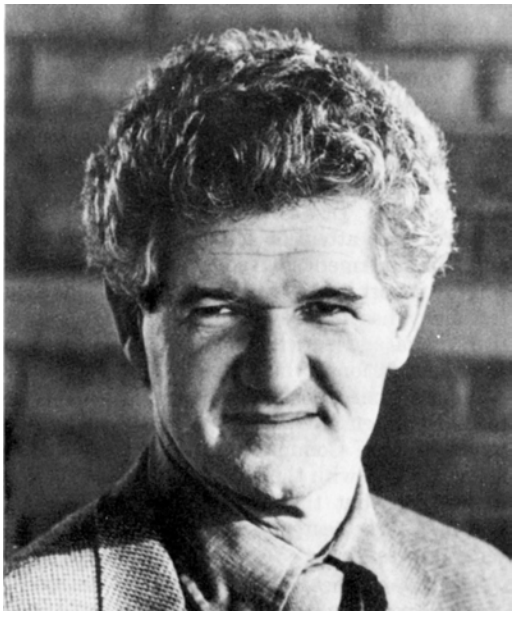
Wolf Prize Awarded to Ito and Lax

The Wolf Foundation has announced that the 1987 prize in mathematics is to be shared by Kiyoshi Ito, of the Research Institute for Mathematical Sciences of Kyoto University, and Peter D. Lax, of the Courant Institute of Mathematical Sciences of New York University. The prize for mathematics is $100,000.

KIYOSHI ITO is being honored for "his fundamental contributions to pure and applied probability theory, especially the creation of the stochastic differential and integral calculus." He has given us a full understanding of the infinitesimal development of Markovian sample paths. This may be viewed as Newton's law in the stochastic realm, providing a direct translation between the governing partial differential equation and the underlying probabilistic mechanism. Its main ingredient is the differential and integral calculus of functions of Brownian motion. The resulting theory is a cornerstone of modern probability, both pure and applied. His work has led to a profound understanding of the problems and the phenomena associated with planning, control, and optimization of engineering and other systems which are basically random rather than certain. In addition, Professor Ito has been the inspirer and teacher of a whole generation of Japanese probabilists.

Kiyoshi Ito

PETER D. LAX is being awarded the prize for "his outstanding contributions to many areas of analysis and applied mathematics" that have decisively influenced numerical computations involved in solving differential equations which occur in the description of real phenomena. A graduate of the Courant Institute, he embodies the best traditions of D. Hilbert as continued by R. Courant. Among his many contributions are the solution of the Cauchy problem with oscillatory data, the comprehensive development of scattering theory, the theory of non-linear conservation laws, and a deep insight into the Korteweg-de Vries equation. Professor Lax's influence has been profound and decisive in both pure and applied mathematics.



Peter D. Lax

Hopcroft and Tarjan Receive 1986 ACM A. M. Turing Award

The 1986 A. M. Turing Award, the highest honor of the Association for Computing Machinery (ACM) for technical contributions in computing, was presented to Robert E. Tarjan and to John E. Hopcroft at the ACM/IEEE Computer Society's Fall Joint Computer Conference in Dallas, Texas, on November 6, 1986.

John Hopcroft and Robert Tarjan were recognized "for fundamental achievements in the design and analysis of algorithms and data structures. Their work stimulated intensive study in these areas and demonstrated the importance of graph theory in practical computing. They showed that

a few simple techniques combine powerfully and elegantly to yield efficient algorithms for problems arising in many areas of computer applications."

In their joint work, Hopcroft and Tarjan showed the importance of depth-first search in graph algorithms, which led eventually to their discovery of a linear-time algorithm for testing graph planarity. Hopcroft is also recognized for his discovery of 2-3 trees, one of the simplest of the so-called "height-balanced" data structures. In the area of graph algorithms, Tarjan's algorithms hold most of the world records for performance.

John Hopcroft is the Joseph C. Ford Professor of Computer Science at Cornell University where he directs the Robotics Laboratory. Robert Tarjan is the James S. McDonnell Distinguished Professor of Computer Science at Princeton University and a Distinguished Member of the Technical Staff at AT&T Bell Laboratories.

– ACM News Release

Irving Reiner
1924–1986

Irving Reiner, internationally known for his work in representation theory, died on October 28, 1986. He had been a member of the University of Illinois faculty for 38 years, an AMS member for 42 years, and a member of the Mathematical Association of America for 38 years.

Reiner's work in representation theory was in large part responsible for the current interest and activity in this area. He wrote over 100 research papers and several books. His 1962 book, *Representation Theory of Finite Groups and Associative Algebras*, written in collaboration with Charles W. Curtis, is a classic work widely praised for its presentation of the subject. Reiner and Curtis recently completed an encyclopedic, 2-volume work, *Methods of Representation Theory*, which his colleagues expect to become a standard reference.

Born February 8, 1924, in Brooklyn, New York, Reiner graduated magna cum laude from Brooklyn College in 1944 with a B.A. in mathematics and physics. He received his M.A. in 1945 and Ph.D. in 1947, both from Cornell University.

In 1948 he married Irma Moses, and that year they both joined the Department of Mathematics at the University of Illinois at Urbana-Champaign. He was a member of the Institute for Advanced Study at Princeton University in 1947–1948 and 1954–1956, and of the Center for Advanced Study at the University of Illinois in 1975–1976 and 1982–1983. Reiner held at various times visiting appointments at the University of Paris, Queen Mary College and King's College of the University of London, and the University of Warwick, Coventry.

He received many awards in recognition of his work, including a Guggenheim Fellowship in 1962, the Distinguished Alumnus Award from Brooklyn College in 1963, and a NATO senior fellowship in 1977.

Reiner served on several AMS committees and was an associate editor of Contemporary Mathematics (1981–1985). He was also Editor of the *Illinois Journal of Mathematics* from 1978 to 1985, and for the last six months of his life was a collaborating editor of the problem section of the *American Mathematical Monthly*.

He was coordinator of the special year in Algebraic Number Theory and Algebra at the University of Illinois in 1981–1982 and co-coordinator of the conference on Orders and their Applications held in 1984 at the Mathematics Institute in Oberwolfach, West Germany.

Nelson Dunford
1906–1986

Nelson Dunford, formerly James E. English Professor at Yale University, died on Sunday, September 7, 1986, in Sarasota, Florida, after a short illness.

Professor Dunford was born on December 12, 1906, in St. Louis, Missouri, the son of James W. and Maude Dunford. He received a Ph.B. (1931) and M.A. (1932) from the University of Chicago, and a Ph.D. (1934) from Brown University, under the direction of Professor J. D. Tamarkin. He was an instructor at Brown (1934–1935), went to Yale in 1936, and became a full professor in 1943. He was given the James E. English Chair in 1950 and retired in 1960.

He was a member of the *Transactions* (1941–1949) and the *Mathematical Surveys* (1945–1949) editorial committees, and a member-at-large of the Council (1942–1944). He gave invited hour lectures to the Society in April 1943 and January 1958, and to the International Congress of Mathematicians in 1950. He and J. T. Schwartz (his former student) received the Steele Prize for mathematical exposition for their 3-volume joint work, *Linear Operators*, published by Wiley-Interscience in 1958, 1963, and 1971. The citation of the Steele Committee reads, in part: "This monumental work of 2,592 pages must be the most comprehensive of its kind in mathematics... A whole generation of analysts has been trained from it."

Nelson Dunford was a lucid expositor and a splendid teacher. He is widely known for his pioneering research on (vector-valued) integration and on ergodic theory, for his seminal work with B. J. Pettis (which is the foundation for many recent developments in Banach space theory), and as the creator of the theory of "spectral operators." Although Dunford had only a few doctoral students, he had a profound influence on researchers and students of functional analysis and operator theory through his publications.

Geoffrey S. S. Ludford
1928–1986

Geoffrey S. S. Ludford, Professor of Applied Mathematics in the Department of Theoretical and Applied Mechanics at Cornell University for the past 25 years, died December 11, 1986, in his home in Cayuga Heights, New York, after a brief illness. He was 58.

Professor Ludford was recently appointed the first director of the newly created Mathematical Sciences Institute at Cornell. He had been instrumental in organizing the effort to win the five-year grant that brought the Institute there. He was also recently elected a professor of mathematics in the Department of Mathematics at Cornell University.

Born in London in 1928, he attended Cambridge University and earned his bachelor's, master's, and doctoral degrees there.

He was at Harvard University from 1949–1951 and at the University of Maryland from 1951–1960. After a year at Brown University, he came to Cornell University in 1961 as a Professor of Applied Mathematics. There he established a series of graduate courses that served as the mathematical foundation for doctoral students from all over that university.

His research interests centered on the application of mathematics to fluid phenomena, including magneto-fluid-dynamics and combustion. He was the author of more than 160 research papers and four books. The latter includes completion, along with Hilda Geiringer, of a fundamental work on compressible fluid flow by Professor R. von Mises and a 1982 book, *The Theory of Laminar Flames*, along with his former student, Professor J. D. Buckmaster.

In addition, he won numerous fellowships, including a Guggenheim Fellowship and a Fulbright-Hays Scholarship. He was also given an Alexander von Humboldt Award, was a United Kingdom Science Research Council Visiting Fellow at Cambridge, was a fellow of the Cambridge Philosophical Society, and was a member of numerous professional societies, including the AMS and SIAM. –Cornell University Release

Alexander M. Ostrowski
1893–1986

On November 20, 1986, Alexander Markovič Ostrowski died in his home near Lugano, Switzerland, at the age of 93. A believer in the unity of his science, Ostrowski worked in almost every one of its branches, in both pure and applied areas, and made many lasting contributions.

Ostrowski was born on September 25, 1893, in Kiev. At the age of 18 he had already begun to engage in mathematical research under the guidance of the algebraist Dimitriĭ Aleksandrovič Grave, who at one time was a student of Chebyshev. His first mathematical paper, a study of Galois fields, was written during this period and published a year later. He continued his studies in Marburg, Germany, where he became entangled in the upheavals of World War I and ended up a civil prisoner, but remained mathematically active. After peace was restored, Ostrowski moved on to Göttingen, where he became an assistant to Felix Klein and, in this capacity, prepared the publication of Klein's collected works.

In 1920 he received his doctorate *summa cum laude* under Edmund Landau and David Hilbert with a thesis that, among other things, proved a conjecture stated in Hilbert's 18th problem. The next couple of years saw him first as assistant and then as "Privatdozent" at the University of Hamburg and back in Göttingen. After two more years as a Rockefeller Research Fellow at the Universities of Oxford and Edinburgh, he accepted in 1927 a call to a chair at the University of Basel. He remained there for over thirty years until his retirement in 1958.

Beginning in 1949, and as late as 1966, Ostrowski made many visits to the United States. He was a guest professor at Indiana and Brown Universities and frequently a guest at the National Bureau of Standards. He was awarded honorary doctoral degrees from the Federal Institute of Technology in Zürich in 1958, and the Universities of Besançon in 1967 and Waterloo in 1968.

Ostrowski's work, from the very beginning, showed extraordinary variety. He quickly moved into the forefronts of abstract and multivariate algebra, number theory, functional equations, real analysis and notably complex function theory and conformal mapping. Ostrowski's quickness in absorbing new ideas, his unerring instinct for what was important and potentially fruitful, his phenomenal memory, and his rigorous and disciplined work habits all helped in maintaining this broad base of research throughout his active life. In the late 1930s, and more so in the 1950s, Ostrowski's interests began to shift toward problems of numerical computation. As a result of his frequent visits to the National Bureau of Standards, he became increasingly involved in numerical conformal mapping and questions of matrix theory and matrix computation. Ostrowski's collected works, whose publication by Birkhäuser he was still able to supervise at the age of 90, comprises six volumes—a total of some 4000 pages—the last having appeared only a year ago in 1985. It represents a monumental testimony to a rich and distinguished mathematical career.

Ostrowski's merits, nevertheless, are not restricted to research alone; they are eminent also on the didactic level. His three volumes on differential and integral calculus began to appear in the mid 1940s, and in particular the extensive collection of exercises later published separately with solutions, are splendid models of mathematical exposition which today still serve to educate generations of mathematicians and scientists. His

book on the solution of nonlinear equations and systems of equations, published in the United States in 1960, continues to be one of the standard works in the field. And last but not least, he had well over 30 students, some having attained international stature of their own.

Harry Pollard
1919–1985

Harry Pollard, Professor of Mathematics at Purdue University, died on November 20, 1985, at the age of sixty-six. He was born on February 28, 1919, in Boston, Massachusetts, and he did both his undergraduate and graduate work at Harvard University where he received his Ph.D. in 1942. Professor Pollard held positions at Kenyon College, Columbia University, Yale University, Cornell University (15 years), and Purdue University (24 years) with visiting positions at the Institute for Advanced Study, Harvard University, and the University of Maryland, among others.

He is well known for his research contributions to several areas of mathematics including classical analysis, celestial mechanics, and applied mathematics. In addition to his solution of the Bernstein approximation problem, his work included special functions, convergence methods, nonlinear filtering problems, and transform methods. Within celestial mechanics, he was one of the pioneers and leaders in the mathematical development of the asymptotic theory of the Newtonian N-body problem. This body of research includes his extension of the Virial Theorem, his joint work on the asymptotic behavior of general collisions for N-body systems, and his several seminal papers on the asymptotic properties of evolving Newtonian systems. Two of his four books, *The Theory of Algebraic Numbers* and *Celestial Mechanics*, are in the Carus Mathematical Monographs Series. Not only was Professor Pollard a creative, productive mathematician, but he was an inspiring lecturer, expositor, and teacher.

Erratum. In the December 1986 issue of *Notices*, the names of four individuals, James Eells, B. K. Ghosh, Paul R. Halmos, and Robert H. Lewis, were incorrectly listed in the index for Volume 33 (1986) under Deaths of Members of the Society. Their names actually appeared in the Personal Items section of the June 1986 issue in announcements involving their activities. This section was adjacent to the list of members who had died and the error occurred while collecting information for the index.

The Managing Editor deeply regrets that this error occurred and apologizes for any confusion and inconvenience it may have caused.

A review by J. Galambos of the book, *Extremes and related properties of random sequences and processes*, by Leadbetter, Lindgren, and Rootzen was published in the *Bulletin of the American Mathematical Society*, vol. 13, 65–67. That review contained the statement, "the list of references from Galambos (1978) is reproduced (without acknowledgment)." Opinions expressed in a review are, of course, those of the reviewer, not of the editors. The quoted statement, however, was inappropriate and unwarranted. The Editors regret its publication.

Hyman Bass, Editor
Bulletin of the American Mathematical Society

To the Mathematical Community:

The editors of *Mathematical Reviews* and *Zentralblatt für Mathematik* have initiated the process of revising the 1980 Mathematics Subject Classification, which is used by both journals as their classification system. The editors do not plan a radical revision of the present 1980 system, but it is clear that some changes will be needed in order to accommodate recent developments in mathematical research. It will be necessary to have this revision completed by the end of 1988 so that it can be used in *Current Mathematical Publications* beginning in 1989, and in *Mathematical Reviews* and *Zentralblatt für Mathematik* beginning in 1990.

We hereby solicit comments and suggestions from the mathematical community to be considered in this revision process. Please write to either one of us with your comments and suggestions, for we are eager that research mathematicians and scholars have input in this revision process as soon as possible.

Copies of the present system can be found in the most recent index issues of *Mathematical Reviews* and *Zentralblatt für Mathematik.*

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Fulbright Awards for 1986-1987

Almost 1,000 Fulbright Awards for 1986-1987 have been announced by the Council for International Exchange of Scholars, an affiliate of the American Council on Education. Among those selected for these awards are twenty-seven listed in the categories of mathematics and computer science. Of the entire group selected, about two-thirds will lecture and one-third will conduct research. They will work for periods of up to one year at institutions in over 100 different countries.

The names of those listed in the field of mathematics or computer science, with home institutions and countries in which they will be teaching or doing research, are given below:

JAMES W. BROWN, Chairman of Computer Education, Nautilus Junior High School (Miami), Colombia; MYRON A. CALHOUN, Associate Professor of Computer Science, Kansas State University, Nigeria; MICHAEL J. FOLK, Associate Professor of Computing and Information Science, Oklahoma State University, Zambia; ANTONY S. HALARIS, Vice-President for Computing and Information Services, Iona College, Peru; ALAN C. SHAW, Professor of Computer Science, University of Washington, France; FREDERICK N. SPRINGSTEEL, Associate Professor of Computer Science, Oregon State University, Yugoslavia; BERNARD A. ASNER, Associate Professor of Mathematics, University of Dallas, Portugal; RAYMOND G. AYOUB, Professor of Mathematics, Pennsylvania State University, West Bank; AUSTIN R. BROWN, JR., Professor of Mathematics, Colorado School of Mines, Cyprus; RICHARD N. CORNEZ, Assistant Professor of Mathematics, University of Colorado, Botswana; ROBERT J. DAVERMAN, Professor of Mathematics, University of Tennessee at Knoxville, Yugoslavia; JOHN E. DENNIS, JR., Professor of Mathematical Sciences, Rice University, Argentina; JAMES E. FALK, Professor of Operations Research, George Washington University, U.S.S.R.; ROBERT FINN, Professor of Mathematics, Stanford University, West Germany; PETER B. GILKEY, Professor of Mathematics, University of Oregon, Yugoslavia; JOHN L. GOLDWASSER, Assistant Professor of Mathematics, Amherst College, Malawi; SUE E. GOODMAN, Associate Professor of Mathematics, University of North Carolina at Chapel Hill, Brazil; KYONG T. HAHN, Professor of Mathematics, Pennsylvania State University, West Germany; KENNETH J. HOCHBERG, Associate Professor of Mathematics and Statistics, Case Western Reserve University, Israel; LAWRENCE S. HUSCH, Professor of Mathematics, University of Tennessee at Knoxville, Yugoslavia; SHIRLEY KOLMER, Associate Professor of Mathematics, Saint Louis University, Liberia; FRANK H. LESTER, Professor of Curriculum and Instruction, Indiana University, Brazil; DAVID A. LUDWIG, Director of the Statistical Consulting Center, University of North Carolina at Greensboro, Egypt; MURRAY M. SCHACHER, Professor of Mathematics, University of California at Los Angeles, Belgium; DOUGLAS S. SHAFER, Associate Professor of Mathematics, University of North Carolina at Charlotte, Belgium; MERWIN L. WAITE, Professor of Mathematics, East Los Angeles College, France; and SCOTT W. WILLIAMS, Professor of Mathematics, State University of New York at Buffalo, Czechoslovakia.

– *The Chronicle of Higher Education*

Fulbright Scholar Awards 1988–1989 Competition Opens

The Council for International Exchange of Scholars has announced the opening of the competition for the 1988–1989 Fulbright grants in research and university lecturing abroad.

The awards for 1988–1989 include more than 300 grants in research and 700 grants in university lecturing for periods ranging from three months to a full academic year. There are openings in over 100 countries and, in some instances, the opportunity for multi-country research is available. Fulbright Awards are granted in virtually all disciplines, and scholars in all academic ranks are eligible to apply. Applications are also encouraged from retired faculty and independent scholars.

Benefits include round-trip travel for the grantee and, for most full academic year awards, one dependent; maintenance allowance to cover living costs of grantee and family; tuition allowance, in many countries, for school-age children; and book and baggage allowances.

The basic eligibility requirements for a Fulbright Award are U.S. citizenship; Ph.D. or comparable professional qualifications; university or college teaching experience; and, for selected assignments, proficiency in a foreign language. It should be noted that a new policy removes the limit of two Fulbright grants to a single scholar.

Application deadlines for the awards are: **June 15, 1987** (for Australasia, India, and Latin America, except lecturing awards to Mexico, Venezuela, and the Caribbean); **September 15, 1987** (for Africa, Asia, Europe, the Middle East, and lecturing awards to Mexico, Venezuela, and the Caribbean); **November 1, 1987** (for institutional proposals for the Scholar-in-Residence Program); **January 1, 1988** (for Administrators' Awards in Germany, Japan, and the United Kingdom; the Seminar in German Civilization; the NATO Research Fellowships, and the Spain Research Fellowships); and **February 1, 1988** (for the France, Italy, and Germany Travel-Only Awards).

For more information and applications, call or write Council for International Exchange of Scholars, Eleven Dupont Circle N.W., Washington, D.C. 20036-1257. Telephone: 202-939-5401.

– CIES News Release

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

From February–April 1987, the IMA is holding a Period of Concentration on Structural Mechanics and Properties of Materials. Two events during this period are a Workshop on Constitutive Equations and Modeling of Distributed Cracking, Strain Softening, and Localization held February 16–18 and a Workshop on Scientific Software to be held March 23–26.

In addition to the AMS-SIAM Summer Seminar in Applied Mathematics on VLSI design from April 30 to May 7, the IMA will have two longer summer programs designed to acquaint mathematicians with potential applications of mathematics in the areas of Molecular Structure and Dynamics and of Robotics.

The last part of the 1986–1987 program on Scientific Computing will be a six-week long workshop on Atomic and Molecular Structure and Dynamics. This program will begin on June 15 and is being organized by Donald G. Truhlar of the Department of Chemistry at the University of Minnesota. It will feature lecture series (usually three lectures) by eleven distinguished lecturers. One or two lecturers will be in residence during each of the six weeks. They will discuss a wide variety of topics including Electronic Structure Theory, Spectural Studies on Atoms and Molecules, Coupled Cluster Approaches to the Many-Electron Corelation Problem, Many-Body Dynamics in an Electromagnetic Field, Computer Simulation of Chemical and Biomolecular Systems, Lie Algebraic Approach to Molecular Structure and Dynamics, and Unitary Group Approach to Configuration Interaction Problems.

The lecturers have been selected for their excellence at expository seminars, for their internationally acknowledged expertise in specific subject areas, and for the promise for mathematical development of these subject areas. Their lectures will be specially prepared for a mathematical audience interested in studying frontier areas in mathematical chemistry and physics. Each lecture series will include expository material to introduce the subject to nonchemists, nonphysicists, and nonspecialists. Lectures will also emphasize computational and mathematical aspects of current or recent research.

The program on Robotics will occur from August 3 to 28. The organizing committee for this program consists of J. T. Schwartz, R. Brockett, J. Hopcroft, T. Lozano-Perez, and R. Volz.

The purpose of the program is to introduce mathematicians to interesting mathematical research problems which arise in the area of Robotics. The first week will be devoted to an overview of the subject. The following three weeks will present lectures by a number of specialists on several topics.

C. Brown of the University of Rochester will organize a program on Computer Vision and Other Sensors during the second week. M. Mason of Carnegie-Mellon University is organizing a program on Robot Manipulation, Kinematics, and Control during the third week, and C. Hoffman of Purdue University is organizing a program on Computational Issues in Geometry during the last week. The lecturers have been asked to present these subjects to an audience of interested mathematicians.

Visitors are welcome at all IMA programs. Some support for participants will be available for both of the above programs.

1988–1989 Advanced Research Fellowships in India

The Indo-U.S. Subcommission on Education and Culture is offering twelve long-term (6–10 months) and nine short-term (2–3 months) awards for 1988–1989 research in India. These grants will be available in all academic disciplines, including mathematics. Applicants must be U.S. citizens at the postdoctoral or equivalent professional level. The fellowship program seeks to open new channels of communication between academic and professional groups in the United States and India and to encourage a wider range of research activity between the two countries than now exists. Therefore, scholars and professionals with limited or no prior experience in India are especially encouraged to apply.

Fellowship terms include: $1,500 per month, of which $350 per month is payable in dollars and the balance in rupees; an allowance for books and study/travel in India; and international travel for the grantee. In addition, long-term fellows receive international travel for dependents; a dependent allowance of $100–$250 per month in rupees; and a supplementary research allowance of up to 34,000 rupees. This program is sponsored by the Indo-U.S. Subcommission on Education and Culture and is funded by the United States Information Agency, the National Science Foundation, the Smithsonian Institution, and the Government of India.

The application deadline is June 15, 1987. Application forms and further information are available from the Council for International Exchange of Scholars, Attention: Indo-American Fellowship Program, Eleven Dupont Circle, Suite 300, Washington, D.C. 20036-1257. Telephone: 202-939-5469. –CIES News Release

Travel Support for Foreign Graduate Students

The Society is pleased to announce that travel support for foreign graduate students attending 1987 AMS conferences is expected to be available again this year through a grant from the STEP program of the Institute of International Education. An application has been filed by the Society for funds to support non-U.S. government-sponsored foreign students attending the Summer Research Institute to be held July 6–24 at Bowdoin College, New Brunswick, Maine; the Symposium on the Mathematical Heritage of Hermann Weyl to be held May 12–16 at Duke University, Durham, North Carolina; the Summer Seminar to be held April 30–May 9 at the University of Minnesota, Minneapolis; and the Joint Summer Research Conferences (SRC's) to be held June 14–July 25 at the University of Colorado and July 19–August 15 at Cornell University, Ithaca, New York.

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

In order to apply, send a letter stating your name, home country, and student status, the name of the institution at which you are enrolled, the name of an official at the institution who can verify your status and financial situation, and the name of the AMS conference you plan to attend to: Dr. James W. Maxwell, Associate Executive Director, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940.

Math Awareness Week 1987

In 1986, Mathematics Awareness Week focused on national events, including President Reagan's proclamation of April 14–20 as Mathematics Awareness Week, and a fractal-space public service announcement that appeared on about 200 television stations around the country. This year, Mathematics Awareness Week will be April 12–18 and will focus on stimulating interest in mathematics at the state and local levels in order to reach a larger number of people. Department chairs and other interested groups will receive two mailings asking them to begin making plans for Mathematics Awareness Week, and containing materials for use in promoting Mathematics Awareness Week. The theme this year is "The Beauty and Challenge of Mathematics."

The mailings contain several suggestions for public information activities during Mathematics Awareness Week. Some of them are:

- contacting public information/public relations offices to tell them Mathematics Awareness Week is coming and to keep them informed of Mathematics Awareness Week activities;
- having state legislation passed proclaiming April 12–18 as Mathematics Awareness Week, and obtaining an official proclamation from the state governor;
- a Mathematics Awareness Week reception for local dignitaries;
- exhibits of mathematics texts and pictures;
- public lectures on mathematics; and
- contacting local media.

If you have questions or would like more information, call or write Kenneth Hoffman, the coordinator of some of these activities.

Kenneth M. Hoffman
Joint Policy Board for Mathematics
Office of Governmental Affairs
1529 Eighteenth Street, N.W.
Washington, DC 20036
202-332-0175

Pitcher Lectures

The next series of Everett Pitcher lectures will be held on Lehigh University's Bethlehem, Pennsylvania, campus, April 27–29, 1987. They will be delivered by Professor John Tate of Harvard University. The lectures are open to the public and are in honor of Everett Pitcher, Secretary of the AMS, who served in the Mathematics Department at Lehigh from 1938 until 1978, retiring as Distinguished Professor of Mathematics. Further information can be obtained by writing Pitcher Lecture Series, Department of Mathematics, Lehigh University, Bethlehem, Pennsylvania 18015; 215-758-3753.

American Mathematician Kidnapped in Beirut

Jesse Turner, an American serving as a visiting professor of mathematics and computer science at Beirut University College in Lebanon, was kidnapped on January 24, 1987. He and three other professors from the college, two Americans and one Indian, are being held hostage by a group called the Islamic Jihad for the Liberation of Palestine.

The group threatened to kill the captives unless Israel released 400 Arab prisoners within a week, but when the February 9 deadline was not met, the group announced it would extend the deadline indefinitely.

Turner received his Ph.D. at the University of Idaho at Moscow and taught at the University of Hawaii and California State University at San Bernadino before accepting the visiting position in Beirut.

Sixth International Congress on Mathematical Education

The Sixth International Congress on Mathematical Education (ICME 6) will be held July 23–August 3, 1988, in Budapest, Hungary. The United States Commission on Mathematical Instruction seeks to encourage American participation in ICME 6. The presentations to be made at ICME 6 are organized into Action Groups and Theme Groups as follows:

Actions Groups: Early Childhood Years (ages 4–8), Elementary School (ages 7–12), Junior Secondary School (ages 11–16), Senior Secondary School (ages 15–19), Tertiary/Post-Secondary/Academic Institutions (age 18+), Pre-Service Teacher Education; and Adult, Technical and Vocational Education.

Theme Groups: The Profession of Teaching, Computers and the Teaching of Mathematics, Problem Solving, Modelling and Applications, Evaluation and Assessment, The Practice of Teaching and Research in Didactics, Mathematics, and other subjects, and Curriculum towards the Year 2000.

For more information about submitting abstracts for consideration, send your name, mailing address, affiliation, and name of the group to which you wish to make a contribution to Eileen L. Poiani, Chairperson, USCMI, Department of Mathematics, Saint Peter's College, Jersey City, New Jersey 07306.

Gomory Named Chief Scientist at IBM

Ralph E. Gomory, a senior vice-president and Head of the Research Division at International Business Machines Corporation (IBM), has been named Chief Scientist for IBM. He will remain in charge of the 3,000-member research division and take on new responsibilities as part of a reorganization at IBM.

The three IBM functions of long-range fundamental research, technology assessment, and keeping abreast of and supporting university research will be combined into a single organization, which Gomory will head. The consolidation is intended to enhance the company's use of advanced technology while providing additional coordination in applying new technologies to IBM products.

Gomory received his Ph.D. in mathematics from Princeton University in 1954, and originally joined IBM in 1959 as a research mathematician. His mathematical background includes work in differential equations, linear and integer programming, combinatorics, and network flows. Since 1985 he has been a senior vice-president at IBM, a position now filled by physicist John A. Armstrong, formerly vice-president in charge of logic and memory for IBM's research division. As Chief Scientist Gomory succeeds physicist Lewis M. Branscomb, who is retiring after serving fourteen years in the position.

Gomory was named an IBM Fellow in 1964 and was Director of IBM's Mathematical Sciences Division from 1965 to 1970, when he became Research Director. He was elected to the National Academy of Sciences (NAS) in 1972 and the National Academy of Engineering in 1975, and served on the NAS Council. He has also served on the governing board of the National Research Council and, this year, became a member of the White House Science Council and the Council of the National Academy of Engineering.

Institute for Retraining in Computer Science (IFRICS)

The IFRICS program was established in an effort to help meet the critical shortage of qualified college teachers of computer science by providing retraining for faculty from other fields such as mathematics. Each IFRICS class participates in two summers of intensive course work. During the intervening academic year each participant is expected to teach a computer science course at their home university and to complete a major programming project. The curriculum consists of eight four-week courses designed to prepare participants to teach a major portion of the ACM '87 core curriculum in computer science. In addition to the regular two-summer program, IFRICS will offer two independent four-week courses entitled "Data Bases and File Management" and "Computer Based Discrete Mathematics" during the summer of 1987.

The two campuses of IFRICS have enrolled 246 participants representing over 200 schools from 44 states and 6 foreign countries during the first four summers of operation. IFRICS has been guided since its creation by the joint ACM/MAA Committee on Retraining for Computer Science. Faculty for the Institute are selected from among the top computer science departments in North America based upon outstanding records in both research and teaching.

The dates for the classes scheduled to begin in the summer of 1987 are as follows: Clarkson University, June 1, 1987–July 31, 1987, and Kent State University, June 15, 1987–August 14, 1987. Interested candidates should write for more information and application forms to either: Ed Dubinsky, IFRICS Director, Department of Mathematics and Computer Science, Clarkson University, Potsdam, New York 13676 or Darrell Turnidge, IFRICS Director, Department of Mathematical Sciences, Kent State University, Kent, Ohio 44242.

National Conference on Undergraduate Research

The University of North Carolina at Asheville (UNCA) Undergraduate Research Program in-

vites participants for the first annual National Conference on Undergraduate Research, April 23–25, 1987.

The conference will span all disciplines of the arts and sciences, providing an opportunity for interchange and cross-fertilization between traditionally divided academic fields. Both students and faculty will participate in the conference. Undergraduate students will have the opportunity to present the results of their research in paper or poster sessions. Faculty will speak during the conference on the nature, problems, and possibilities of undergraduate research. The conference speakers are: Michael P. Doyle, D. R. Semmes Distinguished Professor of Chemistry at Trinity University; Robert Shoenberg, former Dean of Undergraduate Studies at the University of Maryland at College Park; and Neal B. Abraham, Associate Professor of Physics and Chairman of the Department of Physics at Bryn Mawr College.

The conference also includes a Symposium on Undergraduate Research, during which faculty and administrators will present papers on various aspects of undergraduate research. The symposium will have three sessions: Getting Started in Undergraduate Research; The Impact of Undergraduate Research on the Students, Faculty, and Institution; and Undergraduate Research and its Relationship to Teaching. A panel discussion will follow each session so that the presenters may entertain questions and invite discussion.

The deadline for reservation is April 13, 1987. For more information, contact the Office of Undergraduate Research, 211A Rhoades Hall, UNCA, Asheville, NC 28804-3299.

Television Program Promotes Mathematics

"Square-One TV," a new children's educational television series designed to reinforce positive attitudes about mathematics, debuted January 26. The half-hour program will appear daily on nearly 300 public television stations across the nation.

Aimed at 8–12 year-olds, the main goals of "Square-One TV "are to promote a greater interest and enthusiasm for mathematics, to encourage children to use problem-solving in their everyday lives, and to introduce a broad spectrum of important mathematical topics.

The show's fast-paced, humorous, magazine format is intended to overcome the boredom and indifference that many children feel toward mathematics. The seven-member repertory company performs a variety of skits parodying familiar television programming, such as commercials, game shows, situation comedies, sports events, dramas, and newscasts. For example, there are music videos about angles and square numbers, commercials for such products as bar graphs, and daily episodes of "Mathnet," a continuing detective drama in which the characters use mathematics and problem-solving techniques to unravel a mystery.

"Square-One TV" is produced by the Children's Television Workshop (CTW), producers of "Sesame Street," "3-2-1 Contact," and "The Electric Company." After 3 years of research, which included questioning both students and mathematics teachers about the problems they encountered learning and teaching mathematics, CTW produced 5 test shows that were viewed by children across the nation. The children's responses to the test shows provided the information needed to produce the first season's 75 half-hour episodes.

A panel of mathematicians and educators worked with the producers of "Square-One TV" to ensure that the concepts taught on the program are sound and worthwhile. Blending entertainment and education, "Square-One TV" is intended to complement, rather than replace, the teaching of mathematics in schools, and to help children make the link between mathematical concepts and their own lives. "We want children to know that it's all right to think about math and to get excited about it," says Joel Schneider, Content Director for "Square-One TV." "Kids say, 'Math? That's school stuff.' We want them to see math as part of the real world."

Recursion Theory

Anil Nerode and Richard A. Shore, Editors

(Proceedings of Symposia in Pure Mathematics, Volume 42)

The proceedings of the 1982 AMS Summer Research Institute in Recursion Theory, this volume represents the largest and most comprehensive meeting ever devoted to recursion theory. The book contains major surveys with expository papers as well as important new research.

Graduate students and active researchers alike with interests in any aspect of recursion theory, including its interactions with set theory, model theory, constructive mathematics, foundations of mathematics and computer science, will be interested in this book. Some papers require only a basic course in logic or recursion theory; others are aimed at active researchers in the field.

1980 *Mathematics Subject Classifications*: 03D25, 03D30, 03D45, 03D55, and others
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Presidential Young Investigators Named

The NSF announced on December 12, 1986, the selection of 200 engineers and scientists to receive Presidential Young Investigators (PYI) Awards.

The awards, which fund research by faculty members near the beginning of their careers, are intended to help universities attract and retain outstanding young Ph.D.s who might otherwise pursue nonteaching careers. Each recipient can receive up to $100,000 per year for five years in a combination of federal and matching private funds.

The awards address growing faculty shortages in highly competitive fields of engineering and science. This problem exists in all scientific and technical disciplines, but is especially acute in engineering and computer science. Of the 200 awards, more than three-fourths will go to engineering and the physical sciences.

NSF Director Erich Bloch said, "The National Science Foundation is concerned about the supply of highly talented science and engineering faculty in the United States, and I am pleased with the success of this program in attracting bright young Ph.D.s into faculty positions and encouraging them to remain in academic careers. In its first three years of existence, the PYI award has been given to 500 of our most promising young scientists and engineers. Through the industrial matching feature, the PYIs have attracted almost $25 million in private sector support for their research. This year's group of 200 awardees, I am convinced, will be no less successful in their pursuit of teaching and research careers in our universities."

The awards carry an annual base grant from NSF of $25,000. To encourage university-industry cooperation, NSF will provide up to $37,500 per year to match industrial support on a dollar-for-dollar basis, bringing the possible total support to $100,000 per year. Individual universities provide academic salaries and agree to assist the investigator in attracting nonfederal support.

A total of 197 Ph.D.-granting institutions submitted 1,122 nominations for the 200 awards. The new investigators will conduct research at 69 universities in 32 states and the District of Columbia. Of the 200 awardees, 189 are faculty members at universities and 11 have not yet begun academic appointments. The latter were nominated by the universities where they received the Ph.D. degree. These individuals will be able to activate their awards at a Ph.D.-granting institution of their choice upon appointment to a tenure-track faculty position.

The 1987 recipients of the PYI awards in the mathematical sciences, along with their institutional affiliations and research interests, are:

CHRISTOPHER R. ANDERSON (University of California, Los Angeles), *Applied Mathematics*; RICHARD ANDERSON (University of Washington), *Theory of Parallel Algorithms*; MICHAEL J. ARZIZ (Harvard University), *Kinetics and Thermodynamics of Phase Transformation*; LAURENT CLOZEL (University of Michigan), *Representation Theory of Lie Groups*; THOMAS G. DIETTERICH (Oregon State University), *Artificial Intelligence*; DAVID GELERNTER (Yale University), *Parallel Programming*; PHILIP J. HANLON (University of Michigan), *Combinatorics*; MICHAEL J. HOPKINS (Princeton University), *Algebraic Topology*; RANDY J. LEVEQUE (University of Washington), *Numerical Analysis and Partial Differential Equations*; FAI MA (University of California, Berkeley), *Engineering Science and Applied Mathematics*; DANIEL A. REED (University of Illinois), *Parallel Processing*; THOMAS M. SELLKE (Purdue University), *Statistics and Probability*; STEPHEN W. SEMMES (Washington University), *Analysis*; JAMES A. SETHIAN (University of California, Berkeley), *Applied Mathematics*; DAVID B. SHMOYS (Massachusetts Institute of Technology), *Algorithm Theory*; DANIEL D. SLEATOR (Carnegie-Mellon University), *Design and Analysis of Algorithms*; PANAGIOTIS E. SOUGANIDIS (Brown University), *Nonlinear Partial Differential Equations*; UMESH V. VAZIRANI (Harvard University), *Complexity Theory*; RUTH J. WILLIAMS (University of California, San Diego), *Stochastic Processes*; DAVID D. YAO (Harvard University), *Operations Research and Systems Engineering.*

PYI Competition for 1988

There will be a competition for 200 Presidential Young Investigators (PYI) awards for 1988, but because the program is undergoing changes, details about the program will not be available until the middle of March. *Notices* will run announcements about program information as it becomes available. The information can also be obtained from W. Frederick Oettle, Program Director for PYI awards, 202-357-9466. For information about the 1987 program, see "Presidential Young Investigators Named" in this section.

NSF Announces Mathematical Sciences Postdoctoral Research Fellowships

Thirty recent recipients of doctoral degrees in the mathematical sciences have been offered fellowship

awards designed to contribute to the future vitality of the Nation's scientific effort. The awards will be made under NSF's Mathematical Sciences Postdoctoral Research Fellowship program, now in its eighth year. They will permit recipients to choose research environments that will have maximal benefit to their scientific development.

The awards are made to U.S. citizens or nationals on the basis of ability of the applicant and the likely improvement on his or her future in science. A panel of mathematical scientists, chosen by the AMS, the IMS, and SIAM evaluated 112 applications; final selections were made by NSF.

The stipend of $66,000 provides support for two nine-month academic years and three two-month summers, with the awardee's having two options for receiving the academic year support: as full-time support for any eighteen academic year months in a three-year period, in intervals not shorter than three consecutive months (the Research Fellowship option), or as a combination of full-time and half-time support over a period of three academic years, usually one academic year full-time and two academic years half-time (the Research Instructorship option).

The recipients in the mathematical sciences are listed below (institutions in parentheses are the current institutions, those outside the parentheses are those at which the fellowship will be held): JONATHAN ASHLEY (University of California, Santa Cruz), University of Washington; DAVID J. BARSKY (Rutgers University), University of Arizona; CHRISTOPHER BISHOP (University of Chicago), University of California, Los Angeles; RUSSELL M. BROWN (University of Minnesota), University of Chicago; THOMAS F. BUTTKE (Lawrence Livermore National Laboratory), Princeton University; CAROLYN A. DEAN (University of Chicago), University of Chicago; WILLIAM D. DUKE (University of California, San Diego), Rutgers University; PAUL FEIT (University of Chicago), University of Chicago; MICHAEL FRAZIER (University of New Mexico), Washington University; JOEL FRIEDMAN (University of California, Berkeley), University of California, Berkeley; LESLIE GREENGARD (Yale University), Yale University; BRIAN GREENE (Harvard University), Massachusetts Institute of Technology; CHRISTINE HAUGHT (Loyola University), University of Illinois; JONATHAN L. KING (State University of New York at Albany), University of Maryland; ALAN F. LIPPMAN (Brown University), Brown University; GENNADY LYUBEZNIK (University of Chicago), University of Chicago; FRANKLIN MALEY (Massachusetts Institute of Technology), Princeton University; RAFE R. MAZZEO (Stanford University), Stanford University; CURTIS MCMULLEN (Institute for Advanced Study), City University of New York, New York; LEE MOSHER (Institute for Advanced Study), City University of New York, New York; JILL C. PIPHER (University of Chicago), University of Chicago; JAMES G. PROPP (University of California, Berkeley), Stanford University; JOHN A. RHODES (Bates University), Harvard University; DANIEL RUBERMAN (Brandeis University), Harvard University; LESLIE D. SAPER (Duke University), University of California, San Diego; TAMAR SCHLICK (Courant Institute of Mathematical Sciences, New York University), Courant Institute of Mathematical Sciences, New York University; DOUGLAS SIMPSON (University of Illinois-Urbana), University of Illinois-Urbana; PHILIP STARK (University of California, San Diego), University of California, San Diego; JEREMY TEITELBAUM (University of Michigan-Ann Arbor), University of Michigan; and MICHAEL WOLF (Massachusetts Institute of Technology), Massachusetts Institute of Technology.

–NSF News Release

NSF-CBMS Regional Conferences in the Mathematical Sciences

The NSF will sponsor nine regional conferences between May 1987 and January 1988, designed to stimulate interest in mathematical research. The successful proposals for these conferences were selected by a panel chosen by the Conference Board of the Mathematical Sciences under a contract with the NSF.

Each conference features ten lectures delivered over a five-day period by a guest lecturer and typically involves about twenty-five participants. The lecturer subsequently prepares and submits to the Conference Board a paper based on these lectures. This paper normally is published as a monograph in either the *Regional Conference Series in Mathematics* published by the AMS or the *Regional Conference Series in Applied Mathematics* published by SIAM.

It is expected that the regional conference project will continue and that an announcement inviting proposals from prospective host institutes will be made by the NSF by this summer. The regional conferences for this coming year are: May 4–8, 1987, Brigham Young University, *Nonlinear Diffusive Waves and Applications*, Paul Fife (Lecturer); June 1–5, 1987, Washington University, *Gauge Theory*, Karen Uhlenbeck (Lecturer); June 15–19, 1987, University of Michigan at Ann Arbor, *Group Invariance Applications in Statistics*, Morris L. Eaton (Lecturer); August 4–8, 1987, Colorado College, *Algorithms*, Herbert S. Wilf (Lecturer); August 10–14, 1987, Texas Tech University, *Methods of Equivalence and Applications to Control Systems*, Robert B. Gardner (Lecturer); July 13–17, 1987, Virginia Polytechnic Institute and State University, *Conference on Group Actions on Manifolds*, Sylvain Cappell (Lecturer); August 1987 (date to be arranged), Howard University, *Theory and Applications of Multivariate Splines*, Charles Chui (Lecturer);

and January 11–15, 1988, University of New Mexico, *Kaluza-Klein Theory*, Jean-Pierre Bourguignon (Lecturer). A ninth conference is being arranged. –NSF News Release

FY 1988 NSF Budget Request

President Reagan's request for the NSF's FY 1988 budget is $1.893 billion, which represents a 16.5% increase over FY 1987. The NSF intends to request a 14% increase for FY 1989, and, beyond that, will seek to double its budget by 1992.

The constraints of the Gramm-Rudman-Hollings deficit reduction promise a competitive budget process. The NSF has described Congress's reaction to doubling the NSF budget as "hesitatingly supportive," and believes that, given the budget climate, each member of Congress, not just those in the pertinent committees, must be persuaded that the increases are justified. The Foundation believes that its success in securing last year's 11% increase was largely due to the active participation of the scientific community, which must continue to educate and inform Congress about the importance of basic science and engineering research and education. Given Washington's current concern with enhancing the nation's competitiveness, the timing is crucial.

In his letter presenting the budget request to Congress, NSF director Erich Bloch identifies three major initiatives for FY 1988:

- to provide a broad range of incentives, including research opportunities and fellowships, to broaden participation in research, and to encourage our best students to choose science and engineering careers;
- to extend the proven concept of partnerships between industry and universities to establish new science and technology centers, which will support scientifically exciting and economically promising basic research;
- to continue strong support for all the science and engineering disciplines in keeping with the NSF's fundamental mission.

These initiatives include nearly $70 million—more than double the FY 1987 amount—for new and expanded programs to improve undergraduate instruction. A total of about 1,700 fellows, 14,000 graduate assistants, and nearly 3,700 postdoctoral associates will be supported in FY 1988. Special emphasis will be placed on increasing graduate and postdoctoral support for interdisciplinary training opportunities in such areas as mathematics, biotechnology, and political economy. The Foundation will also enhance support for participation in science and engineering by underrepresented groups, such as women, minorities, and the disabled.

Five hundred and twenty-nine million dollars will be spent to establish centers and research groups in a variety of interdisciplinary areas, including behavioral and neural sciences, computer and computation research focused on parallel architectures, and decision and risk assessment sciences. Strong industry participation is expected.

The budget contains $1.1 billion for disciplinary programs and facilities. The request of the Mathematics and Physical Sciences Directorate for an increase of 10.9% to $514 million contains an increase of 13.3% to $67.8 million for the Division of Mathematical Sciences (DMS). The DMS plans to increase support for graduate students and postdoctoral researchers, and, as part of the NSF-wide expansion of support for undergraduate instruction, will initiate a major effort in calculus curriculum development. Among the DMS programs, Computational Mathematics and Special Projects will receive the largest increases.

The budget request for Computer and Information Science and Engineering (CISE) is $143 million, an increase of 22.7% over FY 1987. In FY 1988, CISE will strengthen its support of parallel processing and make several large group or "mini-center" awards in automation, robotics, and intelligent systems.

It is important to understand that the NSF has only submitted a request to Congress, and that the long and complicated process by which the budget is approved can significantly alter the budget's size and structure. The process begins in mid-February, by which time Bloch will have testified before the House Science, Space, and Technology Committee in support of the NSF budget request. The various committees in the House and Senate will then take several months to examine the request, and it will not be until summer at the earliest that the NSF budget will be finalized.

Computer Addresses for DMS Program Officers

Program officers in the Division of Mathematical Sciences at NSF may now all be reached through computer addresses over the various networks (ARPANET, CSNET, BITNET). The form of the address is: first letter of the first name, followed by the last name, followed by @NSF.GOV. For example, John Polking, Division Director, may be reached at the following address:

JPOLKING@NSF.GOV

New Program for Undergraduates

One of the principal goals of the NSF is to ensure an adequate supply of high quality mathematicians, scientists, and engineers for the future. Talented undergraduate students must be attracted to research careers in these fields. To this end, the

NSF is beginning in FY 1987 to significantly expand its programs directed toward undergraduate mathematics, science, and engineering education.

Research Experiences for Undergraduates (REU) is a new NSF program intended to provide approximately 2,000 undergraduate students with opportunities to participate in active research in mathematics, science, and engineering. In contrast to past procedures with this kind of program, REU will be conducted by the research divisions. The Division of Mathematical Sciences (DMS) is placing particular emphasis on increasing the level of participation of women, minorities, and the disabled in the mathematical sciences and this factor may influence decisions about the REU awards.

There will be two categories of awards: REU sites and REU supplements. In the first category, the grants will support undergraduate research participation sites, usually involving at least 8 students of whom half are expected to come from outside the host institution. The programs can be carried out during the summer and/or the academic year. The sites might serve a geographical region or focus on a particular set of topics.

The REU supplements provide additional funds to ongoing NSF research grants to provide for research training experiences for 1-2 undergraduates. Normally funds will be available for up to 2 students, but exceptions will be considered for training additional minority, physically disabled, or women students. These projects could also be carried out during the summer and/or the academic year.

Unfortunately, the December announcement of the REU program fell between the January issue of *Notices*, which was mailed in early December, and the present issue. Therefore the March 1, 1987, deadline for proposals for the REU sites will have passed by the time this issue of *Notices* reaches its readers. However, requests for REU supplements may be made any time before May 15, 1987, either by attaching the request to a new or continuing grant application, or, for those holding an ongoing NSF grant, by simply sending a letter to their program director. Awards will be made within three months of the supplement request.

Awards of either kind are expected to average $4,000 per student, with at least half going to the student as a stipend. The NSF expects to commit $9 million to the REU project in FY 1987. The DMS will spend $380,000, with approximately three-quarters going to REU sites and the rest to supplements. The DMS is planning a substantial increase in the REU program for 1988 and the details of the program and its deadlines will be published in *Notices*.

To clarify the range of activities eligible for support under this program, the DMS has formulated the following examples.

- Direct involvement of a student in a research project operating in an experimental mode, e.g., generating data or working out examples in order to develop conjectures.
- Independent study activities where the student is expected to carry out literature searches that indicate the development over time of the area under study, possibly working through the details in seminal papers. Depth and difficulty of material could be adjusted to meet the student's background.

Bill Adams, Program Director for Algebra and Number Theory, will be coordinating the REU review process for the DMS. If you have questions or need more information, he can be reached at 202-357-9764.

Committee Examines NSF Review Procedures

An advisory committee, appointed in April 1985 by NSF Director Erich Bloch to examine competitive review procedures at the NSF and other federal agencies, has found that the system is working well and that major changes are not needed.

Bloch said that the agency's primary criteria for selection of research projects have always been the quality of the investigators and their proposed research. "However," he said, "once excellence has been established, additional criteria are applied. Specifically, attention is given to the effect of the project on the research infrastructure and to contributions to related goals of equity and distribution of resources among institutions and geographic areas." Because of this policy the NSF has adopted, on the committee's recommendation, the term "merit review" in place of "peer review."

The NSF has already begun implementing some of the advisory committee's recommendations, including:

- the use of multistage review panels to evaluate large projects like Engineering Research Centers,
- procedures to process and review unsolicited interdisciplinary research proposals that don't fall into established program areas,
- periodic review of data bases containing information on the review process to determine whether they need improvement or expansion,
- adoption of long-term programs to improve the nation's science and engineering base. The NSF already has several such programs that it will monitor for effectiveness and progress.

Waterman Award Increased

The National Science Board, the policy-making arm of the NSF, has approved a proposal to increase the amount of the Waterman Award from $300,000 to $500,000.

The three-year research grant, named after the NSF's first director, Alan T. Waterman,

has been awarded annually for the past eleven years. The recipient must be an outstanding researcher who is less than 35 years of age and who has received a doctorate in any field of science, mathematics, or engineering in the last five years. The increase in the monetary value of the award is intended to bolster its prestige and visibility.

Nominations for the award are usually invited in the fall. The deadline is **December 31**. Since it was established, two mathematicians have won the award: Charles L. Fefferman in 1976 and Harvey M. Friedman in 1984.

Reagan Announces National Science Board Nominee

President Reagan has announced his intention to nominate Frank H.T. Rhodes, President of Cornell University, to serve on the National Science Board (NSB). The 24-member NSB is the policymaking body of the National Science Foundation. Rhodes will serve a six-year term ending in May 1992.

–NSF News Release

Multiple Trigonometric Sums

G. I. Arhipov, A. A. Karacuba and V. N. Čubarikov

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II. Estimates for multiple trigonometric sums
III. Applications of the theory of multiple trigonometric sums

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Dual Algebras with Applications to Invariant Subspaces and Dilation Theory

Hari Bercovici, Ciprian Foiaş and Carl Pearcy

(CBMS Regional Conference Series, Number 56)

This book is a slightly expanded and revised version of the lecture notes from the NSF/CBMS Regional Conference held in Tempe, Arizona in May, 1984, at which the third author was the principal lecturer. In the book the authors have tried to summarize some of the voluminous progress that has been made in the theory of dual algebras since the appearance in 1978 of Scott Brown's pioneering paper which clearly showed the utility of this concept for studying the structure theory of bounded linear operators on Hilbert space. The aim of the book is to present an approach for studying (non-self-adjoint) dual algebras that allows one, in particular, to obtain results on invariant subspaces and dilation theory.

The book is put together as follows. Chapter I contains facts of a general nature about dual algebras. Chapters II and III describe a general method for proving structure theorems concerning the preduals of operator algebras. Several instances in which these general structure theorems for preduals can be applied are studied in Chapters VI, VII and IX. Chapter IX, for example, contains a very general reflexivity theorem for operator algebras. The remaining chapters are dedicated to the study of singly generated algebras, with special emphasis on a new dilation theory (Chapter V). Chapters VIII and X contain applications to special classes of operators, like weighted shifts and subnormal operators.

This book may serve as an introduction to this area of research for those not already familiar with it. Results in this area are scattered throughout the literature and, sometimes, unpublished. The book provides a unified approach to developments following Scott Brown's invariant subspace theorem for subnormal operators.

A background in basic functional analysis and operator theory on Hilbert space will prepare the reader. Some knowledge of canonical models for contractions will also be helpful, especially for Chapter VIII.

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Letters to the Editor

EDITOR'S NOTE: The text of the two motions referred to in the following letter may be found in the Report of the Business Meeting in San Antonio in the AMS Reports and Communications section of this issue of *Notices*.

Comments on AMS Business Meeting Motions

As a member of the Joint Policy Board for Mathematics (JPBM), I received statements of the two motions by Thurston et al to be introduced at the business meeting at San Antonio. Permit me to comment on these motions by letter as I shall be on sabbatical leave abroad at the time of the meeting.

I disagree with motion 2. Military agencies have, in general, supported mathematics in an understanding and reasonable manner. They have rarely imposed unacceptable military restrictions on their support and their programs have been of benefit to our community. The question of distribution of funding between focussed initiatives and individual grants is an important one, but it is too early to tell whether the recent emphasis on group support will be successful or not. Individual grants are still being supported in reasonable numbers and the additional support for graduate students and young investigators is welcome (in fact, necessary for the future of the mathematics profession).

I am more sympathetic to the first motion. Many scientists oppose SDI as either dangerous or ineffective. In a recent poll, only 10% of the members of the National Academy of Sciences supported SDI (see page 7, *Chronicle of Higher Education*, November 5, 1986). It seems anomalous that the Board of Mathematical Sciences of the NRC, through its Committee on Applied Mathematics (CAM), should have arranged a large-scale briefing by SDI program officers to a group of mathematicians. One could take the charitable view that this is innocent brokerage between two interested parties or the more cynical one that the Board is endorsing SDI and providing advisory services to that program.

One of the disturbing elements of the CAM meeting prior to the briefing was that many members thought the SDI program was unlikely to be scientifically successful, but that they nevertheless wanted the mathematical community to share in the large sums available through SDI. I feel this is carrying expediency too far. I opposed the briefing at the CAM meeting and I continue to believe that, unlike individual mathematicians who can do as they wish, the Mathematical Societies and the Board of Mathematical Sciences should not be seen as cooperating with SDI.

Ivar Stakgold
University of Delaware
(Received November 10, 1986)

Board on Mathematical Sciences Role

I wish to make some comments on the role of the Board on Mathematical Sciences (BMS) at the National Research Council (NRC) and its Committee on the Applications of Mathematics (CAM) relative to a meeting held October 6 on the SDI Innovative Science and Technology Program (ISTP) and reported in *Science*, November 7, 1986, "Mathematicians Look to SDI for Research Funds."

One of the principal functions of the BMS and similar boards at the NRC is to serve as an interface group between the federal agencies and the scientific community. As such, the BMS prepares reports on areas of current and future mathematics research, organizes and participates in briefings on the role and importance of mathematics, and offers advice to the federal agencies on mathematics.

The intent of the meeting of October 6 was for ISTP to brief CAM and others on mathematical sciences problems related to ISTP. The briefing was requested by CAM and developed with assistance from BMS staff by a consortium of federal agencies where they presented five mathematical areas as related to scientific undertakings involved with SDI problems.

The audience for the briefing consisted of mathematicians and agency personnel. The audience and non-agency speakers represented them-

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, Post Office Box 6248, Providence, Rhode Island 02940, and will be acknowledged on receipt.

selves and not their institutions nor the NRC. The material presented at the briefing did not represent material of the NRC or its committees. As with other NRC activities it could reasonably be expected that the briefing could relate to policy decisions and in this case, ISTP announced that it would make available enhanced funding in the mathematical sciences. Certainly this is one of the underlying possibilities of such briefings on mathematical or scientific problems related to any program. This briefing was open, as a reporter from *Science* was there, and a number of members of the mathematics community were involved and attended.

As was stated from the outset the purpose of the meeting was for exchange of scientific information. We realized that a portion of the mathematical community would nevertheless view the holding of such a meeting as implicit support, and that SDI is sufficiently objectionable on moral and political grounds that the meeting should not be held. Another portion of the community views the entire project as scientifically intractable, and some attendees left with serious questions about the latter after hearing about the mathematical areas impinging on some problems related to ISTP. However, the mathematical community has a long tradition of free exchange of scientific information, and the NRC participates in a great many briefings, a number of which involve issues of controversy, such as nuclear, environmental, and health related issues. Additionally, the mathematics community is a large and diverse one having an enormous spectrum of scientific interests. Consequently, the BMS supported the request of CAM for an informational scientific meeting with the understanding and statement at the outset of the meeting that this did not imply the support of the Board or its committees for the programs discussed.

Phillip A. Griffiths
Chairman,
Board on Mathematical Sciences
(Received December 15, 1986)

Mathematical Applications

The August 5th issue of Science Times [section of the *New York Times*] carried a fine article by James Gleick on the various beautiful applications of mathematics to physiology discussed at the recent meeting of the Society for Industrial and Applied Mathematics in Boston. A week later he reported on the striking achievements presented at the International Congress of Mathematicians at Berkeley. Many of these were intimately involved with physical theories; one of the Fields medalists used the quantum field theory of Yang-Mills to discover entirely unsuspected phenomena in 4-dimensional differential topology, and another invited speaker related equations describing water waves to a problem in function theory that has baffled mathematicians for a hundred years. Yet the majority of attendees expressed ambivalent feelings about applications:

"Mathematical thinking thrives by disdaining the need for practical applications; applications come later by accident."

"Doing mathematics purely, following an internal compass, seeking elegance and beauty in strange abstract worlds, is the best way in the long run to serve practical science."

"Applied mathematics is a less exalted discipline; mathematical ideas filter down to engineering and other sciences."

All this sounds suspiciously like saying that the applications of mathematics are brought by the stork! The creators of modern mathematics—Newton, Euler, Lagrange, Gauss, Poincaré, Hilbert, Hadamard, Birkhoff, Weyl, Wiener, von Neumann—would have regarded these notions as fairy tales. They knew that mathematics doesn't trickle down to the sciences but lives in a partnership with them. Early in this century, Poincaré (one of whose conjectures was brilliantly proved by one of the Fields medalists) wrote:

"Our science borders on philosophy as well as on physics, and our labors must be directed at both neighbors. We can observe how in the past mathematics has advanced in both directions, and the same will be true in the future."

Fifty years later von Neumann made these observations:

"Mathematical ideas originate in empirics...; but once they are so conceived, the subject begins to have a peculiar life of its own,... governed almost entirely by aesthetical motivations.... But after much abstract inbreeding, a mathematical subject is in danger of degeneration...; whenever this stage is reached, the only remedy seems to me, the reinjection of more or less directly empirical ideas."

Peter D. Lax
New York University
Courant Institute
of Mathematical Sciences
(Received October 14, 1986)

Communicating Mathematics

Professor Yorke (January 1987 *Notices*) advances several ideas that puzzle me. First he deplores what he calls "one-upmanship," but which I call curiosity: "X proved such-and-such; I wonder what happens if...." A great deal of good and even applicable mathematics originated in this way. On the other hand, I would agree with Yorke if he deplored research done just for the sake of doing research.

Yorke proposes, if I understand him, that we should do more expository writing. This suggestion is hardly novel, but it is attractive, and

also quite utopian. As long as administrators hire and promote on the basis of research publications, few mathematicians can afford to devote their time to the kind of work that Yorke approves of. Reforms have to come from the top down, not from the bottom up—from administrations that welcome expository writing, not from the scholars who would like to do the exposition or have it available.

Yorke complains that physicists can't read mathematics papers. (Most mathematicians can't read physics papers, either.) However, they might try looking a little harder before they rush into print. If the mathematics that the physicist needs is not in every textbook, that should not be an excuse for not looking for it. I can cite examples of physicists' publishing mathematics that was both available and comprehensible, but which they could not locate. They could reply that they have no time to make literature searches, because they are under pressure to publish research. This is unfortunately a pretty valid excuse in today's world.

R. P. Boas
Northwestern University
(Received November 10, 1986)

Mathematical History

Those who have had occasion to consult early issues of the *Bulletin* may have noticed that until 1929 it was subtitled *An Historical and Critical Review of Mathematical Science*, and that early outgoing presidential addresses were not infrequently historical in emphasis.

By way of contrast, the current (1986-1987) catalogue of AMS Publications lists precisely eight items under the classification 01: History and Biography. Four of these items are described under recent publications; each of these is a collection of recent papers in a particular area of mathematics (in no case the history of mathematics) and bear no discernible connection with history or biography except that one is a Festschrift for a living mathematician and another commemorates the 100th birthday (in 1983) of a mathematician who died in 1950.

If the history of mathematics is not now to be left to those with little training in mathematics, the current mathematical community, including the AMS, must once again recognize the importance of historical scholarship. In particular, the editorial boards of the AMS should take the trouble to distinguish between what is and what is not an historical publication, and should solicit and publish historical articles and monographs in AMS journals and publication series.

Judy Green
Rutgers University

Paul S. Green
University of Maryland
(Received November 10, 1986)

South African Embargo

During the International Congress of Mathematicians at Berkeley, August 1986, the following petition was circulated:

> We, the undersigned participants in the 1986 International Congress of Mathematicians at Berkeley, California, United States of America, from the third to the eleventh of August 1986, deplore the racist regime in South Africa and judge it a force opposed to the development of Science. The future of Science can only be guaranteed by the untrammeled access to its findings through education, and the full participation in its activities of all peoples independent of race or sex.
>
> We urge the Security Council of the United Nations to enforce an embargo against all trade with the Republic of South Africa until such time that the South African government frees all political prisoners and begins negotiations with the authentic leaders of the Black community in South Africa, the African National Congress.

The 530 signatures obtained have been sent to the Security Council of the United Nations.

Joshua A. Leslie
Northwestern University
(Received September 8, 1986)

COMBINATORICS AND ORDERED SETS
Ivan Rival, Editor
(Contemporary Mathematics, Volume 57)

For the mathematician interested in discrete mathematics, from the senior undergraduate to the professional level, this volume provides first-rate surveys of the important combinatorics themes in ordered sets.

These expository lectures, given at a 1985 Joint Summer Research Conference, cover a wide range of topics, which include: the three-machine problem to illustrate the order-theoretic aspects of scheduling theory; the techniques used in settling the "matching conjecture"; the decomposition of ordered sets into few chains; the reorientation of graphs; the varied occurrences of the meet-distribution property; surveys techniques used in settling binary sorting problems; the formulation of a general view point for retraction; the survey of cutsets; and the role played by subdiagrams in ordered sets.

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Queries

Edited by Hans Samelson and Stuart Antman

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

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

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

Queries

371. Kwangil Koh (Department of Mathematics, North Carolina State University, Raleigh, North Carolina 27695). Does there exist an infinite division ring whose group of units is simple?

372. Jaak Peetre (Matematiska Institutionen, Box 118, S-221 00 Lund, Sweden). I am interested in bibliographical and other information about Daniel Friedrich Ernst Meissel, b. 1826, d. 1894 ($\neq$ F. Meisel). (Perhaps there are still relatives?) Meissel was an "Oberrealschulendirektor" in Kiel, Germany, in the second half of the past century and published some mathematics of note (> 20 entries in *Jahrbuch*). In particular, he announced several theorems, which I at least cannot prove (see my report to the Alfred Haar Memorial Conference, Budapest, August 1985).

373. Aldo Peretti (Murillo 1121, 9° "D" (1414) Buenos Aires, Argentina). Let $p(x)$ be a quintic polynomial (over $\mathbf{Q}$, say) whose Galois group is known to be solvable. How does one go about finding the roots (in terms of radicals)? Specifically, how does one find the coefficients of the auxiliary equations (resolvents) in terms of those of $p(x)$?

374. Mohammad Hailat (Department of Mathematics, Yarmouk University, POB 566, Irbid, Jordan). Let V be a vector space over $\mathbf{Z}/3$, finite or infinite dimension, with a nondegenerate inner product. Does there exist an orthonormal basis?

375. Albert A. Mullin (506 Seaborn Drive, Huntsville, Alabama 35806). Halley's Comet achieved perihelion on 9 February 1986. Since its motion is "periodic", in what year will Halley's Comet next be expected to achieve a perihelion in a February? On a 9 February? How frequently do consecutive perihelia occur in the same month? What special mathematical techniques are used to attain the requisite precision for such long-range predictions?

Responses

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

327B. (vol. 32, p. 379, June 1985, Robert Vinograd) Exact formula for the Gramian $G_{x_1,\dots,x_l;y_1,\dots,y_m}$ (where $\{x_i\}$ and $\{y_j\}$ each are independent sets in $\mathbf{R}^n$ or $\mathbf{C}^n$), involving the usual angles α_i between the spans X and Y of the $\{x_i\}$ and $\{y_j\}$. **Reply:** Let P be the orthogonal projection of $X+Y$ onto Y. Diagonalize the quadratic form $\langle Px, x\rangle$ $(= \langle Px, Px\rangle)$, obtaining an orthonormal (ON) system $\{u_i\}$ spanning X. Let $\{v_k\}_1^r$ be the nonzero Pu_k, normalized, and extend to an ON basis $\{v_j\}$ for Y. Then $\langle u_i, v_i\rangle = \cos\alpha_i$ for $1 \le i \le r$ and $\langle u_i, v_j\rangle = 0$ otherwise, and $G_{x_1,\dots,x_l;y_1,\dots,y_m} = \sin^2\alpha_1 \cdot \sin^2\alpha_2 \cdots \sin^2\alpha_r$. The general formula comes from expressing the x_i (or y_j) in terms of the u_i (or v_j). (Contributed by B. F. Bylov)

370. (vol. 34, p. 47, January 1987, Maurice Machover) Is there a formula similar to $\frac{1}{2\pi i}\int f'/f\,dz$ for the number of zeros of order greater than 1? **Reply:** No, in a suitable interpretation: There is no formula of the type $\int K(f, f', \dots, f^{(n)})$ with K a function of $n+1$ variables that is continuous when evaluated for the given f near the given curve. The reason is that arbitrarily close to f there are holomorphic functions all of whose zeros are simple (and so the integral would take value 0). (Contributed by C. L. Epstein, L. W. Tu)

1987 AMS Elections

Nominations by Petition

Vice-President or Member-at-Large

Two positions of vice-president and member of the Council ex officio for a term of two years are to be filled in the election of 1987. The Council intends to nominate four candidates, whose names may be expected to appear in the June issue of *Notices*, which is scheduled to be mailed by the printer on May 22. Nominations by petition as described in the box are acceptable.

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

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

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

The Nominating Committee for 1988

Four places on the Nominating Committee will be filled by election. There will be four continuing members of the Nominating Committee, namely

M. Salah Baouendi
Paul C. Fife
Carl Pomerance
William P. Ziemer

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

Rules and Procedures

Use separate copies of the form for each candidate for vice-president, member-at-large, or member of the Nominating Committee.

1. To be considered, petitions must be addressed to Everett Pitcher, Secretary, P.O. Box 6248, Providence, Rhode Island 02940, and must arrive by July 6, 1987.

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

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

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

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

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

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

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

NOMINATION PETITION FOR 1987 ELECTION

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

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

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

of the American Mathematical Society for a term beginning January 1, 1988.

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

Journal of the American Mathematical Society

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The Journal of the American Mathematical Society will be published quarterly, beginning in January 1988. It will contain research articles of the highest quality in all areas of pure and applied mathematics. Authors are requested to include introductions which will be accessible to research mathematicians in all fields.

There are no page charges for this journal.

Manuscripts may be submitted to any of the editors. The journal will be set by the AMS, using the $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX macro package developed to simplify the use of TEX for mathematics. So if you prepared your manuscript using $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX, your tapes or floppies can be used directly without need for further proofreading.

Honolulu, March 26–28, 1987, University of Hawaii at Manoa

Program for the 832nd Meeting

The eight hundred and thirty-second meeting of the American Mathematical Society will be held at the University of Hawaii in Honolulu, Hawaii, on Thursday, Friday, and Saturday, March 26–28, 1987. This meeting will be held in conjunction with the Northern California section of the Mathematical Association of America.

The sessions will be held in Keller Hall, 3rd and 4th floors. The invited addresses will be delivered in the auditorium (room 217) of the Physical Science Building which is connected to Keller Hall by overpasses. Keller Hall is across The Mall from the Hamilton Library.

Invited Addresses

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

EDWARD A. BERTRAM, University of Hawaii at Manoa, *Some combinatorial problems in finite groups.*

MARTIN SCHARLEMANN, University of California, Santa Barbara, *Applications of naive graph theory to the topology of 3-manifolds.*

Special Sessions

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

Algebraic topology, CHRISTOPHER J. ALLDAY and HEINER DOVERMANN, University of Hawaii at Manoa. The speakers are Bohumil Cenkl, James F. Davis, Mikiya Masuda, William W. Menasco, John Oprea, and Ted Petrie.

Low-dimensional topology, STEVEN BLEILER, University of British Columbia. The speakers are Selman Akbulut, Mladen Bestvina, David Gillman, P. M. Gilmer, C. McA. Gordon, John Hempel, M. Hilden, Osamu Kakimizu, Akio Kanwuchi, Terry Lawson, Darren Long, Martin Lustig, Kenneth C. Millett, Yasutaka Nakanichi, Richard Osborne, R. C. Penner, Jozef H. Przytycki, Makoto Sakuma, Jonathan Simon, Denis Sjerve, Kay Tatsuoka, Bruce Trace, and Gerard A. Venema.

Complex function theory, GEORGE CSORDAS, WAYNE SMITH, and DAVID STEGENGA, University of Hawaii at Manoa. The speakers are Patrick Ahern, Sheldon Axler, George Csordas, D. Drasin, Albert Edrei, Carl H. Fitzgerald, Simon Hellerstein, Aimo Hinkkanmen, Keiji Izuchi, Boris Korenblum, Frank D. Lesley, Joseph Miles, Bruce Palka, John Rossi, Donald Sarason, W. Schneider, Joel H. Shapiro, Daniel Shea, Wayne Smith, Charles S. Stanton, Kenneth Stephenson, David C. Ullrich, and Richard S. Varga.

Rings and modules, KENT R. FULLER, University of Iowa. The speakers are Gene Abrams, Goro Azumaya, John A. Beachy, Douglas G. Burkholder, John Dauns, Vlastimil Dlab, Joe W. Fisher, K. R. Goodearl, Rogert Gordon, E. L. Green, Yasuo Iwanaga, T. Lenagan, W. K. Nicholson, James Osterburg, Mark L. Teply, and Birge Zimmermann-Huisgen.

Combinatorics, JERROLD J. GRIGGS, University of South Carolina, Columbia. The speakers are Brian Alspach, Fan R. K. Chung, Vasek Chvatal, R. L. Graham, Katherine Heinrich, Pavol Hell, I. D. MacDonald, Bojan Mohar, W. T. Trotter, and Victor K. Wei.

Set theory and its applications, THOMAS JECH, Pennsylvania State University. The speakers are James E. Baumgartner, Andreas R. Blass, Qi Feng, Matthew Foreman, Marcia J. Groszek, Yuzuru Kakuda, Aki Kanamori, Alexander S. Kechris, Richard Laver, Menachem Magidor, D. A. Martin, Masanao Ozawa, Karel Prikry, Robert M. Solovay, J. R. Steel, and W. Hugh Woodin.

Differential geometry, PETER LI, University of Utah, RICHARD M. SCHOEN, and S.-T. YAU, University of California, San Diego. The speakers are Robert Brooks, Robert L. Bryant, Shiu-Yuen Cheng, Hyeong In Choi, Robert E. Greene, Karsten Grove, Meinhard E. Mayer, Frank Morgan, Mario J. Micallef, S. Walter Wei, Brian White, Andrew Winkler, Paul C. Yang, and Stephen S.-T. Yau.

Contributed Papers

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

MAA Program

The MAA program will take place on Saturday and will include the following invited speakers. VICTOR L. KLEE, JR., University of Washington, will deliver a lecture titled *The even cycle mystery and its relatives.* At a noon luncheon IVAN NIVEN of the University of Oregon will deliver an address titled *The way things were.* HENRY O. POLLAK, Bell Communications Research (retired) will speak on *The loop-switching addressing problem, or How to embed an arbitrary graph in a squashed cube.* All three of the speakers are past presidents of the MAA.

Registration

The meeting registration desk will be located on the fourth floor of Keller Hall and will be open from 9:00 a.m. to 11:00 a.m. and 1:00 p.m.

to 3:00 p.m. on Thursday and Friday, and from 9:00 a.m. to 11:00 a.m. on Saturday. The registration fees are $10 for members of the AMS or MAA, $16 for nonmembers, and $5 for students or unemployed mathematicians.

Tourist information will be available at the registration desk.

Petition Table

A petition table will be set up in the registration area. Additional information can be found in a box on page 62 in the San Antonio meeting announcement in the January issue of *Notices*.

Accommodations

A block of rooms is being held for meeting participants in the Hale Manoa and Hale Kuahine residence halls at the East-West Center on the campus. Participants should make reservations by writing to Dr. Adolph Mader, Department of Mathematics, 2565 The Mall, University of Hawaii at Manoa, Honolulu, Hawaii 96822. The rates are $14 for single occupancy, $17 for single occupant in a double room, and $19 per person for double occupancy. A deposit is not required, but the one-night rate for a room reserved will be charged if the reservation is not cancelled at least 72 hours prior to anticipated check-in.

Lincoln Hall, also at the East-West Center, has hotel-like rooms with rates ranging from $22 to $37 per night; however it is uncertain whether these rooms will be available since priority is given to visitors at the East-West Center.

NOTE: Childen cannot be accommodated in sleeping rooms at the East-West Center residence halls.

A block of rooms is also being held at the following hotel at Waikiki. Participants should make their reservations as early as possible, and be sure to mention participation in the AMS-MAA meeting at the University of Hawaii. Rates are subject to change by 1987, and do not include the 4.17 percent state sales tax and 5.25 percent hotel room tax. A credit card number or check as a deposit to cover the room rate for one night must be provided when making reservations. The deposit will be refunded if necessary, provided that cancellation is received a minimum of 72 hours prior to anticipated check-in.

Waikiki Plaza Hotel
2045 Kalakaua Avenue, Honolulu 96815
Telephone: 800-367-8047, extension 101, or 808-955-6363
Single $44 Double $44
Triple $54 Quadruple $64

Although rooms have **not** been blocked at the following locations, they are included here for information purposes. Again, rates do not include applicable taxes and are subject to change. Unless indicated otherwise, the rate indicated for single occupancy is generally the same when room is occupied by two persons.

Ala Wai Terrace Hotel
1547 Ala Wai Boulevard, Honolulu 96815
Telephone: 800-367-5170 (U.S.), 800-826-6786 (Canada), or 808-926-0679
Single $28 to $47

The Ala Wai Terrace also has special weekly and 30-day rates, and all rooms have kitchen facilities equipped with pots, pans, and linens.

Hilton Hawaiian Village
2005 Kalia Road, Honolulu 96815
Telephone: 800-HILTONS or 808-949-4321
Single $80 to $140

Holiday Inn-Waikiki Beach
2570 Kalakaua Avenue, Honolulu 96815
Telephone: 800-HOLIDAY or 808-922-2511
Single $68 to $78, $85, $98

Hyatt Regency Waikiki
2424 Kalakaua Avenue, Honolulu 96815
Telephone: 800-228-9000 or 808-922-9292
Single $90 to $190

Island Colony Hotel
445 Seaside Avenue, Honolulu 96815
Telephone: 800-367-5124 or 808-923-2345
Single $55 to $85 (Studios)

New Otani Kaimana Beach Hotel
2863 Kalakaua Avenue, Honolulu 96815
Telephone: 800-421-8795 or 808-923-1555
Single $56 to $125 Double $62 to $125

The New Otani is at the outer end of Waikiki and on the beach.

Quality Inn Waikiki
175 Paoakalani Avenue, Honolulu 96815
Telephone: 800-367-2317
Single $39 to $52 Double $42, $55

Reef Hotel
2169 Kalia Road, Honolulu 96815
Telephone: 800-367-5170 or 808-923-3111
Single $45 to $85

Food Service

The Campus Center Cafeteria is scheduled to be open Monday through Friday from 7:00 a.m. to 1:30 p.m. during the meeting. In addition, a variety of restaurants are located on University Avenue, Beretania, and King Streets, within easy walking distance (10 to 15 minutes). A list of restaurants with a street map attached will be available at the meeting registration desk. In addition to the usual fast food places, there are a variety of Chinese, Hawaiian, Korean, Mexican, and Japanese restaurants.

Travel

Honolulu is located on the island of Oahu, two time zones west of the Pacific Time Zone states. It is served by most major airlines, and there are many flights daily. Flying time from the west coast of the U.S. mainland to Honolulu is approximately four and one-half hours. Because this is a vacation resort area and March is still the high season, participants are advised to make

hotel, airline, and car rental reservations as early as possible.

The University of Hawaii at Manoa is situated east of Honolulu, near Waikiki Beach. The bus system in Honolulu is quite good. To go from Waikiki to the University, take bus #4 Nuuanu-Dowsett and for the reverse trip take bus #4 University-Waikiki; the bus stops are located on University Avenue. The buses run every 15 minutes and require 60 cents in exact change each way.

Participants driving to the campus from Waikiki are advised to proceed northwest on Ala Wai Boulevard and take the first right onto McCully Street; take the first right turn off McCully onto Kapiolani Boulevard, then turn left onto University Avenue (the first street which crosses Kapiolani). Proceed north to Dole Street and turn right; continue on Dole Street to East-West Road and turn left. Visitor parking is at the lot between the Kennedy Theater of the East-West Center and the Keller Hall/Physical Sciences Building. The parking fee is 50 cents per hour.

Persons driving to the campus via the Lunalilo Freeway should take the University Avenue exit, proceed north on University Avenue, and then follow the instructions in the preceding paragraph.

Weather

The weather at this time of the year should be warm and sunny, with occasional showers in the morning and near the mountains. The average high for March is 81.5° F, and the average low is 67.5° F; the record high is 88° F and record low is 55° F. Only light, informal clothing is required.

q-SERIES: Their Development and Application in Analysis, Number Theory, Combinatorics, Physics and Computer Algebra
George E. Andrews
(CBMS Regional Conference Series, Number 66
Supported by the National Science Foundation)

This book integrates recent developments and related applications in q-series with a historical development of the field, focusing on major breakthroughs and the author's own research interests. The author develops both the important analytic topics (Bailey chains, integrals, and constant terms) and applications to additive number theory. He concludes with applications to physics and computer algebra and a section on results closely related to Ramanujan's "Lost Notebook."

With its wide range of applications, the book will interest researchers and students in combinatorics, additive number theory, special functions, statistical mechanics, and computer algebra. It is understandable to even a beginning graduate student in mathematics who has a background in advanced calculus and some mathematical maturity.

Contents
Found opportunities; Classical special functions and L. J. Rogers; W. N. Bailey's extension of Roger's work; Constant terms; Integrals; Partitions and q-series; Partitions and constant terms; The hard hexagon model; Ramanujan; Computer algebra

1980 *Mathematics Subject Classifications*: 33, 11, 82, 05
ISBN 0-8218-0716-1, LC 86-14061, ISSN 0160-7642
110 pages (softcover), 1986
List price $16, All individuals $10
Code CBMS/66NA

Shipping/Handling: 1st book $2, each add'l $1.
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AMS, P.O. Box 1571, Annex Station,
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800-556-7774 to use VISA or MasterCard.

NON-RIEMANNIAN SYMMETRIC SPACES
Mogens Flensted-Jensen
(CBMS Regional Conference Series, Number 61
Supported by the National Science Foundation)

This book presents the first systematic treatment of the basic problems in harmonic analysis on generalized symmetric spaces and discusses some of the more important recent developments in the field. The author's primary contribution is the idea of how to construct the discrete series for such a space. In this book, a fundamental role is played by the ideas behind that construction, namely, the duality principle, the orbit picture related to it, and the definition of representations by means of distributions on the orbits.

Intended as a text at the upper graduate level, the book assumes the reader's basic knowledge of Fourier analysis, differential geometry, and functional analysis. In particular, the reader should have a good knowledge of the general theory of real and complex Lie algebras and groups and of the root and weight theories for semisimple Lie algebras and groups.

Contents
Structure and classification of symmetric spaces; Harmonic analysis on semisimple symmetric spaces; The noncompact Riemannian form X^r of a semisimple symmetric space; The Poisson transform on a symmetric space of noncompact type; The H^d-orbits on the boundary and the corresponding representation of G; Representations related to the closed H^d-orbits; The discrete series for a semisimple symmetric space

1980 *Mathematics Subject Classifications*: 43, 22, 58, 53
ISBN 0-8218-0711-0, LC 85-30694, ISSN 0160-7642
88 pages (softcover), 1986
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Code CBMS/61NA

Shipping/Handling: 1st book $2, each add'l $1.
$25 max. By air, 1st book $5, each add'l $3.
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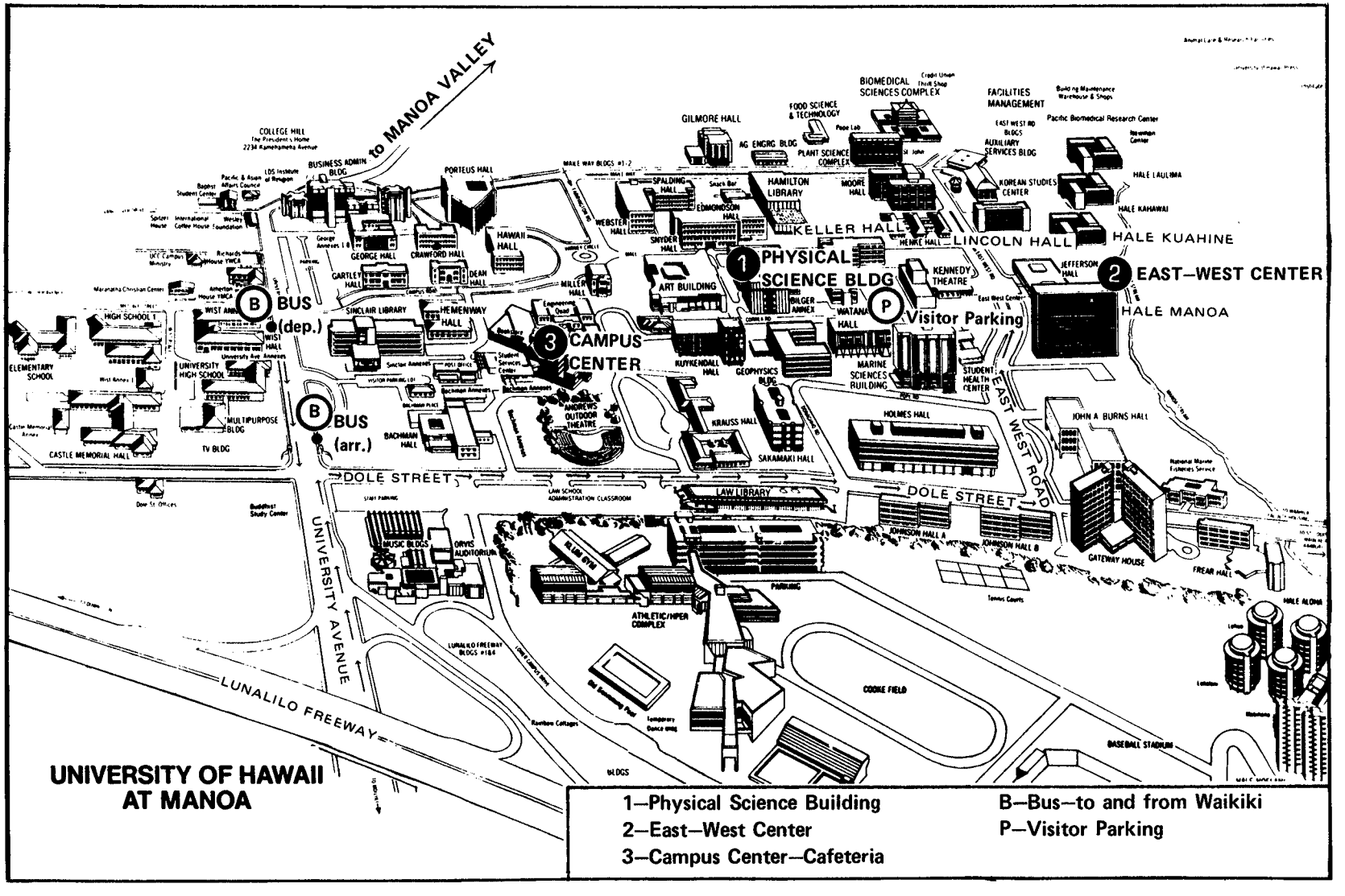
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UNIVERSITY AVENUE
ATHLETIC/HPER COMPLEX
PARKING
Tennis Courts
LUNALILO FREEWAY
COOKE FIELD
BASEBALL STADIUM
UNIVERSITY OF HAWAII AT MANOA
1–Physical Science Building
2–East–West Center
3–Campus Center–Cafeteria
B–Bus–to and from Waikiki
P–Visitor Parking

Program of the Sessions

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

Abstracts of papers presented in AMS sessions at this meeting will be found in the February 1987 issue of *Abstracts of papers presented to the American Mathematical Society*, ordered according to the numbers in parentheses following the listings below.

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

Thursday, March 26, 1987, 8:15 a.m.

AMS Special Session on Low-dimensional Topology, I — Keller Hall, Room 301

8:15 - 8:35 (1) *Embedding Heegaard splittings into S^4.* Preliminary report. BRUCE TRACE, University of Alabama, Tuscaloosa (832-57-17) (Sponsored by Steven Bleiler)

8:40 - 9:00 (2) *Combinatorics of automorphisms of free groups.* Preliminary report. KAY TATSUOKA, University of Texas, Austin (832-57-60) (Sponsored by Steven Bleiler)

9:05 - 9:25 (3) *A wild conformal action of a free group.* Preliminary report. MLADEN BESTVINA, University of California, Los Angeles (832-57-106)

9:30 - 9:50 (4) *Minimal genus actions of $PSL_2(p^n)$.* HENRY GLOVER, Ohio State University, Columbus, and DENIS SJERVE*, University of British Columbia (832-57-87) (Sponsored by Steven Bleiler)

9:55 - 10:15 (5) *Calculus on the moduli space of Riemann surfaces.* R. C. PENNER, University of Southern California (832-57-25)

10:20 - 10:40 (6) *Representing 3-manifold groups.* DARREN LONG, University of California, Santa Barbara (832-57-34) (Sponsored by Steven Bleiler)

10:45 - 11:05 (7) *On free group automorphisms, the rank of their fixed subgroup and their realization by surface homeomorphisms.* MARTIN LUSTIG*, Massachusetts Institute of Technology, and MARSHALL COHEN, Cornell University (832-57-107)

11:10 - 11:30 (8) *Universal groups.* M. HILDEN, University of Hawaii at Manoa, Honolulu (832-57-130)

11:35 - 11:55 (9) *Hyperbolic imitations of 3-manifolds.* AKIO KAWAUCHI, Osaka City University, Japan (832-57-86) (Sponsored by Steven Bleiler)

Thursday, March 26, 1987, 9:00 a.m.

AMS Special Session on Rings and Modules, I — Keller Hall, Room 402

9:00 - 9:20 (10) *Torsion free modules.* Preliminary report. JOHN DAUNS, Tulane University (832-16-09)

9:30 - 9:50 (11) *On dense subrings of $RFM(R)$.* GENE ABRAMS, University of Colorado, Colorado Springs (832-16-40)

10:00 - 10:20 (12) *On inversive localization in Noetherian rings.* Preliminary report. JOHN A. BEACHY, Northern Illinois University (832-16-83)

10:30 - 10:50 (13) *Azumaya rings, Pierce stalks and central ideal algebras.* DOUGLAS G. BURKHOLDER, Wichita State University (832-16-52)

11:00 - 11:20 (14) *On some applications of the representation theory of finite dimensional algebras.* Preliminary report. VLASTIMIL DLAB, Carleton University (832-16-67)

11:30 - 11:50 (15) *Invariants of finite linear groups acting on relatively free algebras: A survey.* JOE W. FISHER, University of Cincinnati (832-16-30)

Thurdsay, March 26, 1987, 9:00 a.m.

AMS Special Session on Set Theory and its Applications, I — Keller Hall, Room 404

9:00 - 9:20 (16) *Non-freeness modulo closed unbounded sets.* Preliminary report. JAMES E. BAUMGARTNER, Dartmouth College (832-03-38)

9:25 - 9:45 (17) *The non-stationary ideal on ω_2.* MATTHEW FOREMAN, Ohio State University, Columbus (832-04-104)

9:50 - 10:10 (18) *A hierarchy of Ramsey cardinals.* Preliminary report. QI FENG, Pennsylvania State University, University Park (832-04-07)

10:15 - 10:35 (19) *Degrees of constructibility of reals.* Preliminary report. MARCIA GROSZEK, Dartmouth College (832-04-35) (Sponsored by Thomas Jech)

10:40 - 11:00 (20) *Critical points of elementary embeddings.* RICHARD LAVER, University of Colorado, Boulder (832-04-47)

11:05 - 11:25 (21) *The first cardinal fixed point can be compact.* MENACHEM MAGIDOR, University of California, Los Angeles (832-03-48) (Sponsored by John B. Garnett)

11:30 - 11:50 Discussion Period

Thursday, March 26, 1987, 9:00 a.m.

General Session, I — Keller Hall, Room 304

9:00 - 9:10 (22) *Graph coloring and spectra.* RUSSELL MERRIS, California State University, Hayward (832-05-65) (Sponsored by Chi Fai Ho)

9:15 - 9:25 (23) *Further results and problems in combinatorial (constructive) associativity theory equivalent or related to 4CM: Refinement of linear mapping approach.* Preliminary report. DOV TAMARI, California State University, Los Angeles (832-05-46)

9:30 - 9:40 (24) *Combinatorial expectation methods.* Preliminary report. ROGER C. GRIMSON, State University of New York, Stony Brook (832-05-117)

9:45 - 9:55 (25) *Areas of hex-lattice polygons, with short sides.* JOHN REAY, Western Washington University (832-51-55)

10:00 - 10:10 (26) *Non-embeddable o-rings.* ROBERT REDFIELD, Hamilton College (832-06-102)

10:15 - 10:25 (27) *Inverse scattering and analytic functions.* ALEXANDER G. RAMM, Kansas State University (832-30-04)

10:30 - 10:40 (28) *On uniform approximation by harmonic functions.* Preliminary report. DMITRY KHAVINSON, University of Arkansas, Fayetteville (832-31-03)

10:45 - 10:55 (29) *Hardy space interpolation in the ball.* PASCAL J. THOMAS, Occidental College (832-46-05)

11:00 - 11:10 (30) *On curvature and moment map.* Preliminary report. EN-BING LIN, University of Toledo (832-53-64)

11:15 - 11:25 (31) *Fission-nuclear fusion superlogic* A_5. STEPHEN L. WEINBERG, Berkeley Academy of Artscience, Berkeley, California (832-73-29)

Thursday, March 26, 1987, 1:30 p.m.

AMS Special Session on Differential Geometry, I — Keller Hall, Room 401

1:30 - 1:50 (32) *Complete metrics with holonomy* G_2 *or* Spin(7). Preliminary report. ROBERT L. BRYANT, Rice University (832-53-80)

1:55 - 2:15 (33) *Minimal surfaces, harmonic forms and manifolds of non-negative curvature on isotropic two-planes.* Preliminary report. MARIO J. MICALLEF, Oklahoma State University, Stillwater (832-53-122)

2:20 - 2:40 (34) *Prescribing Gaussian curvature on* S^2. SUN-YUNG A. CHANG, University of California, Los Angeles, and PAUL C. YANG*, University of Southern California (832-53-59)

2:45 - 3:05 (35) *Metric rigidity of the Hopf fibrations.* DELLEF GROMOLL, State University of New York, Stony Brook, and KARSTEN GROVE*, University of Maryland, College Park (832-53-74)

3:10 - 3:30 (36) *Low eigenvalues of hyperbolic manifolds.* Preliminary report. ROBERT BROOKS, University of Southern California (832-58-82)

3:35 - 3:55 Discussion Period

Thursday, March 26, 1987, 1:30 p.m.

AMS Special Session on Low-Dimensional Topology, II — Keller Hall, Room 301

1:30 - 1:50 (37) *Topological symmetry groups of knotted graphs.* Preliminary report. JONATHAN SIMON, University of Iowa (832-57-77)

1:55 - 2:15 (38) *Polynomial invariants of AP1 knots.* Preliminary report. KENNETH C. MILLETT, University of California, Santa Barbara (832-57-58)

2:20 - 2:40 (39) *Fox's congruence classes and Conway's potential functions of knots and links.* YASUTAKA NAKANISHI, Kobe University, Japan (832-57-23)

2:45 - 3:05 (40) *The Jones-Conway and Kauffman polynomials of periodic links.* JOZEF H. PRZYTYCKI, University of British Columbia and Warsaw University, Poland (832-57-88)

3:10 - 3:30 (41) *Link invariants in rational homology three-spheres.* Preliminary report. P. M. GILMER, Louisiana State University, Baton Rouge (832-57-37)

3:35 - 3:55 (42) *Energy of geodesic links in* S^3. Preliminary report. MAKOTO SAKUMA, Osaka City University, Japan (832-57-109) (Sponsored by Steven Bleiler)

Thursday, March 26, 1987, 1:30 p.m.

AMS Special Session on Complex Function Theory, I — Keller Hall, Room 302

1:30 - 1:50 (43) *Angular derivatives via Hilbert space.* Preliminary report. DONALD SARASON, University of California, Berkeley (832-30-49)

2:00 - 2:20 (44) *Inner functions and division in Douglas algebras.* KEIJI IZUCHI*, Kanagawa University, Japan, and YUKO IZUCHI, Kanagawa Dental College, Japan (832-30-110)

2:30 - 2:50 (45) *Algebras generated by analytic and harmonic functions.* SHELDON AXLER*, Michigan State University, and ALLEN SHIELDS, University of Michigan, Ann Arbor (832-30-92)

3:00– 3:20 (46) *Angular derivatives, counting functions, and composition operators on Hardy, Bergman, and Dirichlet spaces.* JOEL H. SHAPIRO, Michigan State University (832-30-93)

3:30– 3:50 (47) *Holomorphic Sobolev functions and transverse curves.* PATRICK AHERN, University of Wisconsin, Madison (832-32-128)

Thursday, March 26, 1987, 1:30 p.m.

AMS Special Session on Rings and Modules, II Keller Hall, Room 402

1:30– 1:50 (48) *Finitely projective modules.* Preliminary report. GORO AZUMAYA, Indiana University, Bloomington (832-16-51)

2:00– 2:20 (49) *Linked injectives and Ore localizations.* Preliminary report. K. R. GOODEARL, University of Utah (832-16-06)

2:30– 2:50 (50) *Characterization of categories of group-graded modules.* Preliminary report. ROBERT GORDON, Temple University (832-16-72)

3:00– 3:20 (51) *Commutative graded algebras and finite dimensional algebras.* Preliminary report. E. L. GREEN, Virginia Polytechnic Institute and State University (832-16-81)

3:30– 3:50 (52) *On a noether ring with finite self-injective dimension.* YASUO IWANAGA, Shinshu University, Japan (832-16-61)

Thursday, March 26, 1987, 4:15 p.m.

AMS Invited Address Auditorium, Physical Science Building, Room 217

4:15– 5:05 (53) *Applications of naive graph theory to the topology of 3-manifolds.* MARTIN G. SCHARLEMANN, University of California, Santa Barbara (832-57-99)

Friday, March 27, 1987, 8:15 a.m.

AMS Special Session on Low-Dimensional Topology, III Keller Hall, Room 301

8:15– 8:35 (54) *Compactness results for orbifolds.* Preliminary report. TERRY LAWSON, Tulane University (832-57-11)

8:40– 9:00 (55) *Finding boundary for the semistable ends of 3-manifolds.* OSAMU KAKIMIZU, Hiroshima University (832-57-21) (Sponsored by Steven Bleiler)

9:05– 9:25 (56) *Neighborhoods of compacta in 4-manifolds.* Preliminary report. GERARD A. VENEMA, Calvin College (832-57-41)

9:30– 9:50 (57) *The Zeeman conjecture is valid in 3-space.* DAVID GILLMAN, University of California, Los Angeles (832-57-26)

9:55–10:15 (58) *$\mathbf{Z}_2$-framed link theory.* SELMAN AKBULUT, Michigan State University (832-57-118)

10:20–10:40 (59) *Three manifolds as branched covers and their monodromy representations.* Preliminary report. JOHN HEMPEL, Rice University (832-57-126)

10:45–11:05 (60) *Coverings of the four crossing knot.* RICHARD OSBORNE, Colorado State University (832-57-84)

11:10–11:30 (61) *The knot complement problem.* Preliminary report. C. MCA. GORDON*, University of Texas, Austin, and J. LUECKE, Courant Institute of Mathematical Sciences, New York University (832-57-95)

11:35–11:55 Problem Session

Friday, March 27, 1987, 8:40 a.m.

AMS Special Session on Complex Function Theory, II Keller Hall, Room 302

8:40– 9:00 (62) *Computations with the Turán inequalities and the Riemann hypothesis.* RICHARD S. VARGA, Kent State University, Kent (832-30-113)

9:05– 9:25 (63) *On the deficiency sum of entire and meromorphic functions of finite order.* Preliminary report. D. DRASIN* and A. WEITSMAN, Purdue University, West Lafayette (832-30-116)

9:30– 9:50 (64) *The zero distribution of solutions of second order ODE's with transcendental coefficients.* Preliminary report. JOHN ROSSI, Virginia Polytechnic Institute and State University (832-30-15)

9:55–10:15 (65) *On the growth of a meromorphic function and its derivative.* W. K. HAYMAN, University of York, England, and JOSEPH MILES*, University of Illinois, Urbana-Champaign (832-30-111)

10:20–10:40 (66) *Zeros of derivatives of entire functions.* THOMAS CRAVEN, GEORGE CSORDAS and WAYNE SMITH*, University of Hawaii, Honolulu (832-30-97)

10:45–11:05 (67) *Complex zeros of solutions of a class of second order linear O.D.E.s* Preliminary report. SIMON HELLERSTEIN, University of Wisconsin, Madison (832-30-120)

11:10–11:30 (68) *Zeros of successive derivatives of analytic functions having a single essential singularity.* ALBERT EDREI, Syracuse University (832-30-98) (Sponsored by George Csordas)

Friday, March 27, 1987, 9:00 a.m.

AMS Special Session on Algebraic Topology, I — Keller Hall, Room 303

9:00– 9:20 (69) *Cohomology of nilmanifolds.* BOHUMIL CENKL* and RICHARD PORTER, Northeastern University (832-55-70)

9:30– 9:50 (70) *Relative semicharacteristic classes.* JAMES F. DAVIS, Indiana University, Bloomington (832-55-125)

10:00–10:20 (71) *On the inertia groups of semifree actions.* Preliminary report. MIKIYA MASUDA, Osaka City University, Japan (832-57-89) (Sponsored by C. Allday)

10:30–10:50 (72) *Decompositions of localized fibres and cofibres.* Preliminary report. JOHN OPREA, Cleveland State University (832-55-39)

11:00–11:20 (73) *Algebraic group actions on complex n space.* Preliminary report. TED PETRIE, Rutgers University, New Brunswick (832-55-105) (Sponsored by Heiner Dovermann)

11:30–11:50 (74) *Studying links via closed braid.* Preliminary report. WILLIAM W. MENASCO, State University of New York, Buffalo (832-55-131)

Friday, March 27, 1987, 9:00 a.m.

AMS Special Session on Combinatorics, I — Keller Hall, Room 403

9:00– 9:35 (75) *Back-tracking, depth-first search and super-greedy linear extensions.* Preliminary report. H. A. KIERSTEAD and W. T. TROTTER*, University of South Carolina, Columbia (832-05-71)

9:45–10:20 (76) *Extremal graph problems in network embedding.* FAN R. K. CHUNG, Bell Communications Research, Morristown, New Jersey (832-05-53)

10:30–11:05 (77) *Paths and cycles in matroid base graphs.* Preliminary report. BRIAN ALSPACH*, Simon Fraser University, and GUIZHEN LIU, Shandong University, People's Republic of China (832-05-62)

11:15–11:50 (78) *A connection between a convex programming problem and the LYM property on perfect graphs.* Preliminary report. VICTOR K. WEI, Bell Communications Research, Morristown, NJ (832-05-19) (Sponsored by Jerrold R. Griggs)

Friday, March 27, 1987, 9:00 a.m.

AMS Special Session on Rings and Modules, III — Keller Hall, Room 402

9:00– 9:20 (79) *Growth of algebras.* T. H. LENAGAN, University of Washington (832-16-66) (Sponsored by R. S. Irving)

9:30– 9:50 (80) *Morita context functors.* Preliminary report. W. K. NICHOLSON*, University of Calgary, and J. F. WATTERS, University of Leicester, England (832-16-43)

10:00–10:20 (81) *A rank two indecomposable projective module over a Noetherian domain of Krull dimension one.* TIMOTHY J. HODGES and JAMES OSTERBURG*, University of Cincinnati (832-16-02)

10:30–10:50 (82) *Deviation, density, and depth.* WILLIAM G. LAU, University College of Bahrain, Bahrain, and MARK L. TEPLY* and ANN K. BOYLE, University of Wisconsin, Milwaukee (832-16-73)

11:00–11:20 (83) *Torsion modules, lattices, ultrafilters: A roundtrip.* Preliminary report. BIRGE ZIMMERMANN-HUISGEN, University of California, Santa Barbara (832-16-36)

Friday, March 27, 1987, 1:30 p.m.

AMS Special Session on Differential Geometry, II — Keller Hall, Room 401

1:30– 1:50 (84) *Algebraic determination of diffeomorphism types of CR-manifolds.* H. BLAINE LAWSON, JR., State University of New York, Stony Brook, and STEPHEN S.-T. YAU*, University of Illinois, Chicago (832-53-08)

1:55– 2:15 (85) *Minimal submanifold with finite total curvature.* Preliminary report. SHIU-YUEN CHENG* and JOHAN TYSK, University of California, Los Angeles (832-53-75)

2:20– 2:40 (86) *Dirichlet problem for harmonic maps.* HYEONG IN CHOI, University of Illinois, Chicago, and University of Utah (832-53-76)

2:45– 3:05 (87) *Boundary localization of automorphism groups.* ROBERT E. GREENE, University of California, Los Angeles (832-53-79)

3:10– 3:30 (88) *Minimal surfaces in positively curved three-spheres.* BRIAN WHITE, Stanford University (832-53-115)

3:35– 3:55 Discussion Period

Friday, March 27, 1987, 1:30 p.m.

AMS Special Session on Combinatorics, II — Keller Hall, Room 403

1:30– 1:50 (89) *A combinatorial object from group theory.* Preliminary report. I. D. MACDONALD, Lafayette College (832-05-20)

2:00– 2:35 (90) *Packings and coverings of 2-paths by 4-cycles.* Preliminary report. KATHERINE HEINRICH* and GILLIAN NONAY, Simon Fraser University (832-05-63)

2:45– 3:20 (91) *Theory of perfect graphs.* VASEK CHVATAL, Rutgers University, New Brunswick (832-05-127) (Sponsored by Jerrold J. Griggs)

3:30– 4:00 Problem Session, I

Friday, March 27, 1987, 1:30 p.m.

AMS Special Session on Set Theory and its Applications, II — Keller Hall, Room 404

1:30– 1:50 (92) *Filters and rates of growth of functions.* ANDREAS BLASS, University of Michigan, Ann Arbor (832-03-56)

2:00– 2:20 (93) *Generalized Horn sentences and compact cardinals.* Preliminary report. GEORGE BERGMAN and ROBERT M. SOLOVAY*, University of California, Berkeley (832-04-13)

2:30– 2:50 (94) *On Borel diagonalization.* Preliminary report. AKI KANAMORI, Boston University (832-04-14)

3:00– 3:20 (95) *A nonstandard universe constructed from Boolean valued universe.* Preliminary report. MASANAO OZAWA, University of Nagoya, Japan (832-04-33) (Sponsored by Tosiyuki Tugue)

3:30– 3:50 (96) *Disintegrations of the Lebesgue measure.* KAREL PRIKRY, University of Minnesota, Minneapolis (832-28-44)

Friday, March 27, 1987, 1:40 p.m.

AMS Special Session on Complex Function Theory, III — Keller Hall, Room 302

1:40– 2:00 (97) *Quasisymmetric groups.* A. HINKKANEN, University of Michigan, Ann Arbor (832-30-16)

2:10– 2:30 (98) *Cone conditions and quasiconformal mappings.* RAIMO NÄKKI, University of Jyväskylä, Finland, and BRUCE PALKA*, University of Texas, Austin (832-30-12)

2:40– 3:00 (99) *Integrability of the derivative of the Riemann mapping function.* CARL H. FITZGERALD, University of California at San Diego, La Jolla, and F. D. LESLEY*, San Diego State University (832-30-114)

3:10– 3:30 Discussion Period

Friday, March 27, 1987, 2:00 p.m.

AMS Special Session on Algebraic Topology, II — Keller Hall, Room 303

2:00– 4:00 Discussion Period

Friday, March 27, 1987, 4:15 p.m.

AMS Invited Address — Auditorium, Physical Science Building, Room 217

4:15– 5:05 (100) *Some combinatorial problems in finite groups.* EDWARD A. BERTRAM, University of Hawaii, Honolulu (832-20-100)

Saturday, March 28, 1987, 1:30 p.m.

AMS Special Session on Differential Geometry, III — Keller Hall, Room 401

1:30– 1:50 (101) *Constrained variational problems and BRS-cohomology.* MEINHARD E. MAYER, University of California, Irvine (832-81-124)

1:55– 2:15 (102) *Calibrations and area-minimizing surfaces.* FRANK MORGAN, Massachusetts Institute of Technology and Stanford University (832-53-96)

2:20– 2:40 (103) *Variational problems in Riemannian geometry.* S. WALTER WEI, University of Oklahoma (832-53-69)

2:45– 3:05 (104) *An immersion theorem for globally symmetric spaces.* ANDREW WINKLER, IBM T. J. Watson Research Center, Yorktown Heights, New York (832-53-132)

3:10– 3:30 Discussion Period

Saturday, March 28, 1987, 1:45 p.m.

AMS Special Session on Complex Function Theory, IV — Keller Hall, Room 302

1:45 – 2:05 (105) *Moment inequalities and the Riemann hypothesis.* GEORGE CSORDAS*, University of Hawaii, Honolulu, and RICHARD S. VARGA, Kent State University, Kent (832-30-112)

2:10 – 2:30 (106) *Value distribution theory for functions of slow growth in the disc.* DANIEL SHEA*, University of Wisconsin, Madison, and LINDA SONS, Northern Illinois University (832-30-119)

2:35 – 2:55 (107) *Examples and counter-examples in complex analysis.* Preliminary report. M. ORTEL, University of Hawaii, Honolulu, and W. SCHNEIDER*, Carleton University (832-30-85)

3:00 – 3:20 (108) *An embedding theorem for functions having two valences.* Preliminary report. ABDALLAH LYZZAIK, University of Petroleum and Minerals, Saudi Arabia, and KENNETH STEPHENSON*, University of Tennessee, Knoxville (832-30-121)

3:25 – 3:45 (109) *On the magnitude of the Hilbert transform of a measure.* Preliminary report. BORIS KORENBLUM, State University of New York, Albany (832-30-10)

3:50 – 4:10 (110) *Khinchin's inequality and the zeroes of Bloch functions.* DAVID C. ULLRICH, Oklahoma State University, Stillwater (832-30-42) (Sponsored by George Csordas)

4:15 – 4:35 (111) *Domains of functions and majorization.* Preliminary report. CHARLES S. STANTON, University of California, Riverside (832-30-101)

4:40 – 5:00 (112) *Arcs on which a univalent function has small magnitude.* Preliminary report. CARL H. FITZGERALD, University of California at San Diego, La Jolla (832-30-108)

Saturday, March 28, 1987, 2:00 p.m.

AMS Special Session on Combinatorics, III — Keller Hall, Room 403

2:00 – 2:20 (113) *An obstruction to embedding graphs in surfaces.* BOJAN MOHAR, Simon Fraser University (832-05-78)

2:30 – 3:05 (114) *Length-restricted two-factors.* PAVOL HELL*, Simon Fraser University, DAVID KIRKPATRICK, University of British Columbia, and JAN KRATOCHVIL and IGOR KIRZ, Charles University, Czechoslovakia (832-05-50)

3:15 – 3:50 (115) *Iterated combinatorial density theorems.* Preliminary report. P. FRANKL, Centre National de la Recherche Scientifique, France, R. L. GRAHAM*, AT&T Bell Laboratories, Murray Hill, New Jersey, and V. RÖDL, Czechoslovakian Technical University, Husova (832-05-68)

4:00 – 4:30 Problem Session, II

Saturday, March 28, 1987, 2:00 p.m.

AMS Special Session on Set Theory and its Applications, III — Keller Hall, Room 404

2:00 – 2:20 (116) *Descriptive set theory and classical harmonic analysis.* ALEXANDER S. KECHRIS, California Institute of Technology (832-04-32)

2:30 – 2:50 (117) *Inner models for Woodin cardinals,* I. Preliminary report. J. R. STEEL, University of California, Los Angeles (832-04-54) (Sponsored by Yiannis Moschovakis)

3:00 – 3:20 (118) *Inner models for Woodin cardinals,* II. Preliminary report. D. A. MARTIN, University of California, Los Angeles (832-04-57) (Sponsored by Yiannis Moschovakis)

3:30 – 3:50 (119) *Weakly homogeneous inner model operators.* Preliminary report. W. HUGH WOODIN, California Institute of Technology (832-04-31) (Sponsored by Alexander S. Kechris)

4:00 – 4:20 (120) *Deontic set theory.* YUZURU KAKUDA, Kobe University, Japan (832-04-28)

Saturday, March 28, 1987, 2:00 p.m.

General Session, II — Keller Hall, Room 304

2:00 – 2:10 (121) *Complete positivity and locally compact groups.* MARTIN E. WALTER, University of Colorado, Boulder (832-43-91)

2:15 – 2:25 (122) *Littlewood's correspondence between Schur polynomials and immanants.* WILLIAM WATKINS, California State University, Northridge (832-15-123) (Sponsored by U. V. Satyanarayana)

2:30 – 2:40 (123) *Valuation rings in finite-dimensional division algebras.* H. H. BRUNGS*, University of Alberta, and JOACHIM GRÄTER, Technische Universität (832-16-27)

2:45 – 2:55 (124) *Normality and exactness in pointed categories.* Preliminary report. F. E. J. LINTON, Wesleyan University (832-18-90)

3:00 – 3:10 (125) *An extension of the Fenchel duality theorem.* Preliminary report. S. SIMONS and B. RODRIGUES*, University of California, Santa Barbara (832-49-18)

3:15 – 3:25 (126) *Continuity of non-linear integral functionals and Arkin-Levin's variational problem.* Preliminary report. TORU MARUYAMA, Keio University, Japan (832-49-103)

3:30 – 3:40 (127) *Lebesgue integrability on a subinterval for Henstock integrable functions.* Preliminary report. KRZYSZTOF OSTASZEWSKI, University of Louisville (832-26-94)

3:45- 3:55 (128) *On measure repleteness and support for lattice regular measures.* PANAGIOTIS D. STRATIGOS, Long Island University, Brooklyn Center (832-28-24)

4:00- 4:10 (129) *Approximately normal joint distributions.* Preliminary report. EUGENE RODEMICH, California Institute of Technology (832-60-129)

Salt Lake City, Utah

Hugo Rossi
Associate Secretary

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New Books in Contemporary Mathematics

Function Estimates
J. S. Marron, Editor

This volume collects together papers presented at the 1985 Conference in Function Estimation held at Humboldt State University. The papers focus especially on various types of spline estimations and convolution problems. The use of estimation and approximation methods as applied to geophysics, numerical analysis, and nonparametric statistics was a special feature of this conference.

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D. Sundararaman, Editor

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Ivan Rival, Editor

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Kent, April 3–4, Kent State University

Program for the 833rd Meeting

The eight hundred and thirty-third meeting of the American Mathematical Society will be held at Kent State University in Kent, Ohio, on Friday and Saturday, April 3–4, 1987.

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 are as follows:

WILLIAM G. DWYER, University of Notre Dame, *Solving classification problems in algebraic topology.*

PETER LOEB, University of Illinois, Urbana-Champaign, *Standard Brownian motion is non-standard coin tossing.*

L. RIDGWAY SCOTT, Pennsylvania State University, *Discretization of incompressibility constraints.*

LUCIEN SZPIRO, Université de Paris VI, France, and Mathematical Sciences Research Institute, Berkeley, *Elliptic curves and Diophantine equations.*

These invited addresses will be presented in Kiva Auditorium, which is attached to the Kent State University Student Center.

Special Sessions

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

Algebraic combinatorics: Association schemes and related topics, EIICHI BANNAI, Ohio State University and PAUL TERWILLIGER, University of Wisconsin, Madison. The speakers are Richard Askey, Eiichi Bannai, Laura M. Chihara, Charles F. Dunkl, Jonathan I. Hall, D. G. Higman, Tatsuro Ito, Kenneth W. Johnson, R. A. Liebler, R. A. Mena, D. K. Ray-Chaudhuri, Ernest Shult, N. M. Singhi, N. J. A. Sloane, Jonathan D. H. Smith, Stephen D. Smith, Sung-Yell Song, Dennis Stanton, Paul Terwilliger, and Richard M. Weiss.

Summability theory, JOHN A. FRIDY, Kent State University. The speakers are Grahame Bennett, Johann Boos, David Borwein, F. P. Cass, S.-C. Chang, Jeff Connor, J. DeFranza, D. J. Flemming, T. A. Keagy, J. C. Magee, R. N. Mohapatra, Ferenc Moricz, B. E. Rhoades, William H. Ruckle, Bruce Shawyer, and A. K. Snyder.

Characters of finite groups, STEPHEN M. GAGOLA, JR., Kent State University, and DAVID C. BUCHTAL, University of Akron. The speakers are Pamela A. Ferguson, I. M. Isaacs, Eliot Jacobson, R. J. List, Olaf Manz, Michael C. Slattery, Alexandre Turull, and Thomas R. Wolf.

Noncommutative ring theory, TIMOTHY J. HODGES and JAMES OSTERBURG, University of Cincinnati. The speakers are Allan Berele, Jeffrey Bergen, Victor Camillo, William Chin, E. L. Green, Darrell Haile, Chan Huh, Karl A. Kosler, Lawrence Levy, Alexander Lichtman, L. Makar-Limanov, Ian M. Musson, D. S. Passman, Declan Quinn, and Steven Tesser.

Boundaries in potential theory, PETER A. LOEB, University of Illinois, Urbana-Champaign. The speakers are Oscar Blasco, Jurgen Bleidtner, Moses Glasner, Myron Goldstein, Peter A. Loeb, and W. H. Ow.

Cyclic homology and applications, HENRI MOSCOVICI, Ohio State University, and DAN BURGHELEA, IHES, France. The speakers are Jonathan L. Block, Jean-Luc Brylinski, Ezra Getzler, Phil Hanlon, Peter Haskell, Jerome Kaminker, Joseph Lipman, Andrew J. Nicas, Crichton Ogle, and R. W. Thomason.

Scientific computation, L. RIDGWAY SCOTT. The speakers are Jessee L. Barlow, Max Grunzburger, William W. Hager, George Majda, R. A. Nicolaides, Ricardo H. Nochetto, Edward A. Overman, II, Janet Petersen, Werner C. Rheinboldt, and Bram van Leer.

Geometry of Banach spaces and harmonic analysis, ANDREW M. TONGE and JOE DIESTEL, Kent State University. The speakers are N. L. Carothers, William J. Davis, Robert Deville, P. N. Dowling, S. W. Drury, G. A. Edgar, Per Enflo, Russell A. Gordon, Ananda V. Gubbi, Nigel J. Kalton, Heinrich P. Lotz, David P. McLaughlin, Mario Milman, Richard D. Neidinger, A. Pelczynski, Anton R. Schep, Carsten Schutt, Allen L. Shields, David A. Trautman, J. J. Uhl, Jr., Lutz Weis, Guido Weiss, Wojbor A. Woyczynski, and Robert M. Young.

Unstable homotopy theory, CLARENCE WILKERSON, Wayne State University. The speakers are F. R. Cohen, Linda Fornera, John Harper, Kenshi Ishiguro, Andrzej Kozlowski, Joseph Neisendorfer, Martin Peim, Franklin P. Peterson, Stewart Priddy, Ross E. Staffeldt, Peter Symonds, and Clarence W. Wilkerson.

Contributed Papers

There will also be one session for contributed ten-minute papers. It appears unlikely that late papers can be accommodated.

Registration

The meeting registration desk will be located in the third floor lounge of the KSU Student Center. The desk will be open from 8:30 a.m. to 4:30

p.m. on Friday, and from 8:30 a.m. to noon on Saturday. The registration fees are $30 for members of the AMS, $45 for nonmembers, and $10 for students or unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information can be found in a box on page 62 in the San Antonio meeting announcement in the January issue of *Notices*.

Accommodations

Blocks of rooms are being held at the following locations, all of which are within 4.5 miles from the campus. Participants should make their own arrangements directly with the hotel of their choice and be sure to mention the AMS meeting at Kent State University in order to obtain the special rates indicated. Note that rates do not include applicable taxes, and that the deadline for reservations was **March 7, 1987**.

University Inn (.5 mile)
540 South Water Street, Kent 44240
Telephone: 216-678-0123
Single $26 Double $30

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303 E. Main Street, Kent 44240
Telephone: 216-673-3411
$32 (1 to 4 persons)

Friendship Inn Eastwood (2 miles)
2296 State Road #59, Kent 44240
Telephone: 216-678-1111
Single $26 Double $28

Holiday Inn Akron – Kent (4.5 miles)
4363 State Route #43, Kent 44240
Telephone: 216-678-0101
Single $40 Double $40

Food Service

The cafeteria in the Student Center will be open from 7:00 a.m. to 6:30 p.m. on Friday, and from 7:00 a.m. to 1:30 p.m. on Saturday. More formal dining is available at the Schwebel Garden Room on the third floor of the Student Center. In addition, many fast food restaurants are located within a block of the campus.

Travel

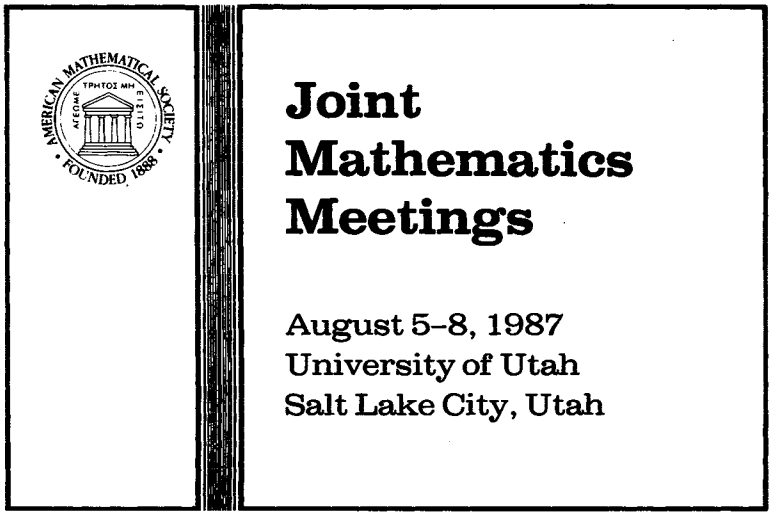
Most major airlines serve Cleveland's Hopkins International Airport, from which Airport Limousine Service transports passengers directly to Kent. The fare is $11 per person, and departures are scheduled at 9:00 a.m., noon, and 5:30 p.m. daily. A special AMS limousine will be provided on Thursday night only, departing the airport terminal at 7:30 and 9:30 p.m. The limo desk is located inside the terminal near exit 6 and the baggage claim area.

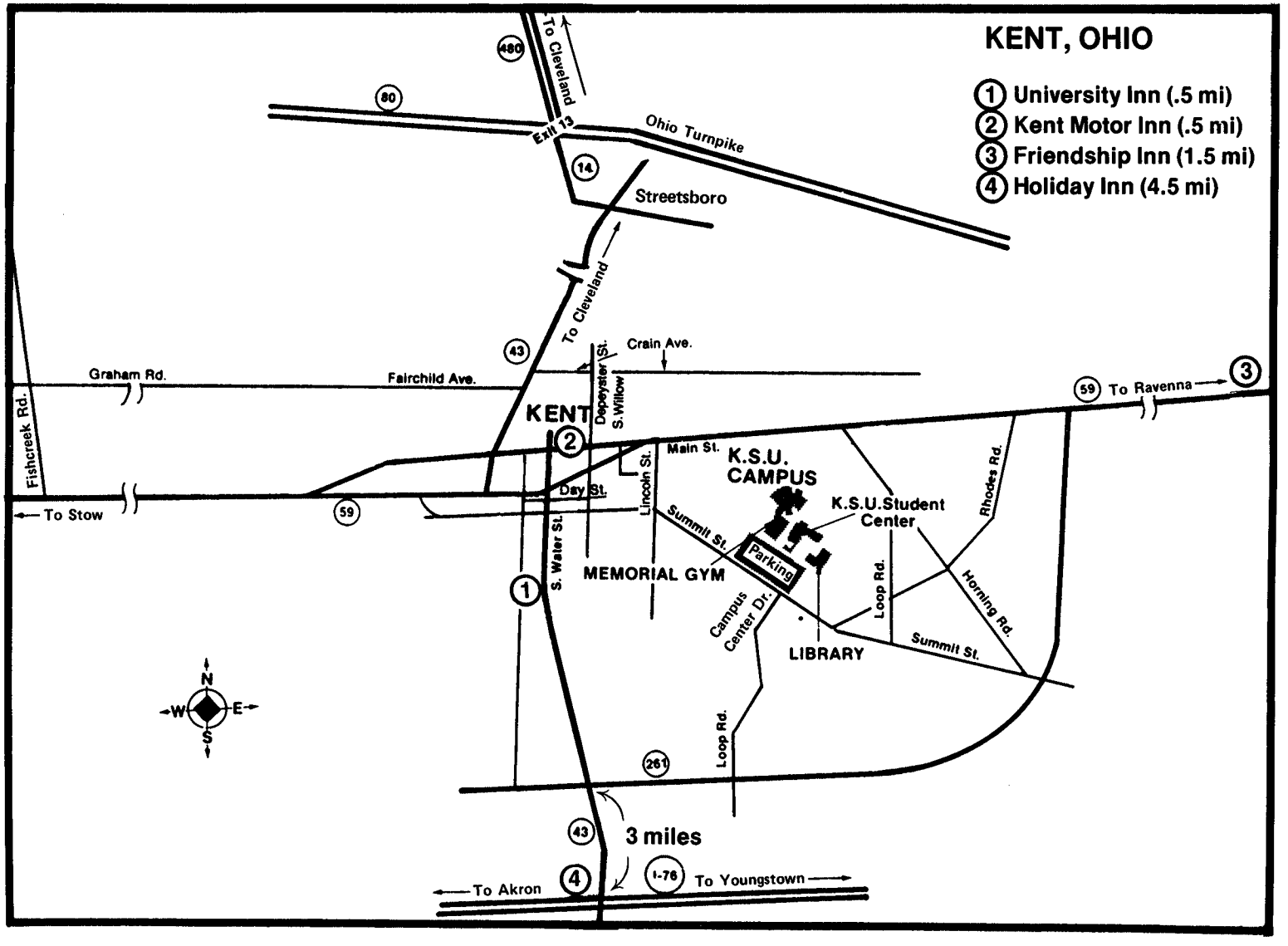
Participants may also telephone Town & Country Taxi Service (216-929-7212) at least 24 hours in advance to arrange for prompt pickup at the airport. The fare to Kent is $15. Regular taxi service is also available without a reservation, but the price is considerably higher.

Kent is located along Ohio Route 59, approximately 10 miles east of Akron, 35 miles southeast of Cleveland, and 100 miles northwest of Pittsburgh, Pennsylvania. By car it can be reached via the Ohio Turnpike to the north or from I-76 to the south. Drivers approaching from the Ohio turnpike should take exit 13 to Routes 14 and 43 south, and those from I-76 should take Route 43 north.

Parking

An all-day fee of $2 will be charged for parking on Friday in the lot adjacent to the Student Center. Stickers can be obtained at the meeting registration desk. There is no charge for parking on Saturday.

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Program of the Sessions

All AMS sessions will take place in the Kent Student Union. The time limit for each contributed paper in the AMS general sessions is ten minutes. In the special sessions, the time limit varies from session to session and within sessions. To maintain the schedule, time limits will be strictly enforced.

Abstracts of papers presented in AMS sessions at this meeting will be found in the February 1987 issue of *Abstracts of papers presented to the American Mathematical Society*, ordered according to the numbers in parentheses following the listings below.

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

Friday, April 3, 1987, 8:00 a.m.

Special Session on Geometry of Banach Spaces and Harmonic Analysis, I Room 319

8:00 - 8:20 (1) *Contractive projections in Banach spaces.* PER ENFLO, Ohio State University, Columbus (833-46-126) (Sponsored by J. Diestel)

8:30 - 8:50 (2) *Differentiation in a Banach space.* Preliminary report. RUSSELL A. GORDON, University of Illinois, Urbana-Champaign (833-46-72)

9:00 - 9:20 (3) *A family of Stone spaces.* Preliminary report. ANANDA V. GUBBI*, Youngstown State University, and THOMAS ARMSTRONG, University of Maryland, Baltimore County (833-46-94)

9:30 - 9:50 (4) *Rearrangements of vector-valued Hardy spaces.* NIGEL J. KALTON, University of Missouri, Columbia (833-46-53)

10:00 - 10:20 (5) *Weak* convergence in the dual of weak L^p.* HEINRICH P. LOTZ, University of Illinois, Urbana-Champaign (833-46-15)

10:30 - 10:50 (6) *Asymptotic trees in duals of Banach spaces with Schauder basis.* Preliminary report. DAVID P. MCLAUGHLIN, University of Alberta (833-46-52)

Friday, April 3, 1987, 8:30 a.m.

Special Session on Algebraic Combinatorics: Association Schemes and Related Topics, I Room 314

8:30 - 8:50 (7) *Distance-regular graphs with fixed valency.* TATSURO ITO, Joetsu University of Education, Japan (833-05-99) (Sponsored by Eiichi Bannai)

9:00 - 9:20 (8) *Partitions in matrices and graphs.* D. R. HUGHES and N. M. SINGHI*, Ohio State University, Columbus (833-05-16) (Sponsored by Eiichi Bannai)

9:30 - 9:50 (9) *Properties of zeros of generalized Krawtchouk polynomials.* Preliminary report. DENNIS STANTON*, University of Minnesota, Minneapolis, and LAURA CHIHARA, St. Olaf College (833-05-95)

10:00 - 10:20 (10) *Association schemes and quadratic transformations for orthogonal polynomials.* LAURA M. CHIHARA*, St. Olaf College, and DENNIS STANTON, University of Minnesota, Minneapolis (833-05-82)

10:30 - 10:50 (11) *The T algebra for certain P-and Q-polynomial association schemes.* PAUL TERWILLIGER, University of Wisconsin, Madison (833-05-83)

Friday, April 3, 1987, 8:30 a.m.

Special Session on Cyclic Homology and Applications, I Room 318

8:30 - 9:05 (12) *Cyclic cohomology and path integrals for Dirac operators.* EZRA GETZLER, Harvard University (833-58-118)

9:10 - 9:40 (13) *K-theory and cyclic homology of simplicial rings.* CRICHTON OGLE, Ohio State University, Columbus (833-55-97)

9:45 - 10:15 (14) *Mixed Hodge structure in algebraic K-theory and cyclic homology.* ANDREW J. NICAS, University of Toronto (833-55-51)

10:20 - 10:50 (15) *K-theory of singular schemes.* Preliminary report. R. W. THOMASON, Johns Hopkins University, Baltimore (833-99-133)

Friday, April 3, 1987, 8:30 a.m.

Special Session on Summability Theory, I Room 316

8:30– 8:50 (16) *Optimal algorithms for best approximation of moment series.* BRUCE SHAWYER, Memorial University of Newfoundland (833-40-61) (Sponsored by John A. Fridy)

9:00– 9:20 (17) *Summability methods related to statistical convergence.* Preliminary report. JEFF CONNOR, Loyola University (833-40-85)

9:30– 9:50 (18) *Linear acceleration over certain classes of sequences ordered with respect to rate of convergence.* T. A. KEAGY, University of Texas, Tyler (833-40-129)

10:00–10:20 (19) *A study of FK-spaces containing* φ. Preliminary report. W. BEEKMANN, Fernuniversität Hagen, Federal Republic of Germany, and S.-C. CHANG*, Brock University (833-40-01)

10:30–10:50 (20) *General theorems of Mazur-Orlicz-type.* JOHANN BOOS*, Fernuniversität Hagen, Federal Republic of Germany, and TOIVO LEIGER, Universität Tartu, U.S.S.R. (833-40-20) (Sponsored by S.-C. Chang)

Friday, April 3, 1987, 9:00 a.m.

Special Session on Scientific Computation, I Room 313

9:00– 9:30 (21) *The direct solution of weighted and equality constrained least squares problems.* JESSE L. BARLOW, Pennsylvania State University, University Park (833-65-22) (Sponsored by L. Ridgway Scott)

9:40–10:10 (22) *Finite element methods for the Ladyzhenskaya model for viscous flow.* QIANG DU and MAX GUNZBURGER*, Carnegie-Mellon University (833-65-117) (Sponsored by L. Ridgway Scott)

10:20–10:50 (23) Inf-Sup *parameters in numerical analysis.* WILLIAM W. HAGER, Pennsylvania State University, University Park (833-65-46)

Friday, April 3, 1987, 11:00 a.m.

AMS Invited Address Kiva Auditorium

11:00–12:00 (24) *Discretization of incompressibility constraints.* L. RIDGWAY SCOTT, Pennsylvania State University, University Park (833-65-77)

Friday, April 3, 1987, 1:30 p.m.

AMS Invited Address Kiva Auditorium

1:30– 2:30 (25) *Elliptic curves and Diophantine equations.* LUCIEN SZPIRO, Université de Paris VI, France, and Mathematical Sciences Research Institute, Berkeley (833-99-135)

Friday, April 3, 1987, 3:00 p.m.

Special Session on Algebraic Combinatorics: Association Schemes and Related Topics, II Room 314

3:00– 3:20 (26) *Quasigroup characters and association schemes.* Preliminary report. KENNETH W. JOHNSON, Pennsylvania State University, Ogontz Campus (833-05-28)

3:30– 3:50 (27) *Fusion and magic rectangles.* Preliminary report. JONATHAN D. H. SMITH, Iowa State University (833-05-62) (Sponsored by Eiichi Bannai)

4:00– 4:20 (28) *The character table of certain association schemes and its relationship to the character table of* $PSL(2,q)$. SUNG-YELL SONG, Ohio State University, Columbus (833-05-17)

4:30– 4:50 (29) *Finding and using automorphisms.* JONATHAN I. HALL, Michigan State University (833-05-88)

5:00– 5:20 (30) *Characterization of geometries of type* F_4 *and extended* F_4. Preliminary report. ERNEST SHULT, Kansas State University (833-51-38)

5:30– 5:50 (31) *Triality configurations.* Preliminary report. D. G. HIGMAN, University of Michigan, Ann Arbor (833-05-102)

Friday, April 3, 1987, 3:00 p.m.

Special Session on Characters of Finite Groups, I Room 311

3:00– 3:20 (32) *On polynomials associated to characters.* ALEXANDRE TURULL, Rutgers University, New Brunswick (833-20-04)

3:30– 3:50 (33) *Applications of prime characters to primitivity.* PAMELA A. FERGUSON, University of Miami (833-20-11)

4:00– 4:20 (34) *Counting characters and not-quite-characters.* Preliminary report. I. M. ISAACS, University of Wisconsin, Madison (833-20-14)

4:30– 4:50 (35) *Character degrees of finite p-groups.* MICHAEL C. SLATTERY, Marquette University (833-20-24)

Friday, April 3, 1987, 3:00 p.m.

Special Session on Geometry of Banach Spaces and Harmonic Analysis, II Room 319

3:00– 3:20 (36) *Lorentz-spaces that embed into L^1.* CARSTEN SCHÜTT, Ohio University, Columbus (833-46-73)

3:30– 3:50 (37) *Real and complex extrapolation theory.* Preliminary report. MARIO MILMAN, Florida Atlantic University (833-46-105)

4:00– 4:20 (38) *Concepts in the real interpolation of Banach spaces.* RICHARD D. NEIDINGER, Davidson College (833-46-09)

4:30– 4:50 (39) *Commensurate sequences of functions.* A. PEŁCZYŃSKI, Institute of Mathematics, Poland, and University of Illinois, Urbana-Champaign (833-46-128) (Sponsored by Andrew M. Tonge)

5:00– 5:20 (40) *Measures of non-compactness of positive operators.* ANTON R. SCHEP, University of South Carolina (833-46-55)

5:30– 5:50 (41) *Some geometric properties of Schreier's space.* DAVID A. TRAUTMAN, The Citadel (833-46-59)

Friday, April 3, 1987, 3:00 p.m.

Special Session on Boundaries in Potential Theory Room 302

3:00– 3:20 (42) *Vector-valued harmonic functions and cone absolutely summing operators.* OSCAR BLASCO, University of Illinois, Urbana-Champaign (833-46-48) (Sponsored by Peter Loeb)

3:30– 3:50 (43) *Dirichlet principle with free boundary values for the Royden boundary.* MOSES GLASNER, Pennsylvania State University, University Park (833-31-08)

4:00– 4:20 (44) *Fine neighborhoods at points of a regular metrizable boundary.* PETER A. LOEB, University of Illinois, Urbana-Champaign (833-31-92)

4:30– 4:50 (45) *Simplicial compactifications.* Preliminary report. JÜRGEN BLIEDTNER, University of Frankfurt, Federal Republic of Germany (833-31-93)

5:00– 5:20 (46) *Boundaries in potential theory.* MYRON GOLDSTEIN, Arizona State University (833-31-02)

5:30– 5:50 (47) *Uniform approximation on closed sets by solutions of elliptic partial differential equations.* A. DUFRESNOY, Fourier Institute, France, P. M. GAUTHIER, Université de Montréal, and W. H. OW*, Michigan State University (833-35-12)

Friday, April 3, 1987, 3:00 p.m.

Special Session on Cyclic Homology and Applications, II Room 318

3:00– 3:30 (48) *The η-invariant and cyclic cocycles.* JEROME KAMINKER, Indiana University-Purdue University, Indianapolis (833-46-131)

3:35– 4:05 (49) *Hochschild homology and residues.* JOSEPH LIPMAN, Purdue University, West Lafayette (833-18-26)

Friday, April 3, 1987, 3:00 p.m.

Special Session on Noncommutative Ring Theory, I Room 310A

3:00– 3:20 (50) *Generic central simple algebras with involution.* ALLAN BERELE, DePaul University (833-16-111) (Sponsored by Jeff Bergen)

3:30– 3:50 (51) *Automorphic-differential identities.* Preliminary report. JEFFREY BERGEN, DePaul University (833-16-98)

4:00– 4:20 (52) *Recent results in ring theory.* VICTOR CAMILLO, University of Iowa (833-16-87)

4:30– 4:50 (53) *Prime ideals in smash products.* WILLIAM CHIN, University of Texas, Austin (833-16-112)

5:00– 5:20 (54) *Ext-algebras of graded rings.* Preliminary report. E. L. GREEN, Virginia Polytechnic Institute and State University (833-16-31)

Friday, April 3, 1987, 3:00 p.m.

Special Session on Summability Theory, II Room 316

3:00– 3:20 (55) *Unconditional Toeplitz sections in sequence spaces.* D. J. FLEMING, St. Lawrence University (833-40-43)

3:30– 3:50 (56) *Sequence spaces and summabililty factors.* J. DEFRANZA* and D. J. FLEMING, St. Lawrence University (833-40-42)

4:00– 4:20 (57) *The strong topology on the dual space of a summability field and the mu-continuity problem.* WILLIAM H. RUCKLE*, Clemson University, and JOHN C. MAGEE, State University of New York, College at Potsdam (833-40-06)

4:30– 4:50 (58) *The β-dual of FK-spaces.* J. C. MAGEE, State University of New York, College at Potsdam (833-40-41)

5:00– 5:20 (59) *Sequence spaces with small β-duals.* GRAHAME BENNETT, Indiana University, Bloomington (833-46-23) (Sponsored by B. E. Rhoades)

5:30– 5:50 (60) *Weak* closed subspaces of ℓ_∞, the existence of ℓ_∞-restrictions, and Meyer-König Zeller theorems.* Preliminary report. A. K. SNYDER, Lehigh University (833-40-19)

Friday, April 3, 1987, 3:00 p.m.

Special Session on Scientific Computation, II Room 313

3:00– 3:30 (61) *Computing unstable branches of a solution curve using fixed point iterations.* JANET PETERSON, Los Alamos National Laboratory (833-65-125) (Sponsored by L. Ridgway Scott)

3:40– 4:10 (62) *Numerical computation of scattering frequencies for acoustic wave equations.* MUSHENG WEI, Institute of Mathematics and its Applications, University of Minnesota, Minneapolis, GEORGE MAJDA*, Ohio State University, Columbus, and WALTER STRAUSS, Brown University (833-65-76)

4:20– 4:50 (63) *A linear algorithm for multidimensional parabolic free boundary problems.* RICARDO H. NOCHETTO, Institute for Mathematics and its Applications, Minneapolis (833-65-58) (Sponsored by L. Ridgway Scott)

5:00– 5:30 (64) *Some recent numerical results for the stationary Cahn-Hilliard equation.* R. A. NICOLAIDES, Carnegie-Mellon University (833-65-130)

Friday, April 3, 1987, 3:00 p.m.

Special Session on Unstable Homotopy Theory, I Room 315

3:00– 3:20 (65) *ImJ is a factor of many spaces.* F. R. COHEN*, University of Kentucky, and F. P. PETERSON, Massachusetts Institute of Technology (833-55-65)

3:30– 3:50 (66) *Divisibility in $K_0(BU)$.* Preliminary report. MARTIN PEIM, University of Kentucky (833-55-66)

4:00– 4:20 (67) *Generators of $H^*(RP^\infty \wedge RP^\infty)$ as a module over the Steenrod algebra.* FRANKLIN P. PETERSON, Massachusetts Institute of Technology (833-55-89)

4:30– 4:50 (68) *Maps from $B\pi$ to BG.* KENSHI ISHIGURO, University of Chicago (833-55-67)

5:00– 5:20 (69) *On fundamental theorems of algebraic K-theory.* Preliminary report. ROSS E. STAFFELDT, Indiana University-Purdue University, Indianapolis (833-18-68)

5:30– 5:50 (70) *Another proof of the generalized Sullivan conjecture.* JOSEPH NEISENDORFER, University of Rochester (833-55-123) (Sponsored by S. J. Summers)

Saturday, April 4, 1987, 8:00 a.m.

Special Session on Geometry of Banach Spaces and Harmonic Analysis, III Room 319

8:00– 8:20 (71) *Unconditional and disjoint sequences in some function spaces.* Preliminary report. N. L. CAROTHERS*, Texas A & M University, College Station, and S. J. DILWORTH, University of Texas, Austin (833-46-90)

8:30– 8:50 (72) *Contractive projections on ℓ_p.* WILLIAM J. DAVIS*, Ohio State University, Columbus, and PER ENFLO, Ohio State University, Columbus, and Royal Institute of Technology, Sweden (833-46-119)

9:00– 9:20 (73) *Some results about weak* convex point of continuity property and related topics.* Preliminary report. ROBERT DEVILLE, University of Alberta (833-46-74)

9:30– 9:50 (74) *Some characterizations of the analytic Radon-Nikodym property in Banach spaces.* P. N. DOWLING* and G. A. EDGAR, Ohio State University, Columbus (833-46-127)

10:00–10:20 (75) *Extreme points for positive forms on ℓ^p.* S. W. DRURY, McGill University (833-52-49) (Sponsored by Andrew M. Tonge)

10:30–10:50 (76) *Radon-Nikodým operators.* Preliminary report. G. A. EDGAR, Ohio State University, Columbus (833-46-86)

Saturday, April 4, 1987, 8:00 a.m.

Special Session on Unstable Homotopy Theory, II Room 315

8:00– 8:20 (77) *Algebraic Smith theory.* Preliminary report. WILLIAM G. DWYER, University of Notre Dame, and CLARENCE W. WILKERSON*, Wayne State University (833-55-109)

8:30– 8:50 (78) *Euler characteristic of groups and ranks of modules.* LINDA FORNERA, Ohio State University, Columbus (833-18-116) (Sponsored by Guido Mislin)

9:00– 9:20 (79) *Cogroup structures on two-cell complexes.* JOHN HARPER, University of Rochester (833-57-54)

9:30– 9:50 (80) *Decompositions of RG-lattices.* PETER SYMONDS, Ohio State University, Columbus (833-18-115) (Sponsored by Guido Mislin)

10:00 - 10:20 (81) *Applications of the Segal conjecture to splittings.* Preliminary report. STEWART PRIDDY, Northwestern University (833-55-124)

10:30 - 10:50 (82) *De-looping the total Stiefel-Whitney class.* ANDRZEJ KOZLOWSKI, Wayne State University (833-55-110)

Saturday, April 4, 1987, 8:30 a.m.

Special Session on Algebraic Combinatorics: Association Schemes and Related Topics, III Room 314

8:30 - 8:50 (83) *The solution to Berlekamp's switching game.* P. C. FISHBURN and N. J. A. SLOANE*, AT&T Bell Laboratories, Murray Hill, New Jersey (833-05-34)

9:00 - 9:20 (84) *S-transitive graphs of small girth.* RICHARD M. WEISS, Tufts University (833-20-81)

9:30 - 9:50 (85) *Directed distance-regular graphs of girth* 4. R. A. MENA, University of Wyoming (833-05-56) (Sponsored by Eiichi Bannai)

10:00 - 10:20 (86) *Certain distance-regular digraphs and related rings of characteristic* 4. R. A. LIEBLER*, Colorado State University, and R. A. MENA, University of Wyoming (833-05-57) (Sponsored by Eiichi Bannai)

10:30 - 10:50 (87) *Groups applied to graphs via association schemes.* Preliminary report. STEPHEN D. SMITH, University of Illinois, Chicago (833-05-29)

Saturday, April 4, 1987, 8:30 a.m.

Special Session on Cyclic Homology and Applications, III Room 318

8:30 - 9:05 (88) *Algebras associated with group actions and their homology.* Preliminary report. JEAN-LUC BRYLINSKI, Brown University (833-55-30)

9:10 - 9:40 (89) *The complete stable decomposition of* $H_*(g\ell_n(A))$. PHIL HANLON, University of Michigan, Ann Arbor (833-22-78)

9:45 - 10:15 (90) *Cyclic cocycles associated to elliptic operators on some noncompact manifolds.* Preliminary report. PETER HASKELL, Purdue University, West Lafayette (833-58-50)

10:20 - 10:50 (91) *A Mayer-Vietoris sequence for cyclic homology.* Preliminary report. JONATHAN L. BLOCK, Harvard University (833-46-132)

Saturday, April 4, 1987, 8:30 a.m.

Special Session on Noncommutative Ring Theory, II Room 310A

8:30 - 8:50 (92) *A class of central simple algebras determined by Stickelberger conditions.* Preliminary report. DARRELL HAILE, Indiana University, Bloomington (833-16-32)

9:00 - 9:20 (93) *Invariants of finite abelian groups acting on the algebra of* 2×2 *generic matrices.* CHAN HUH, University of Cincinnati (833-16-47)

9:30 - 9:50 (94) *Localization at collections of minimal primes.* ANN K. BOYLE, University of Wisconsin, Milwaukee, and KARL A. KOSLER*, University of Wisconsin, Waukesha Center (833-16-45)

10:00 - 10:20 (95) *A problem in noncommutative elementary divisor theory.* Preliminary report. ROBERT GURALNICK, University of Southern California, and LAWRENCE LEVY*, University of Wisconsin, Madison (833-16-40)

10:30 - 10:50 (96) *On the residual nilpotence of the multiplicative group of the fields generated by universal enveloping algebras.* Preliminary report. ALEXANDER LICHTMAN, University of Wisconsin, Parkside (833-16-104)

Saturday, April 4, 1987, 8:30 a.m.

Special Session on Summability Theory, III Room 316

8:30 - 8:50 (97) *Nörlund and weighted mean matrices as operators on* ℓ_p. F. P. CASS*, University of Western Ontario, and W. KRATZ, Universität Ulm, West Germany (833-47-27) (Sponsored by David Borwein)

9:00 - 9:20 (98) *Tauberian and other theorems concerning Dirichlet's series with non-negative coefficients.* DAVID BORWEIN, University of Western Ontario (833-40-18)

9:30 - 9:50 (99) *Matrix transformations of orthonormal series.* B. E. RHOADES, Indiana University, Bloomington (833-40-10)

10:00 - 10:20 (100) *On* Λ*-strong convergence of numerical sequences and Fourier series.* Preliminary report. FERENC MÓRICZ, Syracuse University (833-40-84) (Sponsored by John A. Fridy)

10:30 - 10:50 (101) *On saturation results for generalized harmonic summability.* R. N. MOHAPATRA, University of Central Florida (833-40-39)

Saturday, April 4, 1987, 9:00 a.m.

Special Session on Characters of Finite Groups, II Room 311

9:00– 9:20 (102) *Prime factors of character degrees.* OLAF MANZ, University of Mainz, West Germany (833-20-33) (Sponsored by Stephen M. Gagola)

9:30– 9:50 (103) *The permutation index of p-defect zero characters.* ELIOT JACOBSON, Ohio University, Athens (833-20-05)

10:00–10:20 (104) *Characters of certain wreath products.* Preliminary report. R. J. LIST, University of Michigan, Ann Arbor (833-20-13) (Sponsored by Aimo Hinkkanen)

10:30–10:50 (105) *Variations on McKay's conjecture.* Preliminary report. THOMAS R. WOLF, Ohio University, Athens (833-20-44)

Saturday, April 4, 1987, 9:00 a.m.

Special Session on Scientific Computation, III Room 313

9:00– 9:30 (106) *Multi-parameter equilibrium problems.* WERNER C. RHEINBOLDT, University of Pittsburgh (833-65-63)

9:40–10:10 (107) *The rise and fall of flux-vector splitting.* BRAM VAN LEER, University of Michigan, Ann Arbor (833-65-36) (Sponsored by L. Ridgway Scott)

10:20–10:50 (108) *Coherence and chaos in the driven, damped sine-Gordon equation.* ALAN R. BISHOP, Los Alamos National Laboratory, Los Alamos, New Mexico, DAVID W. MCLAUGHLIN, University of Arizona, and EDWARD A. OVERMAN, II*, Ohio State University, Columbus (833-35-60) (Sponsored by George Majda)

Saturday, April 4, 1987, 9:00 a.m.

General Session Room 302

9:00– 9:10 (109) *Topoi, intuitionism, and intensionality.* Preliminary report. THOMAS DRUCKER, Dickinson College (833-03-114)

9:15– 9:25 (110) *Definitions of finite* II. Preliminary report. MARY F. YORKE* and PAUL E. HOWARD, Eastern Michigan University (833-04-108)

9:30– 9:40 (111) *Representation theory of a tactical configuration.* KEN W. SMITH, Central Michigan University (833-05-121)

9:45– 9:55 (112) *The etale cohomology of p-torsion sheaves,* II. WILLIAM A. HAWKINS, JR., University of the District of Columbia (833-14-64)

10:00–10:10 (113) *Prestabilization for K_1 of Banach algebras.* BRUCE MAGURN*, Miami University, Oxford, and LEONID VASERSTEIN, Pennsylvania State University, University Park (833-15-69)

10:15–10:25 (114) *Nucleus of a nonassociative ring with an invertible or nilpotent valued derivation.* Preliminary report. TAE-IL SUH, East Tennessee State University (833-17-107)

10:30–10:40 (115) *Classification of multipliers bounded on $H^1(R^2)$.* Preliminary report. JAMES E. DALY*, University of Colorado, Colorado Springs, and KEITH L. PHILLIPS, New Mexico State University, Las Cruces (833-42-120)

10:45–10:55 (116) *Superlogic manifold: Metric spacetime.* STEPHEN L. WEINBERG, Berkeley Academy of Artscience, Berkeley, California (833-78-07)

Saturday, April 4, 1987, 11:00 a.m.

AMS Invited Address Kiva Auditorium

11:00–12:00 (117) *Standard Brownian motion is nonstandard coin tossing.* PETER A. LOEB, University of Illinois, Urbana-Champaign (833-60-35)

Saturday, April 4, 1987, 1:30 p.m.

AMS Invited Address Kiva Auditorium

1:30– 2:30 (118) *Solving classification problems in algebraic topology.* WILLIAM G. DWYER, University of Notre Dame (833-55-122)

Saturday, April 4, 1987, 3:00 p.m.

Special Session on Algebraic Combinatorics: Association Schemes and Related Topics, IV — Room 314

3:00– 3:20 (119) *On primitive commutative association schemes with large numbers of classes.* Preliminary report. EIICHI BANNAI, Ohio State University, Columbus (833-05-100)

3:30– 3:50 (120) *Finite configurations on the sphere and orthogonal polynomials.* Preliminary report. CHARLES F. DUNKL, University of Virginia (833-05-96)

4:00– 4:20 (121) *Orthogonal polynomials and compact two point homogeneous spaces.* Preliminary report. RICHARD ASKEY, University of Wisconsin, Madison (833-33-106)

4:30– 4:50 (122) *On existence and number of orthogonal arrays.* D. K. RAY-CHAUDHURI* and N. M. SINGHI, Ohio State University, Columbus (833-05-101)

Saturday, April 4, 1987, 3:00 p.m.

Special Session on Geometry of Banach Spaces and Harmonic Analysis, IV — Room 319

3:00– 3:20 (123) *Nearly representable operators.* R. KAUFMAN, MINOS PETRAKIS, and J. J. UHL, JR.*, University of Illinois, Urbana-Champaign (833-46-75)

3:30– 3:50 (124) *Banach lattices with the subsequence splitting property.* LUTZ WEIS, Louisiana State University, Baton Rouge (833-46-71)

4:00– 4:20 (125) *Complex interpolation of subspaces and quotient spaces.* Preliminary report. RICHARD ROCHBERG and GUIDO WEISS*, Washington University (833-42-113)

4:30– 4:50 (126) *Random series in Orlicz spaces and their applications in the theory of multiple integral.* WOJBOR A. WOYCZYNSKI, Case Western Reserve University (833-60-91)

5:00– 5:20 (127) *The uniqueness problem for exponential basis in* $L^2(-\pi,\pi)$. Preliminary report. ROBERT M. YOUNG, Oberlin College (833-41-70)

5:30– 5:50 (128) *Invariant subspaces of the Dirichlet space.* ALLEN L. SHIELDS*, University of Michigan, Ann Arbor, and STEFAN RICHTER, University of Virginia (833-99-134)

Saturday, April 4, 1987, 3:00 p.m.

Special Session on Cyclic Homology and Applications, IV — Room 318

3:00– 4:00 Problem Session

Saturday, April 4, 1987, 3:00 p.m.

Special Session on Noncommutative Ring Theory, III — Room 310A

3:00– 3:20 (129) *Example of a skew field without a trace in which some elements are not commutators.* L. MAKAR-LIMANOV, Wayne State University (833-16-21)

3:30– 3:50 (130) *Injective modules, localization and completion in group algebras.* IAN M. MUSSON, University of Wisconsin, Milwaukee (833-16-37)

4:00– 4:20 (131) *Prime ideals in restricted enveloping rings.* D. S. PASSMAN, University of Wisconsin, Madison (833-16-25)

4:30– 4:50 (132) *Inner actions of Hopf algebras on central simple algebras.* JAMES OSTERBURG, University of Cincinnati, and DECLAN QUINN*, University of Utah (833-16-103)

5:00– 5:20 (133) *On Azumaya algebras arising from Clifford algebras.* Preliminary report. DARRELL HAILE, Indiana University, Bloomington, and STEVEN TESSER*, University of Cincinnati (833-16-80)

Robert M. Fossum
Associate Secretary

Urbana, Illinois

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Some Basic Hypergeometric Orthogonal Polynomials that Generalize Jacobi Polynomials

Richard Askey and James Wilson

(Memoirs of the AMS, Number 319)

The classical orthogonal polynomials include those of Hermite, Laguerre, Jacobi and discrete analogues found by Chebychev, Charlier, Meixner and Hahn. In an earlier paper the authors found the most general set of classical orthogonal polynomials whose weight function is discrete. The same polynomials with different choices of parameters have an absolutely continuous weight function. The explicit orthogonality relation is obtained, many special cases are considered, and a few facts about these polynomials are discovered. These include quadratic transformations for some basic hypergeometric series, a solution of the connection coefficient problem which gives Watson's extension of the Rogers-Ramanujan identities, inequalities for the polynomials on the spectral interval, a divided difference equation and a Rodrigues type formula. All of the paper rests on a new extension of the beta integral which has four rather than two free parameters in addition to the q associated with basic hypergeometric series.

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Newark, April 25–26, New Jersey Institute of Technology

Program for the 834th Meeting

The eight hundred and thirty-fourth meeting of the American Mathematical Society will be held at New Jersey Institute of Technology in Newark, New Jersey, on Saturday and Sunday, April 25–26, 1987.

Welcome Address

SAUL FENSTER, President of the New Jersey Institute of Technology, will welcome participants to the meeting at 11:00 a.m. on Saturday in the Theater on the NJIT campus.

Invited Addresses

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

ROBERT V. KOHN, New York University, Courant Institute of Mathematical Sciences, *Determining conductivity by boundary measurements*, 1:30 p.m. Sunday.

RODOLFO R. ROSALES, Massachusetts Institute of Technology, *Weakly nonlinear geometrical optics for hyperbolic systems of conservation laws and reacting gas flows*, 11:15 a.m. Saturday.

BIRGIT SPEH, Cornell University. *Representation theory and the cohomology of locally symmetric spaces*, 1:30 p.m. Saturday.

LARS B. WAHLBIN, Cornell University, *Local behavior in finite element methods: An overview*, 11:00 a.m. Sunday.

These four invited lectures will also be presented in the Theater.

Special Sessions

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

Inverse problems, DALJIT SINGH AHLUWALIA, New Jersey Institute of Technology, and ROBERT V. KOHN. The speakers are Tuncay Aktosum, Richard Beals, Margaret Cheney, Percy Deift, Peter G. Doyle, D. Isaacson, Bruce D. Lowe, Alexander G. Ramm, David Stickler, William W. Symes, Alejandro Uribe, Alvin Wexler, and Thomas J. Yorkey.

Computational mathematics and applications, ROMAN ANDRUSHKIW and ROY PLASTOCK, New Jersey Institute of Technology. The speakers are Eugene Allgower, Richard S. Falk, Ned Greene, Patrick T. Harker, Tomaso Poggio, L. B. Rall, J. T. Schwartz, Micha Sharir, Gilbert Strang, and Lars B. Wahlbin.

Nonlinear dynamics and chaos, DENIS BLACKMORE, New Jersey Institute of Technology. The speakers are Mel S. Berger, Denis Blackmore, Paul Blanchard, Jane Cronin, Chjan Lim, John Mallet-Paret, Rober M. May, H. Bruce Stewart, Son Tu, and James A. Yorke.

Cellular automata and symbolic dynamics, ROBERT H. GILMAN, Stevens Institute of Technology. The speakers are Roy Adler, Mike Boyle, Lyman Hurd, Bruce Kitchens, Norman H. Packard, and John Smillie.

Differential geometry, VLADISLAV V. GOLDBERG, New Jersey Institute of Technology. The speakers are Thomas F. Banchoff, Robert J. Currier, Robert B. Gardner, Hillel Gauchman, Herman Gluck, Samuel I. Goldberg, Vladislav V. Goldberg, Alfred Gray, Peter Hall, Howard Jacobowitz, Leon Karp, Theodore Shifrin, Gabor Toth, and Wolfgang Ziller.

Harmonic analysis on reductive p-adic Lie groups, C. DAVID KEYS, Rutgers University, Newark. The speakers are Charles Asmuth, Corinne Blondel, Lawrence Corwin, Phil Kutzko, David Manderscheid, Courtney Moen, Lawrence Morris, and Fiona Murnaghan.

Unitary representations, cohomology and G/Γ, ANTHONY W. KNAPP, SUNY at Stony Brook and Cornell University. The speakers are Jeffrey Adams, Dan Barbasch, Luis Casian, Michael Harris, Bertram Kostant, Stephen S. Kudla, Steve Rallis, Siddhartha Sahi, Freydoon Shahidi, J. Shalika, David Vogan, N. R. Wallach, Floyd Williams, Andrew W. Winkler, and Gregg J. Zuckerman.

Nonlinear functional analysis, PETRONIJE MILOJEVIĆ, New Jersey Institute of Technology. The speakers are V. Cafagna, P. M. Fitzpatrick, Helmut Hofer, Mario Martelli, P. J. McKenna, Petronije S. Milojević, Roger D. Nussbaum, W. V. Petryshyn, Paul H. Rabinowitz, and James R. Ward, Jr.

Group actions on manifolds, JOHN D. RANDALL and MARK STEINBERGER, Rutgers University. The speakers are Faiz Al-Rubaee, William Browder, Sylvain Cappell, Ricardo Cruz, James F. Davis, Michael Davis, Ian Hambleton, Peter Kahn, Ronnie Lee, Monica Nicolau, Frank Quinn, John D. Randall, Melvin Rothenberg, Reinhard Schultz, Justin Smith, Mark Steinberger, Shmuel Weinberger, and James West.

Contributed Papers

There will also be sessions for contributed ten-minute papers. It is unlikely that late papers can be accommodated.

Council Meeting

The Council of the Society will meet at 7:00 p.m. on Saturday, April 25, at the Hilton Gateway Hotel.

Association for Women in Mathematics

By invitation of the New Jersey Chapter of the AWM, ANN HIBNER KOBLITZ of Wellesley College will deliver a lecture titled *Sofia Kovalevskaia and gender perceptions: Was she a monstrosity or the princess of mathematics?* This talk will take place in the Cullimore Lecture Hall at 7:30 p.m. on Saturday, April 25.

Computer Mathematics Exhibit

By invitation of the Center for Nonlinear Science and Mathematical Computation of NJIT, several leading computer vendors will display their latest mathematics (graphics) hardware and software in the Ballroom of The Center at NJIT during and after the Saturday dinner (see below). Mathematicians interested in participating as exhibitors should contact Denis Blackmore at the NJIT Department of Mathematics; the telephone number is 201-596-3495.

Registration

The meeting registration desk will be located in the Lobby of The Center. The desk will be open from 8:15 a.m. to 3:00 p.m. on Saturday, and from 8:15 a.m. to 11:00 a.m. on Sunday. The registration fees are $30 for members of the AMS, $45 for nonmembers, and $10 for students or unemployed mathematicians.

Social Event

A buffet dinner featuring Spanish and Portugese cuisine will take place from 5:30 p.m. to 7:00 p.m. on Saturday, April 25, in the Ballroom at The Center. The price for the dinner, including wine, is $15 and must be paid at the meeting registration desk prior to 3:00 p.m. on Saturday; tickets will **not** be available after that time. Reservations are necessary and may be obtained by calling or writing to Denis Blackmore at the Department of Mathematics; the telephone number is 201-596-3495.

Petition Table

A petition table will be set up in the registration area. Additional information can be found in a box on page 62 in the San Antonio meeting announcement in the January issue of *Notices*.

Accommodations

Rooms have been blocked at the Hilton Gateway Hotel in downtown Newark, which is about 3/5 mile from campus. Participants should make their own reservations directly with the hotel, identifying themselves as attending the American Mathematical Society's meeting at NJIT. The cutoff date for reservations is April 10, 1987.

Hilton Gateway Hotel
Gateway Center
Raymond Boulevard
Newark, NJ 07102
Telephone: 201-622-5000
Single $62 Double $62

Rooms have also been blocked at the following:

Sheraton Inn (4 miles)
U.S. Highways 1 & 9
Elizabeth, NJ 07201
Telephone: 201-527-1600
Single $65 Double $65

Although rooms have not been blocked at the following locations, they are included here for information purposes.

Newark Airport Motel (4 miles)
U.S. Highway 1
Newark, NJ 07114
Telephone: 201-824-3000
Single $50 Double $65

Holiday Inn (4 miles)
160 Holiday Plaza
Newark, NJ 07114
Telephone: 201-589-1000
Single $98 Double $103

Food Service

The Center cafeteria will be open from 8:30 a.m. to 4:30 p.m. on Saturday, and from 11:00 a.m. to 5:00 p.m. on Sunday.

Several fine Spanish and Portuguese restaurants are located in the Ironbound district of Newark, within easy walking distance of the Hilton Gateway Hotel. A list of restaurants will be available at the meeting registration desk.

Travel

Newark International Airport, which is about five miles from the NJIT campus, is served by most major airlines. Several car rental agencies have counters at the airport terminal. The taxi fare from the airport to downtown Newark is approximately $10 to $12. An inexpensive ($2.50) minibus, Newark Airlink, provides service on the half hour to Newark's Pennsylvania Station which is across the street from the Hilton Gateway Hotel. Most hotels and motels provide complimentary limousine service to their guests, which can be summoned by using the courtesy phones at the airport terminal.

Regularly scheduled limousine service between the airport and downtown Newark is available through Newark Airport Limousine and Car Service. The current one-way fare is a flat rate of $15 for one to four persons per car. Reservations should be made a day in advance by calling 201-242-5012.

Newark is also served by AMTRAK trains and Greyhound Bus Lines, with both arriving at and departing from Newark's Pennsylvania Station.

Participants staying at the Hilton Gateway Hotel who do not wish to walk to the NJIT campus can cross the street to Pennsylvania Station and take the subway train to the Warren Street station, which is adjacent to the campus. The current one-way fare is 30 cents.

Persons arriving by car may reach New Jersey Institute of Technology via the Garden State Parkway and the New Jersey Turnpike from north and south; via Interstate Route 280 from east and west; and via Route 21 north from Newark International Airport.

From the Garden State Parkway: Take Exit 145 to Route 280 East, staying in the right lane, and follow signs marked "High Street-Harrison." Take High Street Exit 14A and turn right at the traffic light; proceed through three traffic lights and the NJIT campus is one block further on the right.

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Parking

Ample free parking for meeting participants will be available in Lots #3 and #11 on the NJIT campus.

Pseudodifferential Operators and Applications

François Trèves, Editor

(Proceedings of Symposia in Pure Mathematics, Volume 43)

This volume gathers together nineteen papers devoted to microlocal analysis, which has emerged as one of the most powerful tools of linear analysis since distribution theory. New classes of pseudodifferential operators and Fourier integral operators were introduced in the 1970s and used to tackle many classical and outstanding problems in partial differential equations. Recently, in a very promising area of research, pseudodifferential operators have been used to tackle nonlinear differential problems.

Contents

S. Alinhac and **G. Metivier**, *Propagation of local analyticity for the Euler equation*; **J. L. Antoniano** and **G. A. Uhlmann**, *A functional calculus for a class of pseudodifferential operators with singular symbols*; **M. S. Baouendi**, *Uniqueness in a class of nonlinear Cauchy problems*; **Michael Beals**, *Propagation of smoothness for nonlinear second-order strictly hyperbolic differential equations*; **R. Beals** and **R. R. Coifman**, *Multidimensional inverse scatterings and nonlinear partial differential equations*; **R. R. Coifman** and **Yves Meyer**, *Nonlinear harmonic analysis and analytic dependence*; **H. O. Cordes**, *On some C^*-algebras and Fréchet-algebras of pseudodifferential operators*; **G. Eskin**, *Boundary-value problems for second-order elliptic equations in domains with corners*; **P. C. Greiner**, *Imbedding C^n in H_n*; **Victor Guillemin**, *On some results of Gelfand in integral geometry*; **Lars Hörmander**, *The propagation of singularities for solutions of the Dirichlet problem*; **M. Kashiwara** and **P. Schapira**, *Applications of the microlocal theory of sheaves to the study of O_X*; **C. E. Kenig**, *Recent progress on boundary-value problems on Lipschitz domains*; **J. J. Kohn**, *Estimates for $\overline{\partial}_b$ on compact pseudoconvex CR manifolds*; **Yves Meyer**, *Recent analysis and operator theory*; **L. P. Rothschild**, *Integrability and holomorphic extendibility for rigid CR structures*; **Johannes Sjöstrand**, *Multiple wells and tunneling*; **N. K. Stanton** and **D. S. Tartakoff**, *The real analytic and Gevrey regularity of the heat kernel for $\Box_b$*; **M. E. Taylor**, *Fefferman-Phong inequalities in diffraction theory*

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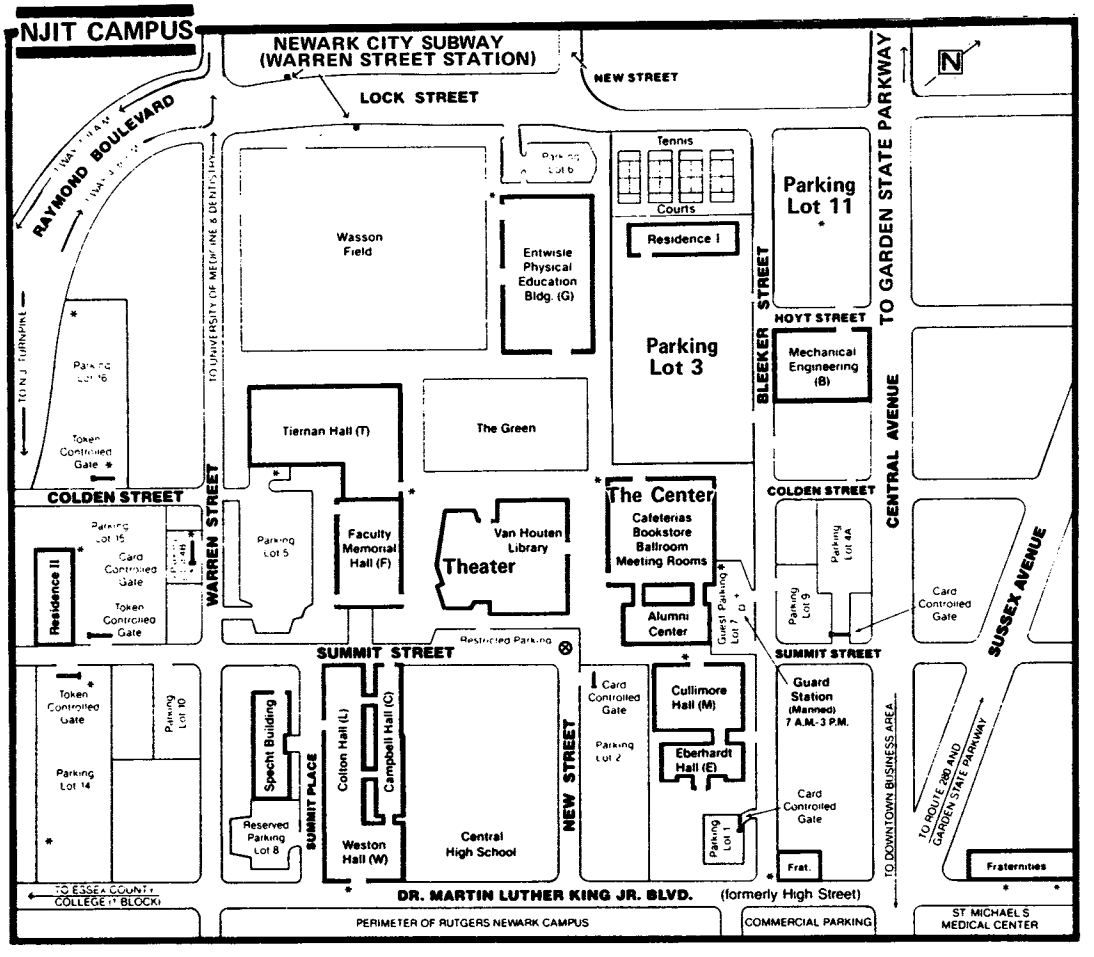

Quasilinear Degenerate and Nonuniformly Elliptic and Parabolic Equations of Second Order

A. V. Ivanov

translated by J. R. Schulenberger

This monograph is devoted to the study of questions of solvability of main boundary value problems for degenerate and nonuniformly elliptic and parabolic equations of second order and to the investigation of differential and certain qualitative properties of the solutions of such equations. The study of various questions of variational calculus, differential geometry, and the mechanics of continuous media leads to quasilinear degenerate or nonuniformly elliptic and parabolic equations.

The monograph consists of four parts. In Part I the principal object of investigation is the question of classical solvability of the first boundary value problem for quasilinear, nonuniformly elliptic and parabolic equations of nondivergence form. Parts II and III are devoted to the construction of a theory of solvability of the main boundary value problems for large classes of quasilinear equations with a nonnegative characteristic form. Part IV is devoted to the study of properties of generalized solutions of quasilinear, weakly degenerate parabolic equations.

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Program of the Sessions

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

Abstracts of papers presented in AMS sessions at this meeting will be found in the February 1987 issue of *Abstracts of papers presented to the American Mathematical Society*, ordered according to the numbers in parentheses following the listings below.

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

Saturday, April 25, 1987, 8:30 a.m.

AMS Special Session on Computational Mathematics and Applications, I — Tiernan Lecture Hall #1

8:30 - 8:50 (1) *A uniformly accurate finite element method for the Mindlin-Reissner plate model.* RICHARD S. FALK*, Rutgers University, New Brunswick, and DOUGLAS N. ARNOLD, University of Maryland, College Park (834-65-118) (Sponsored by Roy Plastock)

9:00 - 9:20 (2) *Finite-dimensional variational and quasivariational inequalities: Algorithmic developments and applications in socio-economic planning.* PATRICK T. HARKER, University of Pennsylvania (834-90-06)

9:30 - 9:50 (3) *Toeplitz matrices: Analysis and numerical analysis.* GILBERT STRANG, Massachusetts Institute of Technology (834-65-27)

10:00 - 10:20 (4) *Numerical computation with validation.* L. B. RALL, University of Wisconsin, Madison (834-65-04)

10:30 - 10:50 (5) *Finite element methods for convection dominated problems.* LARS B. WAHLBIN, Cornell University (834-65-35)

Saturday, April 25, 1987, 8:30 a.m.

AMS Special Session on Differential Geometry, I — Tiernan Hall, Room 112

8:30 - 8:50 (6) *A Picard theorem with an application to minimal surfaces.* PETER HALL, Rutgers University, Newark (834-53-28)

9:00 - 9:20 (7) *Multisupport circles of smooth curves and polygons in the plane.* THOMAS F. BANCHOFF*, Brown University, and P. J. GIBLIN, University of Liverpool, England (834-53-84)

9:30 - 9:50 (8) *Non-linear control theory as a source of geometric problems.* Preliminary report. ROBERT B. GARDNER, University of North Carolina, Chapel Hill (834-93-57)

10:00 - 10:20 (9) *Some invariants of the second fundamental form of a projective hypersurface.* Preliminary report. THEODORE SHIFRIN, University of Georgia (834-53-50)

10:30 - 10:50 (10) *Nonnegatively curved hypersurfaces of hyperbolic space.* Preliminary report. STEPHANIE B. ALEXANDER, University of Illinois, Urbana-Champaign, and ROBERT J. CURRIER*, Smith College (834-53-26)

Saturday, April 25, 1987, 8:30 a.m.

AMS Special Session on Nonlinear Functional Analysis, I — Tiernan Hall, Room 107

8:30 - 8:50 (11) *Solvability of semilinear hyperbolic equations at resonance.* P. S. MILOJEVIĆ, New Jersey Institute of Technology (834-47-98)

9:00 - 9:20 (12) *Hilbert's projective metric and iterated nonlinear maps.* Preliminary report. ROGER D. NUSSBAUM, Rutgers University, New Brunswick (834-47-117)

9:30 - 9:50 (13) *Perturbations of even functionals.* Preliminary report. PAUL H. RABINOWITZ, University of Wisconsin, Madison (834-46-73)

10:00 - 10:20 (14) *Periodic Hamiltonian trajectories on hypersurfaces.* HELMUT HOFER*, Rutgers University, New Brunswick, and E. ZEHNDER, Ruhr University, West Germany (834-51-66) (Sponsored by Tilla Milnor)

10:30 - 10:50 Discussion Period

Saturday, April 25, 1987, 9:00 a.m.

AMS Special Session on Inverse Problems, I — Tiernan Hall, Room 106

9:00– 9:20 (15) *A trace formula for the inverse Dirichlet problem on a finite interval.* DAVID STICKLER, Colorado School of Mines (834-34-49) (Sponsored by Robert V. Kohn)

9:30– 9:50 (16) *Ill-posedness of three-dimensional inverse scattering.* Preliminary report. MARGARET CHENEY*, Duke University, and GERHARD KRISTENSSON, Royal Institute of Technology, Sweden (834-35-41)

10:00–10:20 (17) *Perturbations and stability of the Marchenko inversion method.* TUNCAY AKTOSUN, Duke University (834-81-14)

10:30–10:50 (18) *Geometric optics in nonsmooth stratified media.* Preliminary report. WILLIAM W. SYMES, Rice University (834-35-30) (Sponsored by Dajit Singh Ahluwalia)

Saturday, April 25, 1987, 9:00 a.m.

AMS Special Session on Unitary Representations, Cohomology, and G/Γ, I — Tiernan Hall, Room 108

9:00– 9:20 (19) *The n-cohomology of a limit of discrete series representations.* FLOYD WILLIAMS, University of Massachusetts, Amherst (834-22-45)

9:30– 9:50 (20) *On the Weil-Siegel formula.* STEPHEN S. KUDLA, University of Maryland, College Park (834-11-106)

10:00–10:20 (21) *Arithmetic cohomology classes of non holomorphic discrete series type.* Preliminary report. MICHAEL HARRIS, Brandeis University (834-22-48) (Sponsored by Anthony W. Knapp)

10:30–10:50 (22) *Cusp forms and Hecke groups.* ANDREW M. WINKLER, Thomas J. Watson Research Center, Yorktown Heights, New York (834-22-107)

Saturday, April 25, 1987, 9:00 a.m.

AMS Special Session on Group Actions on Manifolds, I — Cullimore Lecture Hall

9:00– 9:20 (23) *The classical result of determining the possible values of the Alexander polynomial.* FAIZ AL-RUBAEE, University of North Florida (834-57-76)

9:30– 9:50 (24) *Topological realizations of chain-complexes–II. Poincaré complexes.* Preliminary report. JUSTIN SMITH, Drexel University (834-55-47)

10:00–10:20 (25) *Equivariant structure sets.* Preliminary report. PETER KAHN*, Cornell University, and MARK STEINBERGER, Rutgers University, Newark (834-57-87)

10:30–10:50 (26) *Isovariant homotopy and classification of G-manifolds.* Preliminary report. REINHARD SCHULTZ, Purdue University, West Lafayette, and Max Planck Institut für Mathematik, West Germany (834-57-19)

Saturday, April 25, 1987, 9:25 a.m.

AMS Session on Algebra — Tiernan Hall, Room 104

9:25– 9:35 (27) *The dimension of the first cohomology group.* ROBERT M. GURALNICK, University of Southern California (834-20-44)

9:40– 9:50 (28) *A tensor product for complete lattices.* Preliminary report. ANDREW S. GOLFIN, JR., University of Massachusetts, Amherst (834-06-15)

9:55–10:05 (29) *A cuspidal decomposition theorem for quasi-orders.* LESLIE COHN, The Citadel (834-06-122)

10:10–10:20 (30) *A comparison procedure for algebraic numbers.* Preliminary report. TAKIS SAKKALIS, New Mexico State University, Las Cruces (832-14-18)

10:25–10:35 (31) *A theorem on 2-groups of Frobenius type.* IAN D. MACDONALD, Lafayette College (834-20-12)

10:40–10:50 (32) *Some remarks on the quotient ring $R((X))$ of a power series ring $R[[X]]$.* Preliminary report. J. H. KIM, East Carolina University (834-13-60)

Saturday, April 25, 1987, 10:00 a.m.

AMS Special Session on Harmonic Analysis on Reductive p-adic Lie Groups, I — Tiernan Hall, Room 113

10:00–10:20 (33) *Wildly ramified supercuspidal representations.* Preliminary report. CHARLES ASMUTH* and DAVID KEYS, Rutgers University, Newark (834-22-89)

10:30–10:50 (34) *On some exceptional supercuspidal representations of metaplectic groups.* CORINNE BLONDEL, Université Paris VII, France, and University of Iowa (834-22-103) (Sponsored by C. David Keys)

Saturday, April 25, 1987, 11:15 a.m.

AMS Invited Address Theater

11:15–12:15 (35) *Weakly nonlinear geometrical optics for hyperbolic systems of conservation laws and reacting gas flows.* RODOLFO R. ROSALES, Massachusetts Institute of Technology (834-35-83)

Saturday, April 25, 1987, 1:30 p.m.

AMS Invited Address Theater

1:30– 2:30 (36) *Representation theory and the cohomology of locally symmetric spaces.* BIRGIT SPEH, Cornell University (834-22-61)

Saturday, April 25, 1987, 2:45 p.m.

AMS Special Session on Inverse Problems, II Tiernan Hall, Room 106

2:45– 3:05 (37) *Adaptive electric current computed tomography.* D. G. GISSER, D. ISAACSON* and J. C. NEWELL, Rensselaer Polytechnic Institute (834-68-55)

3:15– 3:35 (38) *An impedance computed tomography algorithm: Principles, results and research in progress.* ALVIN WEXLER, University of Manitoba (834-35-78) (Sponsored by Robert V. Kohn)

3:45– 4:05 (39) *Comparing inverse solutions for electrical impedance tomography.* THOMAS J. YORKEY, Lawrence Livermore National Laboratory, Livermore, California (834-35-33) (Sponsored by Robert V. Kohn)

4:15– 4:35 (40) *Electrical detection of cracks in reactor cooling pipes.* Preliminary report. PETER G. DOYLE*, Princeton University, and LARRY A. SHEPP, AT&T Bell Laboratories, Murray Hill, New Jersey (834-35-46)

4:45– 5:05 (41) *A variational method for parameter identification.* ROBERT V. KOHN, Courant Institute of Mathematical Sciences, New York University, and BRUCE D. LOWE*, Center for Naval Analyses, Alexandria, Virginia (834-35-37)

Saturday, April 25, 1987, 2:45 p.m.

AMS Special Session on Computational Mathematics and Applications, II Tiernan Lecture Hall #1

2:45– 3:05 (42) *Computational vision and regularization theory.* TOMASO POGGIO, Massachusetts Institute of Technology (834-68-132)

3:15– 3:35 Discussion Period

3:45– 4:05 (43) *Animating Escher with computer graphics.* NED GREENE, New York Institute of Technology (834-68-77) (Sponsored by Roy Plastock)

4:15– 4:35 Discussion Period

Saturday, April 25, 1987, 2:45 p.m.

AMS Special Session on Nonlinear Dynamics and Chaos, I Tiernan Hall, Room 104

2:45– 3:05 (44) *Visual simulation of nonlinear dynamics.* H. BRUCE STEWART, Brookhaven National Laboratory, Upton, New York (834-58-127) (Sponsored by Denis Blackmore)

3:15– 3:35 (45) *The homoclinic trajectory of the Duffing equation.* SON TU, New Jersey Institute of Technology (834-34-95) (Sponsored by Denis Blackmore)

3:45– 4:05 (46) *A cardiac model and chaos.* Preliminary report. JANE CRONIN, Rutgers University, New Brunswick (834-92-96)

4:15– 4:35 (47) *Some nonlinear problems in ecology and epidemiology.* ROBERT M. MAY, Princeton University (834-92-29) (Sponsored by Denis Blackmore)

4:45– 5:05 Discussion Period

Saturday, April 25, 1987, 2:45 p.m.

AMS Special Session on Cellular Automata and Symbolic Dynamics Cullimore Hall, Room 110

2:45– 3:05 (48) *An algorithm for Markov partitions of toral automorphisms.* Preliminary report. ROY ADLER, IBM Thomas J. Watson Research Center, Yorktown Heights, New York (834-54-52)

3:15– 3:35 (49) *Spectra and shift equivalence classes of nonnegative matrices.* MIKE BOYLE*, University of Maryland, College Park, and DAVID HANDELMAN, University of Ottawa (834-15-80)

3:45– 4:05 (50) *Shift invariant subgroups of* $(Z/2Z)^{Z^2}$. BRUCE KITCHENS*, IBM Watson Research Center, Yorktown Heights, New York, and KLAUS SCHMIDT, Warwick University, England (834-54-56)

4:15– 4:35 (51) *Directional entropy of cellular automata.* JOHN SMILLIE, Lehman College and Cornell University (834-54-72)

4:45– 5:05 (52) *Bifurcation-like phenomena in spaces of cellular automata.* NORMAN H. PACKARD, Center for Complex Systems Research, Champaign, Illinois (834-54-133) (Sponsored by Robert H. Gilman)

5:15– 5:35 (53) *Cellular automata and formal language theory.* LYMAN HURD, Princeton University (834-68-130)

Saturday, April 25, 1987, 2:45 p.m.

AMS Special Session on Differential Geometry, II Tiernan Hall, Room 112

2:45– 3:05 (54) *Calibrated geometries in Lie groups and homogeneous spaces.* HERMAN GLUCK*, University of Pennsylvania, FRANK MORGAN, Stanford University, and WOLFGANG ZILLER, University of Pennsylvania (834-53-36)

3:15– 3:35 (55) *Compact symplectic manifolds and Massey products.* ALFRED GRAY, University of Maryland, College Park (834-53-20)

3:45– 4:05 (56) *Local rigidity of symmetric spaces.* VIKTOR SCHROEDER, University of Muenster, West Germany, and WOLFGANG ZILLER*, University of Pennsylvania (834-53-39)

4:15– 4:35 (57) *A classification of Grassmann $(n+1)$-webs.* VLADISLAV V. GOLDBERG, New Jersey Institute of Technology (834-53-70)

4:45– 5:05 (58) *Intersection of varieties with a totally real submanifold.* HOWARD JACOBOWITZ, Rutgers University, Camden (834-53-94)

Saturday, April 25, 1987, 2:45 p.m.

AMS Special Session on Unitary Representations, Cohomology, and G/Γ, II Tiernan Hall, Room 108

2:45– 3:05 (59) *Plancherel measures and L-functions.* Preliminary report. FREYDOON SHAHIDI, Purdue University, West Lafayette (834-22-53)

3:15– 3:35 (60) *A new way to obtain Euler products.* STEVE RALLIS, Ohio State University, Columbus (834-22-62) (Sponsored by Anthony W. Knapp)

3:45– 4:05 (61) *On the definition of an automorphic form.* Preliminary report. R. MIATELLO, Universidad Nacional de Cordoba, Argentina, and N. R. WALLACH*, Rutgers University, New Brunswick (834-22-81)

4:15– 4:35 (62) *Semi-infinite cohomology of graded Lie algebras.* IGOR B. FRENKEL, HOWARD GARLAND, and GREGG J. ZUCKERMAN*, Yale University (834-22-40)

4:45– 5:05 (63) *The converse theorem for $GSp(4)$.* H. JACQUET, Columbia University, J. SHALIKA*, Johns Hopkins University, Baltimore, and I. I. PIATETSKII-SHAPIRO, Yale University (834-22-108) (Sponsored by Anthony W. Knapp)

Saturday, April 25, 1987, 2:45 p.m.

AMS Special Session on Nonlinear Functional Analysis, II Tiernan Hall, Room 107

2:45– 3:05 (64) *Boundary conditions for k-set-contractive mappings.* W. V. PETRYSHYN, Rutgers University, New Brunswick (834-47-65)

3:15– 3:35 (65) *The parity of a closed curve of Fredholm operators.* P. M. FITZPATRICK*, University of Maryland, College Park, and JACOBO PEJSACHOWICZ, University of Florence, Italy (834-46-125)

3:45– 4:05 (66) *Nonlinear oscillations in suspension bridges.* P. J. MCKENNA, University of Connecticut, Storrs (834-35-131)

4:15– 4:35 (67) *Conley index theory and non-autonomous ordinary differential equations.* JAMES R. WARD, JR., University of Alabama, Tuscaloosa (834-34-25) (Sponsored by Alan Hopenwasser)

4:45– 5:05 Discussion Period

Saturday, April 25, 1987, 2:45 p.m.

AMS Special Session on Group Actions on Manifolds, II Cullimore Lecture Hall

2:45– 3:05 (68) *Isovariant homotopy equivalence.* WILIAM BROWDER, Princeton University (834-57-88)

3:25– 3:35 (69) *Rochlin invariants, theta functions, and the holonomy of some determinant line bundles.* Preliminary report. RONNIE LEE*, Yale University, EDWARD Y. MILLER, Brooklyn Polytechnic, and STEVEN H. WEINTRAUB, Gottingen and Louisiana State University (834-57-113)

3:45– 4:05 (70) *Non-linear similarity in dimension less than or equal to six.* Preliminary report. SYLVAIN E. CAPPELL, Courant Institute of Mathematical Sciences, New York University, and MARK STEINBERGER*, Rutgers University, Newark, SHMUEL WEINBERGER, University of Chicago, and JAMES WEST, Cornell University (834-57-114)

4:15– 4:35 (71) *Rigidity of finite group actions on CP^2.* Preliminary report. IAN HAMBLETON*, McMaster University and Institute for Advanced Study, RONNIE LEE, Yale University, and IB MADSEN, Aarhus University and Institute for Advanced Study (834-57-115)

4:45– 5:05 (72) *Equivariant approximations and applications.* Preliminary report. MARK STEINBERGER, Rutgers University, Newark, and JAMES WEST*, Cornell University (834-57-82)

Saturday, April 25, 1987, 2:45 p.m.

AMS Session on Analysis Cullimore Hall, Room 110

2:45– 2:55 (73) *Necessary and sufficient conditions for oscillations of second order neutral equations.* GERASIMOS LADAS and EVANGELOS C. PARTHENIADIS*, University of Rhode Island, and JOHN G. SFICAS, University of Ioannina, Greece (834-34-21)

3:00– 3:10 (74) *A nonlinear regression model.* B. B. BHATTACHARYYA, North Carolina State University, and G. D. RICHARDSON*, University of Central Florida (834-62-99)

3:15– 3:25 (75) *On generalized polynomial monosplines of minimal uniform norm.* DIANE L. JOHNSON, University of Rhode Island (834-41-86)

3:45– 3:55 (76) *A Galerkin method for Sturm-Liouville problems using projection matched boundaries.* MARK D. DUSTON and GHASI R. VERMA, University of Rhode Island, and DAVID H. WOOD*, NUSC New London Laboratory, New London, Connecticut (834-65-109)

4:00– 4:10 (77) *Actions of differential operators on special functions over P_n.* Preliminary report. THOMAS BENGTSON, Pennsylvania State University, Delaware County Campus (834-33-100)

4:15– 4:25 (78) *Solution in the large of a certain homogeneous differential equation.* T. K. PUTTASWAMY, Ball State University (834-34-121)

4:30– 4:40 (79) *Solutions of analytic differential equations.* ALAN HORWITZ, Pennsylvania State University, Delaware County Campus (834-30-79)

4:45– 4:55 (80) *Continuous selections of Aumann-Olech integrals.* Preliminary report. ANDRZEJ FRYSZKOWSKI, University of Rhode Island (834-49-74) (Sponsored by Emilio O. Roxin)

5:00– 5:10 (81) *On some properties of a set of probability measures.* WIESŁAW ZIĘBA, M. Curie-Sklodowska University, Poland (834-60-85) (Sponsored by Andrzej Bucki)

5:15– 5:25 (82) *A well-posed mixed-type boundary value problem.* Preliminary report. JOHN M. RASSIAS, The American College of Greece, Greece (831-35-192)

Saturday, April 25, 1987, 3:15 p.m.

AMS Special Session on Harmonic Analysis on Reductive p-adic Lie Groups, II Tiernan Hall, Room 113

3:15– 3:35 (83) *Towards a construction of the supercuspidal representations of GL_N.* PHIL KUTZKO, University of Iowa (834-22-134)

3:45– 4:05 (84) *On the supercuspidal representations of $GL(N)$: N the product of two primes.* Preliminary report. PHILIP KUTZKO and DAVID MANDERSCHEID*, University of Iowa (834-22-104)

4:15– 4:35 (85) *Invariant meromorphic distributions on $GL(n)$.* Preliminary report. FIONA MURNAGHAN, University of Chicago (834-22-69)

Saturday, April 25, 1987, 7:30 p.m.

AWM Lecture Cullimore Lecture Hall

7:30– 8:30 *Sofia Kovalevskaia and gender perceptions: Was she a monstrosity or the princess of mathematics?* ANN HIBNER KOBLITZ

Sunday, April 26, 1987, 8:30 a.m.

AMS Special Session on Differential Geometry, III Tiernan Hall, Room 112

8:30– 8:50 (86) *The first eigenvalue of small balls and tubes in Riemannian manifolds.* LEON KARP*, Herbert H. Lehman College, City University of New York, and MARK PINSKY, Northwestern University (834-53-23)

9:00– 9:20 (87) *On Wente's example of an immersed torus in $\mathbf{E}^3$.* SAMUEL I. GOLDBERG*, University of Illinois, Urbana-Champaign, and GABOR TOTH, Rutgers University, Camden (834-53-54)

9:30– 9:50 (88) *Contact metric structures on 3-manifolds.* SAMUEL I. GOLDBERG, University of Illinois, Urbana-Champaign, and GABOR TOTH*, Rutgers University, Camden (834-53-11)

10:00–10:20 (89) *Minimal submanifolds of a sphere with bounded second fundamental form.* HILLEL GAUCHMAN, University of Illinois, Urbana-Champaign (834-53-02)

10:30–10:50 Discussion Period

Sunday, April 26, 1987, 8:30 a.m.

AMS Special Session on Group Actions on Manifolds, III — Cullimore Lecture Hall

8:30– 8:50 (90) *Periodic knots.* Preliminary report. RICARDO CRUZ, Courant Institute of Mathematical Sciences, New York University (834-57-71)

9:00– 9:20 (91) *Chern classes of complex orbifolds.* MICHAEL DAVIS, Ohio State University, Columbus (834-57-123) (Sponsored by Mark Steinberger)

9:30– 9:50 (92) *Reductive group actions on algebraic varieties.* HANSPETER KRAFT, University of Basel, Switzerland, TED PETRIE, Rutgers University, New Brunswick, and JOHN D. RANDALL*, Rutgers University, Newark (834-57-93)

10:00–10:20 (93) *An equivariant Novikov conjecture.* Preliminary report. JONATHAN ROSENBERG, University of Maryland, College Park, and SHMUEL WEINBERGER*, University of Chicago (834-57-112) (Sponsored by John D. Randall)

10:30–10:50 (94) *Smith theory for finite groups.* AMIR ASSADI, University of Wisconsin, Madison, and FRANK QUINN*, Virginia Polytechnic Institute and State University (834-57-119)

Sunday, April 26, 1987, 9:00 a.m.

AMS Special Session on Inverse Problems, III — Tiernan Hall, Room 106

9:00– 9:20 (95) *Inverse scattering and the generalized Sine-Gordon equations.* Preliminary report. RICHARD BEALS*, Yale University, and KETI TENENBLAT, University of Brasilia, Brazil (833-53-34)

9:30– 9:50 (96) *On the spectrum of the Laplacian plus a potential on line bundles.* ALEJANDRO URIBE, Princeton University (834-58-68)

10:00–10:20 (97) *Characterization of the scattering data in 3D inverse scattering problem.* ALEXANDER G. RAMM, Kansas State University (834-35-03)

10:30–10:50 (98) *Inverse theory for nth order operators.* RICHARD BEALS, Yale University, PERCY DEIFT*, Courant Institute of Mathematical Sciences, New York University, and CARLOS TOMEI, Pontificia Universidade Catholica, Brazil (834-34-31)

Sunday, April 26, 1987, 9:00 a.m.

AMS Special Session on Computational Mathematics and Applications, III — Tiernan Lecture Hall #1

9:00– 9:20 (99) *Davenport Schinzel sequences and their geometric applications.* MICHA SHARIR, Courant Institute of Mathematical Sciences, New York University (834-51-22)

9:30– 9:50 (100) *Numerical approximation of two- dimensional solution manifolds.* EUGENE ALLGOWER, Colorado State University (834-65-124)

10:00–10:20 (101) *Decision algorithms for restricted sublanguages of set theory.* J. T. SCHWARTZ*, D. CANTONE, A. FERRO and E. OMODEO, Courant Institute of Mathematical Sciences, New York University (834-51-07)

10:30–10:50 Discussion Period

Sunday, April 26, 1987, 9:00 a.m.

AMS Special Session on Nonlinear Dynamics and Chaos, II — Tiernan Hall, Room 104

9:00– 9:20 (102) *How good is Newton's method for solving polynomials?* Preliminary report. PAUL BLANCHARD* and SCOTT SUTHERLAND, Boston University (834-58-101)

9:30– 9:50 (103) *Dynamical systems representation of vortex breakdown.* DENIS BLACKMORE, New Jersey Institute of Technology (834-34-67)

10:00–10:20 (104) *Hamiltonian systems from vortex trail dynamics.* Preliminary report. CHJAN LIM, University of Michigan, Ann Arbor (834-70-13)

10:30–10:50 (105) *Vortex breakdown and bifurcation.* MEL S. BERGER, University of Massachusetts, Amherst (834-35-16)

Sunday, April 26, 1987, 9:00 a.m.

AMS Special Session on Harmonic Analysis on Reductive p-adic Groups, III — Tiernan Hall, Room 113

9:00– 9:20 (106) *Local factors for covering groups of $GL(2)$.* COURTNEY MOEN, United States Naval Academy (834-11-24)

9:30– 9:50 (107) *Supercuspidal representations of classical p-adic groups.* Preliminary report. LAWRENCE MORRIS, Clark University (834-22-90)

10:00–10:20 (108) *Supercuspidal representations of $GL_{pp'}(F), F$ p-adic.* LAWRENCE CORWIN, Rutgers University, New Brunswick (834-22-75)

Sunday, April 26, 1987, 9:00 a.m.

AMS Special Session on Unitary Representations, Cohomology, and G/Γ, III Tiernan Hall, Room 108

9:00– 9:20 (109) *Socle filtration vs weight filtrations for principal series.* LUIS CASIAN, Massachusetts Institute of Technology (834-22-91)

9:30– 9:50 (110) *Endoscopic groups and duality.* Preliminary report. JEFFREY ADAMS*, University of Maryland, College Park, and DAVID VOGAN, Massachusetts Institute of Technology (834-22-92) (Sponsored by Anthony W. Knapp)

10:00–10:20 (111) *On the adducibility of Speh's representations.* Preliminary report. SIDDHARTHA SAHI* and ELIAS M. STEIN, Princeton University (834-22-58)

10:30–10:50 Discussion Period

Sunday, April 26, 1987, 9:00 a.m.

AMS Special Session on Nonlinear Functional Analysis, III Tiernan Hall, Room 107

9:00– 9:20 (112) *Degenerate cobifurcation and boundary value problems.* CHRISTIAN FABRY, Université Catholique de Louvain, Belgium, and MARIO MARTELLI*, Bryn Mawr College (834-46-09)

9:30– 9:50 Discussion Period

10:00–10:20 (113) *On the finite solvability of some semilinear differential problems.* V. CAFAGNA, Universitá di Salerno, Italy (834-47-97) (Sponsored by Petronije S. Milojevic)

10:30–10:50 Discussion Period

Sunday, April 26, 1987, 9:25 a.m.

AMS Session on Applied Mathematics and Physics Cullimore Hall, Room 111

9:25– 9:35 (114) *A numerical solution of diffusion equation with a special source term.* Preliminary report. J. S. BAKSHI, University of the District of Columbia (834-35-17)

9:40– 9:50 (115) *Extension of the Matheron representation theorem for increasing tau-mappings to gray-scale images.* EDWARD R. DOUGHERTY, Fairleigh Dickinson University, Teaneck, and CHARLES R. GIARDINA*, College of Staten Island, City University of New York (834-94-42)

9:55–10:05 (116) *A categorical approach to image algebra.* EDWARD DOUGHERTY*, Fairleigh Dickinson University, Teaneck, and CHARLES R. GIARDINA, College of Staten Island, City University of New York (834-94-43)

10:10–10:20 (117) *Controlled growth of competing species.* NAGARAJ S. RAO, University of Rhode Island and Mercy College (834-49-59) (Sponsored by Emilio Roxin)

10:25–10:35 (118) *Quantum corrections in synchrotron radiation.* J. S. RNO* and A. LEUDEKE, University of Cincinnati (834-81-102)

10:40–10:50 (119) *Mechanistic effects in EXAM phenomenology.* STEPHEN L. WEINBERG, Berkeley Academy of Artscience, Berkeley, California (834-70-08)

Sunday, April 26, 1987, 9:40 a.m.

AMS Session on Topology Cullimore Hall, Room 110

9:40– 9:50 (120) *On a certain sequence of quotients of a sequence.* Preliminary report. ALEJANDRO NECOCHEA, Pan American University (834-40-01)

9:55–10:05 (121) *Approximation theorems and fixed point theorems in cones.* TZU-CHU LIN, University of Wisconsin, Milwaukee (834-47-10)

10:10–10:20 (122) *An ordering on permutations induced by continuous maps of the real line.* CHRIS BERNHARDT, Lafayette College (833-58-51)

10:25–10:35 (123) *Parallel distributions on almost r-paracontact manifolds.* ANDRZEJ BUCKI, Lycoming College (834-53-64)

10:40–10:50 (124) *A candidate for a counterexample to the 3-dimensional Poincaré conjecture.* Preliminary report. FRANCIS D. LONERGAN, Webster, Massachusetts (834-55-05)

Sunday, April 26, 1987, 11:00 a.m.

AMS Invited Address Theater

11:00–12:00 (125) *Local behavior in finite element methods: An overview.* LARS B. WAHLBIN, Cornell University (834-65-38)

Sunday, April 26, 1987, 1:30 p.m.

AMS Invited Address Theater

1:30– 2:30 (126) *Determining conductivity by boundary measurements.* ROBERT V. KOHN, Courant Institute of Mathematical Sciences, New York University (834-35-129)

Sunday, April 26, 1987, 2:45 p.m.

AMS Special Session on Nonlinear Dynamics and Chaos, III Tiernan Lecture Hall #1

2:45– 3:05 (127) *A Poincaré-Bendixson theorem for monotone cyclic systems.* JOHN MALLET-PARET, Brown University (834-34-116)

3:15– 3:35 (128) *Do computer trajectories of chaotic systems represent true trajectories?* JAMES A. YORKE, University of Maryland, College Park (834-99-126)

3:45– 4:05 Discussion Period

Sunday, April 26, 1987, 2:45 p.m.

AMS Special Session on Group Actions on Manifolds, IV Cullimore Lecture Hall

2:45– 3:05 (129) *Semifree circle actions.* Preliminary report. SYLVAIN CAPPELL*, Courant Institute of Mathematical Sciences, New York University, and SHMUEL WEINBERGER, University of Chicago (834-57-111) (Sponsored by John D. Randall)

3:15– 3:35 (130) *Semifree Z_m actions on spheres.* Preliminary report. MONICA NICOLAU, University of California, Berkeley (834-57-110)

3:45– 4:05 (131) *Equivariant Lipschitz structures.* MELVIN ROTHENBERG, University of Chicago (834-57-32) (Sponsored by J. Peter May)

4:15– 4:35 (132) *Numerical invariants and propagation of group actions.* Preliminary report. JAMES F. DAVIS*, Indiana University, Bloomington, and SHMUEL WEINBERGER, University of Chicago (834-57-128)

Sunday, April 26, 1987, 2:45 p.m.

AMS Special Session on Unitary Representations, Cohomology, and GΓ, IV Tiernan Hall, Room 108

2:45– 3:05 (133) *The cohomology of G/P for Kac-Moody G.* BERTRAM KOSTANT*, Massachusetts Institute of Technology, and SHRAWAN KUMAR, Tata Institute of Fundamental Research, India (834-22-105)

3:15– 3:35 (134) *Spherical representations and unitarity.* Preliminary report. DAN BARBASCH, Rutgers University, New Brunswick (834-22-120) (Sponsored by Anthony W. Knapp)

3:45– 4:05 (135) *Non-commutative algebra and unitary representations.* Preliminary report. DAVID VOGAN, Massachusetts Institute of Technology (834-22-63)

Middletown, Connecticut

W. Wistar Comfort
Associate Secretary

Ten Lectures on Operator Algebras

William Arveson

This book makes available to a wider audience the lectures on nonselfadjoint operator algebras given by the author at a conference in Texas in 1983. The theory of nonselfadjoint algebras has for long been the Cinderella of operator algebra theory but, mainly because of the work of Arveson and his students, it is now beginning to establish itself alongside the "ugly sisters" of $C*$-algebra and von Neumann algebra theory.

Those familiar with the author's expository style will not be surprised to find that these ten lectures are beautifully presented, extremely readable and full of new insights. Topics covered include commutative subspace lattices and problems of spectral synthesis, the absorption principle and its application to solve the similarity problem, quasitriangular algebras and applications to single operator theory. There is also a very interesting section on dilation theory and its use in proving the Feynman-Kac formula.

– E. Christopher Lance
University of Leeds

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Population Biology
Simon A. Levin, Editor

"The reviewer knows of no book which provides access to so many different major topics in population biology. It is not a text for any topic, but it is a road map for the reader, pointing out background, basic structure and important questions, either directly or by references. The stated purpose of acquainting readers with the important mathematical ideas and applications in population biology is achieved, by each author in his own way."
– Fred Brauer
University of Wisconsin-Madison
SIAM Review

Simon Levin, *Mathematical population biology*
James Frauenthal, *Population dynamics and demography*
Thomas Nagylaki, *Some mathematical problems in population genetics*
Ethan Akin, *Evolution: Game theory and economics*
Wayne Getz, *Optimal control and principles in population management*
George Sugihara, *Graph theory, homology and food webs*

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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.

Tacoma, June 1987

Branko Grünbaum
Henryk Hecht

Salt Lake City, August 1987

D. G. Aronson
Edward W. Formanek
David Jerison
Paul Roberts
Karen Vogtmann
Robert Lee Wilson

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.

June 1987 Meeting in Tacoma

Far Western Section
Deadline for organizers: Expired
Deadline for consideration: March 27, 1987

Henryk Hecht, *Geometric methods in representation theory*

Moshe Rosenfeld, *Polyhedral and planar graphs*

August 1987 Meeting in Salt Lake City

Associate Secretary: Hugo Rossi
Deadline for organizers: Expired
Deadline for consideration: To be announced

D. G. Aronson and Hans Othmer, *Nonlinear evolution equations*

Kenneth S. Brown, *Geometric methods in group theory*

Edward W. Formanek, *Ring theory and invariant theory*

Jacob Goodman and Erwin Lutwak, *Discrete geometry and convexity*

John M. Lee, *Geometry and analysis on CR manifolds*

October 1987 Meeting in Lincoln

Central Section
Deadline for organizers: April 15, 1987
Deadline for consideration: To be announced

November 1987 Meeting in Los Angeles

Far Western Section
Deadline for organizers: April 15, 1987
Deadline for consideration: To be announced

Fall 1987 Meeting

Eastern Section
No meeting will be held

Fall 1987 Meeting

Southeastern Section
No meeting will be held

January 1988 Meeting in Atlanta

Associate Secretary: W. Wistar Comfort
Deadline for organizers: April 15, 1987
Deadline for consideration: To be announced

Information for Organizers

Special Sessions at Annual and Summer Meetings are held under the general supervision of the Program Committee. They are administered by the Associate Secretary in charge of the meeting with staff assistance from the Society office in Providence.

Some Special Sessions arise from an invitation to a proposed organizer issued through the Associate Secretary. Others are spontaneously proposed by interested organizers or participants. Such proposals are welcomed by the Associate Secretaries.

The number of Special Sessions at a Summer or Annual Meeting is limited to twelve. Proposals, invited or offered, that are received at least nine months prior to the meeting are screened for suitability of the topic and of the proposed list of speakers, and for possible overlap or conflict with other proposals. (Specific deadlines for requesting approval for Special Sessions at national meetings are given above.) If necessary, the numerical limitation is enforced.

Proposals for Special Sessions should be submitted directly to the Associate Secretary in charge of the meeting (at the address given in the accompanying box). If such proposals are sent to the Providence office, addressed to *Notices*, or directed to anyone other than the Associate Secretary, they will have to be forwarded and may not be received before the quota is filled.

In accordance with an action of the Executive Committee of the Council, no Special Session may be arranged so late that it may not be announced in *Notices* early enough to allow any member of the Society who wishes to do so to submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration.

Special Sessions are effective at Sectional Meetings and can usually be accommodated. They are arranged by the Associate Secretary under the supervision of the Committee to Select Hour Speakers for the section. The limitation on the number of sessions

depends on the space and time available. The same restriction as for national meetings applies to the deadline for announcing Special Sessions at sectional meetings: no Special Session may be approved too late for its announcement to appear in time to allow a reasonable interval for members to prepare and submit their abstracts prior to the special early deadline set for consideration of papers for Special Sessions.

The Society reserves the right of first refusal for the publication of proceedings of any special session. These proceedings appear in the book series *Contemporary Mathematics*.

Information for Speakers

A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special Session has been scheduled. Contributors should know that there is a limitation in size of a single special session, so that it is sometimes true that all places are filled by invitation. Papers not accepted for a Special Session are considered as ten-minute contributed papers.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, RI 02940) by the special deadline for Special Sessions, which is usually three weeks earlier than the deadline for contributed papers for the same meeting. The Council has decreed that no paper, whether invited or contributed, may be listed in the program of a meeting of the Society unless an abstract of the paper has been received in Providence prior to the deadline.

Send Proposals for Special Sessions to the Associate Secretaries

The programs of sectional meetings are arranged by the Associate Secretary for the section in question:

Far Western Section (Pacific and Mountain)

Hugo Rossi, Associate Secretary
Department of Mathematics
University of Utah
Salt Lake City, UT 84112
(Telephone 801-581-8159)

Central Section

Robert M. Fossum, Associate Secretary
Department of Mathematics
University of Illinois
1409 West Green Street
Urbana, IL 61801
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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.

LIE ALGEBRAS AND RELATED TOPICS

D. J. Britten, F. W. Lemire, and R. V. Moody, Editors

As the Proceedings of the 1984 Canadian Mathematical Society's Summer Seminar, these papers focus on some recent advances in the theory of semisimple Lie algebras and some direct outgrowths of that theory. Of particular interest are notes for several courses presented at the meeting: an important survey article by R. Block and R. Wilson on restricted simple Lie algebras, a survey of universal enveloping algebras of semisimple Lie algebras by W. Bohro, a course on Kac-Moody Lie algebras by I. G. Macdonald, and a course on formal groups by M. Hazewinkel.

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1987 Summer Seminar In Applied Mathematics, April 30 – May 7 (New Dates)

Computational Aspects of VLSI Design with an Emphasis on Semiconductor Device Simulation

The eighteenth AMS-SIAM Summer Seminar in Applied Mathematics will be held April 30 – May 7, 1987, **please note the new dates**, at the Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota. The seminar will be sponsored jointly by the American Mathematical Society, the Society for Industrial and Applied Mathematics, and the Institute for Mathematics and its Applications. It is anticipated that it will be supported by grants from federal agencies. The topic, *Computational aspects of VLSI design with an emphasis on semiconductor device simulation*, was selected by an AMS-SIAM Committee on Applied Mathematics whose members at the time were C. K. Chu, Constantine M. Dafermos, James M. Hyman, Alan G. Konheim, George C. Papanicolaou (chairman), and Robert F. Warming. The proceedings of the seminar will be published by the Society in the *Lectures in Applied Mathematics* series.

The seminar will form a part of the 1986 – 1987 Institute for Mathematics and its Applications program on Scientific Computation. The design of very large scale integrated (VLSI) semiconductor devices is an important problem in a variety of technological applications. The goal of simulation is to remove the need of actually fabricating prototype chips in order to study their behavior and optimize their design. Even the simplest system of partial differential equations which can be used to model semiconductor devices poses severe computational challenges. This is true partly because of the strong nonlinearity of the system and partly because of the large and rapid variations in the solution.

The first three days of the seminar will feature a series of three lectures each on process modeling by R. W. DUTTON of Stanford University, on device modeling by W. FICHTNER of the ETH, Zurich, and on circuit modeling by A. SANGIOVANNI-VINCENTELLI of the University of California, Berkeley. These lectures will be expository in nature and will introduce the subject to the participants. The following week will feature lectures of a more technical nature by a set of speakers including R. BANK of University of California, San Diego; J. BLUE of National Bureau of Standards; F. BREZZI of the Universita di Pavia; W. COUGHRAN of AT&T Bell Labs; P. DEGOND of Ecole Polytechnique; J. JEROME of Northwestern University; T. KERKHOVEN of Yale University; P. MARKOWICH of Technical University of Vienna; H. MITTLEMAN of Arizona State University; L. PETZOLD of Lawrence Livermore National Laboratories; C. RAFFERTY of Stanford University; C. RINGHOFER of Arizona State University; and D. ROSE of Duke University. These speakers have been invited by the Organizing Committee which consists of Randolph Bank (chairman), William Coughran, Eric Grosse, R. Kent Smith, and Mitchell Luskin. In order to allow ample time for informal discussion among participants, only three lectures per day will be presented.

A brochure will be available from the AMS office which includes a description of the scientific program, information on accommodations, and local information. Each participant will pay a $10 registration fee.

Those interested in attending the seminar should send the following information to Betty A. Verducci, Conference Coordinator, American Mathematical Society, P. O. Box 6248, Providence, RI 02940. Requests for support to attend the seminar should have been sent to the AMS before **February 13, 1987**.

Please type or print the following:

1. Full name;
2. Mailing address;
3. Telephone number and area code for office and home;
4. Anticipated arrival and departure dates;
5. Your scientific background relevant to the topic of the seminar.

Graduate students who have completed at least one year of graduate school are encouraged to participate.

1987 Symposium in Pure Mathematics, May 12–16

The Mathematical Heritage of Hermann Weyl

With the anticipated support of the National Science Foundation, a symposium on *The Mathematical Heritage of Hermann Weyl* will take place Tuesday through Saturday, May 12–16, 1987, in the Bryan Center at Duke University, Durham, North Carolina. This topic was selected by the 1985 Committee on Summer Institutes and Special Symposia, whose members at the time were Albert Baernstein II, Eric Friedlander, Hui-Hsiung Kuo (chairman), H. Blaine Lawson, Jr., Judith D. Sally, and John Wermer.

The Organizing Committee for the symposium includes Michael F. Atiyah, Lipman Bers, Felix E. Browder, S. S. Chern, George D. Mostow, R. O. Wells, Jr. (chairman), and C. N. Yang.

The symposium is to honor Hermann Weyl for his great accomplishments in mathematics. In addition, it is intended to provide a stimulus to the younger generation of mathematicians by indicating the cohesive nature of modern mathematical ideas as looked at from the vantage point of Weyl's ideas. Although Weyl did not cover all of mathematics, the breadth of his contributions is nevertheless astonishing and formed the basis for some of the best of modern mathematics.

The list of speakers and titles of some of their lectures is as follows: JAMES G. ARTHUR, University of Toronto, *Harmonic analysis and the trace formula* (tentative); MICHAEL F. ATIYAH, University of Oxford, England; RAOUL H. BOTT, Harvard University; FELIX E. BROWDER, University of Chicago; ROBERT L. BRYANT, Rice University, *Surfaces in conformal geometry*; RONALD G. DOUGLAS, SUNY, Center at Stony Brook, *Invariants for elliptic operators* (tentative); HARRY FURSTENBERG, Hebrew University, Israel; PHILLIP A. GRIFFITHS, Duke University; ROGER E. HOWE, Yale University, *The oscillator semigroup*; ROBERT LANGLANDS, Institute for Advanced Study; H. BLAINE LAWSON, JR., SUNY, Center at Stony Brook, *Algebraic cycles and homotopy*; JAMES I. LEPOWSKY, Rutgers University, *Vertex operators and the monster*; LOUIS NIRENBERG, NYU, Courant Institute of Mathematical Sciences, *Nonlinear elliptic equations*; ROGER PENROSE, University of Oxford, England, *Fundamental asymmetry in physical laws*; I. M. SINGER, Massachusetts Institute of Technology; DENNIS P. SULLIVAN, CUNY Graduate School & University Center and IHES, France, *Riemann surfaces applied to one-dimensional dynamical systems*; CLIFFORD TAUBES, Harvard University; DAVID A. VOGAN, JR., Massachusetts Institute of Technology, *Non-commutative algebras and unitary representations*; EDWARD WITTEN, Princeton University; C. N. YANG, SUNY, Center at Stony Brook; and S.-T. YAU, University of California, San Diego, *Yang-Mills theory over Kähler manifolds.* A complete list of titles will be included in the program in the April issue of *Notices.* The lectures will be presented in the Film Theatre, which is located on the intermediate level of the Bryan Center.

Proceedings of the symposium will be published in the AMS series *Proceedings of Symposia in Pure Mathematics.* Registered participants will be able to purchase the volume when available at a discount which is greater than the usual 40 percent individual member discount.

Registration

A registration desk will be located in the Video Screening Room on the intermediate level of the Bryan Center. The desk will be staffed from 8:00 a.m. until 4:00 p.m. on Tuesday, from 8:30 a.m. until 4:00 p.m. Wednesday through Friday, and from 8:30 a.m. until noon on Saturday. The registration fee for the entire symposium is $10 per person.

Book Exhibit and Sale

There will be an exhibit of assorted mathematics books offered by various publishers, and a sale at substantial discounts of recent books published by the American Mathematical Society. The book exhibit and sale will be open during the same hours and in the same location as the registration desk Tuesday through Friday, but **will not** be open on Saturday.

Accommodations

Blocks of rooms are being held for participants at the following hotels which are within walking distance of the campus. Individuals should make their own reservations directly with the hotel of their choice and be sure to identify themselves as participants in the American Mathematical Society's symposium at Duke University, in order to obtain these special rates. The deadline for reservations is **April 10, 1987**, after which reservations will be accepted on a space available basis. Please note that rates do not include the applicable state sales tax, which was recently increased to 8 percent.

Brownestone Inn (.6 mile) (formerly Hilton Inn)
Reservations Manager
2424 Erwin Road, Durham 27705
Telephone: 919-286-7761
Outside North Carolina: 1-800-367-0293
Inside North Carolina: 1-800-872-9009
Single or Double $52
Rate includes continental breakfast.

Sheraton University Center Inn (1.4 miles)
2800 Middleton Avenue at Morreene Road
(Rte. 15-501), Durham 27705
Telephone: 919-383-8575
Single or Double $52

Complimentary airport transportation is provided by the Brownestone Inn and Sheraton University Center Inn for registered guests. NOTE: Participants are strongly advised to provide flight number and arrival time when making their room reservations, because the number of vehicles is limited.

Although rooms have **not** been blocked at the following locations, they are included here for information purposes. Rates do not include applicable tax and are subject to change.

Carolina Duke Motor Inn (3 miles)
2517 Guess Road
Durham 27705
Telephone: 919-286-0771
Single $25.98 Double $32.98

Cricket Inn (1 mile)
2306 Elba Street
Durham 27705
Telephone: 919-286-3111
Single $29.88 Double $39.88

Econo Lodge (3 miles)
I-85 at 2337 Guess Road
Durham 27705
Telephone: 919-286-7746
Single $26.95 Double $32.95

El Rancho Motel (1.5 miles)
500 Elf Street
Durham 27705
Telephone: 919-286-4421
Single $26.98 Double $32.98

Holiday Inn (4 miles)
Routes I-85 & 15-501
Durham 27705
Telephone: 919-383-1551
Single $55 Double $65

Imperial 400 (2 miles)
605 W. Chapel Hill Street
Durham 27701
Telephone: 919-682-5411
Single $32.25 Double $38.70

Radisson Inn (2 miles)
600 Willard Street
Durham 27702
Telephone: 919-683-1531
Single $53 Double $56

Food Service

The University Room on the main level in the West Campus Union is scheduled to be open from 7:30 a.m. until 2:00 p.m. for breakfast and lunch service. NOTE: Lunch service starts at 11:00 a.m. and by noon it is usually crowded. In addition, either the Rathskellar or the Boyd-Pishko Cafe in the Bryan Center will be open (9:00 a.m. - 9:00 p.m.) for the convenience of participants.

A list of local restaurants will be available at the registration desk in the Video Screening Room.

Social Event

A no-host cocktail reception will take place at the Sheraton University Center Inn beginning at 6:00 p.m. on Thursday and is open to all participants.

Travel

The Raleigh-Durham Airport is served by most major airlines, including American, Continental, Delta, Eastern, New York Air, Pan American, Piedmont, TWA, United, and USAir. Car rental agencies at the airport include Avis, Budget, Dollar, Hertz, National, and Triangle. Shannon Limousine offers shuttle service from the airport every hour on the half-hour between 7:30 a.m. and 11:30 p.m. daily. Reservations are not required. The current one-way fare to Duke University and most hotels or motels in Durham is $8.50 per person.

AMTRAK provides train service to Raleigh, which is approximately 20 miles from Durham. Both Greyhound and Trailways offer bus service to Durham, where the terminals are located approximately three miles from the main campus. Taxicabs are available from all of the foregoing locations.

Those driving to Duke University should take either of the following routes to Durham. **From the South:** Drive north on I-85 to Exit #170, then travel 1.5 miles east on Route 70 until reaching Route 751 South. Proceed south on Route 751, take a left turn onto Science Drive, and continue through the first traffic light. A short distance beyond the light is the Biological Sciences Building and parking lot, on the left side of Science Drive. Cars with a permit may park in that lot, and the Bryan Center is across the road. **From the North** (and Richmond, Virginia): Drive south on I-85 to Exit #170 and follow the above directions to Science Drive. **From the West:** Drive east on I-40 to connect with I-85; stay on I-85 until reaching Exit #170, then follow above directions to Science Drive. **From the Raleigh/Durham Airport:** When leaving the airport follow signs to Route I-40 West, staying on I-40 until reaching Exit 279B (Freeway North). Remain on the Freeway until it ends and intersects with Erwin Road. Turn left and proceed 1.5 miles to the fifth traffic light and then turn left onto Research Drive (across from the Brownestone Inn). At the first traffic light on Research Drive take a right turn onto Science Drive. When coming from this direction the Bryan Center is on the left and the Biological Sciences Building and parking lot is on the right.

Parking

Although metered parking is available in the lot at the Bryan Center, the space is limited. Parking permits are required for any of the (also limited)

free parking spaces that are available, including the lot at the Biological Sciences Building. Parking permits will be available at the registration desk in the Video Screening Room at no charge. Please note: Parking is **not** allowed in Zone A (on Chapel Drive), Zone R (Card Gymnasium, Cameron Indoor Stadium), the main quadrangle in front of the Chapel, or in fire lanes, emergency zones, red or yellow curb areas, handicapped spaces, loading zones, or service areas.

Weather

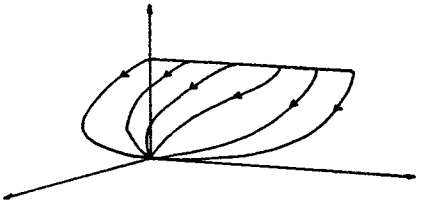
The normal temperatures in mid-May range from a low of 55 degrees F to a high of 80 degrees F, and short afternoon or evening thunderstorms are a possibility.

"This book is a must for anyone deeply interested in Geometric Function Theory."
– A. W. Goodman
Univ. of South Florida

"An interesting and valuable collection of articles ... The first book to mention the amazing proof of the Bieberbach conjecture by Louis de Branges. Every function-theorist should ... buy this."
– David A. Brannan
The Open University, U. K.

Topics in Complex Analysis

Dorothy Brown Shaffer, Editor



The unifying theme of the lectures, presented at the AMS meeting in October, 1983, at Fairfield University was Geometric Function Theory. Some of the papers concern: the class Σ, its support points and extremal configuration; support points for the class S, Loewner chains and the process of truncation; estimates on the radial growth of the derivative of univalent functions; and a conjecture of Bombieri proved for some cases. Because the proof of the Bieberbach conjecture was not known at the time of preparation of the papers, many of the authors, as well as experts in the field, were interviewed regarding the effect of the proof of the conjecture. Their ideas regarding future trends in research in complex analysis are presented in the epilogue. A graduate level course in complex analysis provides a sufficient background for understanding this material.

ISBN 0-8218-5037-7, LC 84-24550, ISSN 0271-4132
March 1985, 142 pages (softcover)
Individual member $11, Institutional member $15, List price $19
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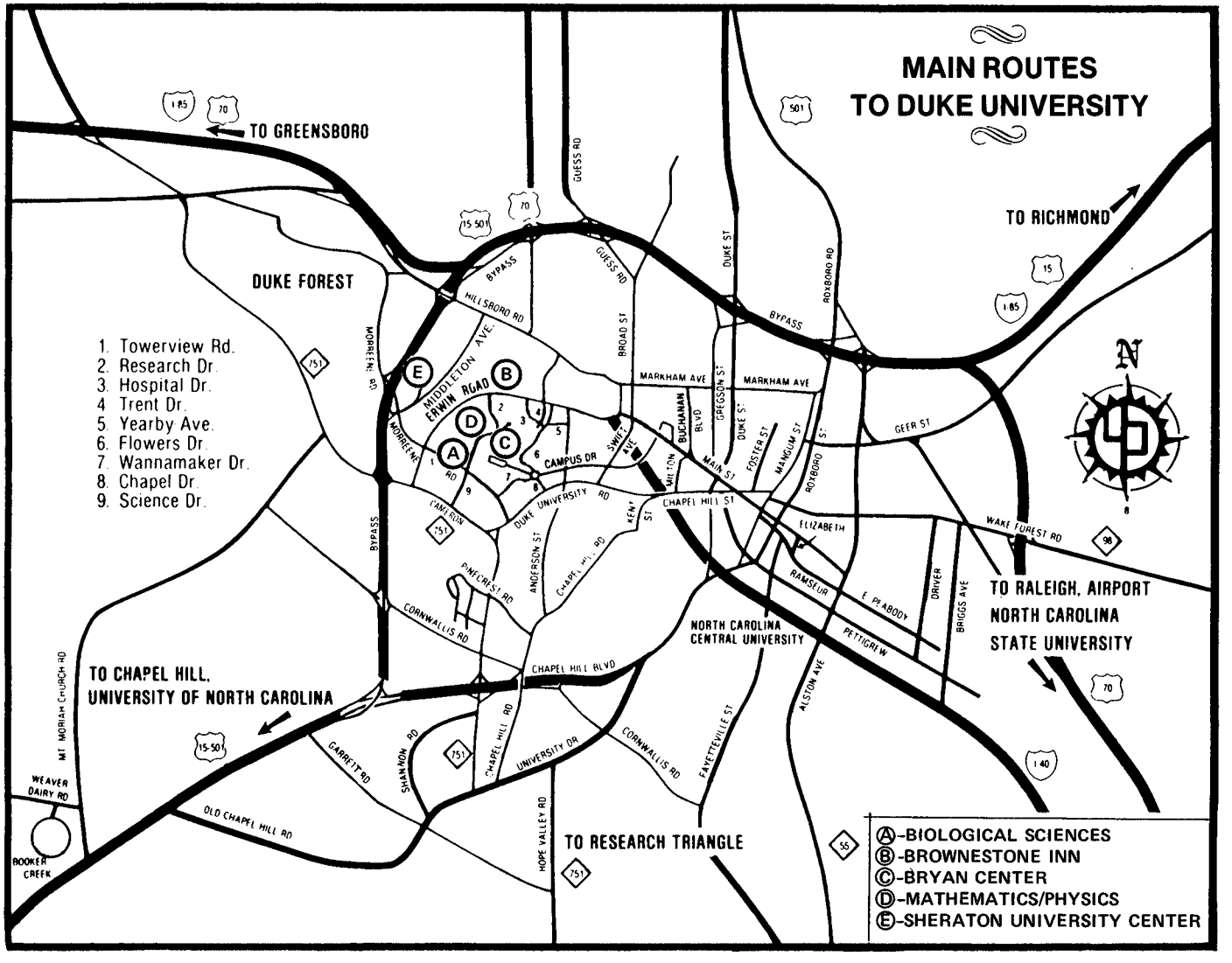
By air, 1st book $5, each add'l $3, $100 max.
PREPAYMENT REQUIRED. Order from American Mathematical Society, PO Box 1571, Annex Station, Providence, RI 02901-9930, or call 800-556-7774 to use VISA or MasterCard.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TO GREENSBORO
TO RICHMOND
DUKE FOREST
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4. Trent Dr.
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7. Wannamaker Dr.
8. Chapel Dr.
9. Science Dr.
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NORTH CAROLINA
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Ⓒ-BRYAN CENTER
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SHANNON RD
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OLD CHAPEL HILL RD
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Joint Summer Research Conferences in the Mathematical Sciences

University of Colorado, Boulder, June 14 to July 25 and Cornell University, July 19 to August 15, 1987

The 1987 Joint Summer Research Conferences in the Mathematical Sciences will be held at the University of Colorado, Boulder, from June 14 to July 25, and at Cornell University, from July 19 to August 15. It is anticipated that the series of conferences will be supported by grants from the National Science Foundation and other agencies.

There will be conferences in different areas of mathematics to be held at each institution. The topics and organizers for the conferences were selected by the AMS-IMS-SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences from proposals submitted by individuals and topics suggested by committee members. The committee considered it important that the conferences represent diverse areas of mathematical activity, with emphasis on areas currently especially active, and paid careful attention to subjects in which there is important interdisciplinary activity at present.

The conferences are similiar in scientific structure to those held throughout the year at Oberwolfach. They are intended to complement the Society's program of annual Summer Institutes and Summer Seminars, which have a larger attendance and are substantially broader in scope. The conferences are research conferences, and are not intended to provide an entree to a field in which a participant has not already worked.

It is expected that support will be available for a limited number of participants in each conference. Others, in addition to those funded, will be welcome, within the limitations of the facilities of the campus. In the spring a brochure will be mailed to all who are invited to attend the conferences. The brochure will include information on room and board rates, the residence and dining hall facilities, travel and local information and a Residence Housing Form to use for on-campus housing accommodations. Information on off-campus housing will also be included in the brochure. Participants are required to make their own housing and travel arrangements. Each participant will be required to pay a fee of $25 to cover the cost of social events and refreshments served at breaks, in addition to a $15 registration fee.

Those interested in attending one of the conferences should send the following information to Carole Kohanski, Summer Research Conference Coordinator, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

Please type or print the following:

1. Title and dates of conference desired
2. Full name
3. Mailing address
4. Telephone number & area code for office and home
5. Your scientific background relevant to the topic of the conference
6. Financial assistance requested. Please estimate cost of travel.
7. Indicate if support is not required, and if interested in attending even if support is not offered.

The deadline for receipt of applications is March 2, 1987. After that date the Organizing Committee for each conference will consider the requests (selection of the participants and the allocation of support is made by the Organizing Committee.) You will be notified by the AMS of the committee's decision no later than May 1, 1987. Funds available for these conferences are limited and individuals who can obtain support from other sources should do so. Women and members of minority groups are encouraged to apply and participate in these conferences.

Any questions concerning the scientific portion of the conference should be directed to the chairman or any member of the Organizing Committee.

The Joint Summer Research Conferences in the Mathematical Sciences are under the direction of the AMS-IMS-SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences. The following Committee members chose the topics for the 1987 conferences: William B. Arveson, Ronald L. Graham, Benedict H. Gross, Malcolm R. Leadbetter, Angus J. Macintyre, Jerrold E. Marsden (Chairman), John R. Martin, James McKenna, Tilla Klotz Milnor, Evelyn Nelson, Katusumi Nomizu.

Descriptions of the subject matter of each of the 1987 Conferences appeared in the October *Notices*, pages 836 to 839; they were accompanied by lists of members of the respective organizing committees.

University of Colorado, Boulder

June 14 to June 20

Categories in computer science and logic

JOHN W. GRAY (University of Illinois at Urbana-Champaign), Chairman

June 21 to June 27

Hamiltonian dynamical systems

KENNETH MEYER (University of Cincinnati), Co-Chairman

DON SAARI (Northwestern University), Co-Chairman

June 28 to July 4

Graphs and algorithms

JOE BUHLER (Reed College), Co-Chairman

PHYLLIS CHINN (Humboldt State University), Co-Chairman

July 5 to July 11

Geometry of group representations

WILLIAM GOLDMAN (University of Maryland), Co-Chairman

ANDY MAGID (University of Oklahoma), Co-Chairman

July 19 to July 25

The connection between infinite dimensional and finite dimensional dynamical systems

BASIL NICOLAENKO (Los Alamos National Laboratories), Chairman

Cornell University

The conference on *Mathematical developments arising from linear programming*, July 12 to July 18, has been cancelled.

July 19 to July 25

Geometry of random motion

RICHARD DURRETT (Cornell University), Co-Chairman

MARK PINSKY (Northwestern University), Co-Chairman

July 26 to August 1

Crystal growth and pattern formation in phase transitions

STUART P. HASTINGS (SUNY at Buffalo), Co-Chairman

NICHOLAS D. KAZARINOFF (SUNY at Buffalo), Co-Chairman

August 2 to August 8

Complex analytic dynamics

JOHN H. HUBBARD (Cornell University), Chairman

August 9 to August 15

Statistical inference from stochastic processes

NARAHARI U. PRABHU (Cornell University), Chairman

COMBINATORIAL METHODS IN TOPOLOGY AND ALGEBRAIC GEOMETRY

John R. Harper and Richard Mandelbaum, Editors

This collection marks the recent resurgence of interest in combinatorial methods, resulting from their deep and diverse applications both in topology and algebraic geometry. Nearly thirty mathematicians met at the University of Rochester in 1982 to survey several of the areas where combinatorial methods are proving especially fruitful: topology and combinatorial group theory, knot theory, 3-manifolds, homotopy theory and infinite dimensional topology, and four manifolds and algebraic surfaces. This material is accessible to advanced graduate students with a general course in algebraic topology along with some work in combinatorial group theory and geometric topology, as well as to established mathematicians with interests in these areas. For both student and professional mathematicians, the book provides practical suggestions for research directions still to be explored, as well as the aesthetic pleasures of seeing the interplay between algebra and topology which is characteristic of this field.

In several areas the book contains the first general exposition to be published on the subject at hand. In topology, for example, the editors have included M. Cohen, W. Metzler and K. Sauerman's article on "Collapses of $K \times I$ and group presentations" and Metzler's "On the Andrews-Curtis-Conjecture and related problems." In addition, J. M. Montesino has provided summary articles on both 3- and 4-manifolds.

1980 *Mathematics Subject Classifications*: 14Jxx, 20Fxx, 55Pxx, 55Sxx, 57Mxx, and others.
ISBN 0-8218-5039-3, LC 85-11244
ISSN 0271-4132
376 pages (softcover), October 1985
List price $34, Institutional member $27, Individual member $20
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Shipping/Handling: 1st book $2, each add'l $1, $25 max. By air, 1st book $5, each add'l $3, $100 max. Prepayment required. Order from AMS, P.O. Box 1571, Annex Station, Providence, RI 02901-9930, or call 800-556-7774 to use VISA or MasterCard.

Tacoma, June 19–20, Pacific Lutheran University

First Announcement of the 835th Meeting

The eight hundred and thirty-fifth meeting of the American Mathematical Socity will be held at Pacific Lutheran University in Tacoma, Washington, on Friday and Saturday, June 19–20, 1987. This meeting will be held in conjunction with the Pacific Northwest section of the Mathematical Association of America.

Invited Addresses

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, there will be two invited one-hour addresses. The speakers are as follows:

BRANKO GRÜNBAUM, University of Washington, *The geometry of polyhedra.*

HENRYK HECHT, University of Utah, title to be announced.

Special Sessions

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

Geometric methods in representation theory, HENRYK HECHT.

Polyhedral and planar graphs, MOSHE ROSENFELD, Pacific Lutheran University.

Most of the papers to be presented at these special sessions will be by invitation. However, anyone submitting an abstract for the meeting and who feels that his or her paper would be particularly appropriate for one of these special sessions should indicate this clearly on the abstract form and submit it by **March 27, 1987**, three weeks before the deadline for contributed papers, in order that it may be considered for inclusion. Participants are reminded that a charge of $16 is imposed for retyping abstracts that are not in camera-ready form.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Abstracts should be prepared on the standard AMS forms available from the AMS office in Providence or in Departments of Mathematics. Abstracts should be sent to the Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, so as to arrive before the **April 17, 1987**, abstract deadline. Participants are reminded that a charge of $16 is imposed for retyping abstracts that are not in camera-ready form. Late papers will not be accommodated.

MAA Program

The MAA program will take place on Saturday and will include a luncheon. Additional information will be included in the announcement in the April issue of *Notices.*

Registration

The meeting registration desk will be open on both Friday and Saturday during hours to be announced. The registration fees are $10 for members of the AMS or MAA, $16 for nonmembers, and $5 for students or unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information can be found in a box on page 62 in the San Antonio meeting announcement in the January issue of *Notices.*

Travel and Local Information

Tacoma is served by all major airlines. The Sea-Tac Airport is situated about halfway between Seattle and Tacoma. The weather in the Puget Sound area should be mild, sunny, and dry in June, with spectacular views of Mount Rainier.

Information concerning accommodations, food service, and surface transportation to and around Tacoma will be included in the next announcement.

Salt Lake City, Utah

Hugo Rossi
Associate Secretary

1987 Summer Research Institute, July 6–24

Theta Functions

The thirty-fifth Summer Research Institute sponsored by the American Mathematical Society will be devoted to *Theta functions* and will take place at Bowdoin College in Brunswick, Maine, from July 6 to 24, 1987. Members of the Organizing Committee include Enrico Arbarello, University of Rome; David Chudnovsky, Columbia University; Gregory Chudnovsky, Columbia University; Leon Ehrenpreis, Temple University (co-chairman); Robert Gunning, Princeton University (co-chairman); Takahiro Kawai, Kyoto University; and Henry McKean, New York University. It is anticipated that the institute will be partially supported by a grant from the National Science Foundation. Funds for financial assistance will be limited and, therefore, it will be necessary for many participants to obtain their own funds. Proceedings of the institute will be published in the AMS series *Proceedings of Symposia in Pure Mathematics.*

This topic was selected by the 1985 Committee on Summer Institutes, whose members at that time were Albert Baernstein II, Eric Friedlander, Hui-Hsiung Kuo (chairman), H. Blaine Lawson, Judith D. Sally, and John Wermer.

Theta functions have a long and distinguished mathematical history, and interest in these functions has been renewed and deepened by the wide variety of areas of mathematical research in which they have currently come to play a major and exciting role, both in extension of their traditional areas of application and in new areas altogether. Recent results on the well-known Riemann-Schottky problem in algebraic geometry have been striking indeed, with great strides in geometric forms of solutions and in the solution of the Novikov conjecture characterizing Jacobi varieties by means of partial differential equations. Considerable progress has been made in extending the classical role of theta functions in the solution of integrable Hamiltonian systems to the study of such nonlinear equations as the KDV, KP, and so on, as part of an intensive recent study of the KP hierarchy and various generalizations. This progress and the work on theta functions in partition theory have come to be of interest in mathematical physics, both in statistical mechanics and in string theory. Theta functions have been a crucial tool in the study of diophantine equations, as well as in the recent solution of Mordell's Conjecture.

The three weeks of the Summer Research Institute are planned to cover various aspects of the theory of theta functions with roughly the following schedule:

Week I: The KP hierarchy and integrable systems; KDV in the scattering case; Kac-Moody algebras; integrable lattice models in statistical mechanics; string theory.

Week II: The KP hierarchy and algebraic geometry; Prym varieties; the Schottky problem and the Novikov conjecture; analytic identities on Riemann surfaces; the τ function; vector bundles over Riemann surfaces.

Week III: Algebraic number theory; moduli of Abelian varieties; transcendental number theory; modular forms; combinatorics; combinatorial identities, mock theta functions.

It is intended that the morning sessions will be systematic expository lectures covering the topics set for that week, while the afternoon sessions will be topical seminars on current research developments as well as working and problem seminars. The hope is to provide an opportunity to learn the wide variety of different roles now played by theta functions, to broaden the perspectives of the participants and provoke further interactions, and to follow recent developments of interest to those engaged in research in the various areas of mathematics covered.

Housing accommodations will be available in the campus residence halls for participants and their families, and cafeteria-style meals will be served daily in the adjacent dining hall. Residence and dining facilities, as well as rooms used for the scientific sessions at Bowdoin College, are accessible to the handicapped.

A brochure of information will be sent to all who are invited to attend the institute. It will include information about the scientific program, the residence and dining facilities, room and board rates, travel and local information, and a reservation form for on-campus housing accommodations. Each participant will pay a registration fee of $10 and a social fee of $25 to cover the cost of social events and refreshments served at breaks.

Anyone who wishes to receive an invitation to participate in the institute and/or be considered for financial assistance should write to John Balletto, American Mathematical Society, P. O. Box 6248, Providence, Rhode Island 02940 prior to **April 3, 1987**. After that date the Organizing Committee will consider the requests, and applicants who are granted support will subsequently be notified that funds are available.

Call For Topics For 1989 Conferences

Suggestions are invited from mathematicians, either singly or in groups, for topics of the various conferences that will be organized by the Society in 1989. The deadlines for receipt of these suggestions, as well as some relevant information about each of the conferences, are outlined below. An application form to be used when submitting suggested topic(s) for any of these conferences (except the Short Course Series) may be obtained by writing to the Meetings Department, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940, or telephoning 401-272-9500.

Individuals willing to serve as organizers should be aware that the professional meeting staff in the Society's Providence office will provide full support and assistance before, during, and after each of these conferences. Organizers should also note that for all conferences, except Summer Research Conferences, it is required that the proceedings be published by the Society, and that proceedings of Summer Research Conferences are frequently published. A member of the Organizing Committee must be willing to serve as editor of the proceedings.

All suggestions must include (1) the names and affiliations of proposed members and chairman of the Organizing Committee; (2) a two- or three-page detailed outline of the subject(s) to be covered, including the importance, timeliness of the topic, and estimated attendance; (3) a list of the recent conferences in the same or closely related areas; (4) a tentative list of names and affiliations of the proposed principal speakers; (5) a list of likely candidates who would be invited to participate and their current affiliations; and (6) any other observations which may affect the size of the conference and the amount of support required. Any suggestions as to sites and dates should be made as early as possible in order to allow adequate time for planning. By action of the AMS Board of Trustees, the Meetings Department of the Society is responsible for the final selection of the site for each conference and for all negotiations with the host institution. Individuals submitting suggestions for the conferences listed below are requested to recommend sites or geographic areas which would assist the Meetings Department in their search for an appropriate site. In the case of Joint Summer Research Conferences in the Mathematical Sciences, a one-, two-, or three-week conference may be proposed.

Refer to the accompanying box titled **Topics of Current and Recent Conferences** for lists of topics.

Topics of Current and Recent Conferences

AMS Summer Institute

1985 – *Algebraic geometry*, organized by DAVID EISENBUD of Brandeis University.

1986 – *Representations of finite groups and related topics*, organized by JONATHAN L. ALPERIN of the University of Chicago.

1987 – *Theta functions*, organized by LEON EHRENPREIS of Yeshiva University and ROBERT GUNNING of Princeton University.

1988 – *Operator theory/Operator algebras and applications*, organized by WILLIAM B. ARVESON of University of California, Berkeley, and RONALD G. DOUGLAS of State University of New York at Stony Brook.

AMS-SIAM Symposium on Some Mathematical Questions in Biology

1985 – *Plant biology*, organized by ROBERT M. MIURA of the University of British Columbia.

1986 – *Modeling circadian rhythms*, organized by GAIL A. CARPENTER of Northeastern University.

1987 – *Models in population biology*, organized by ALAN HASTINGS of the University of California, Davis.

1988 – *Dynamics of excitable media*, organized by HANS G. OTHMER of the University of Utah.

AMS-SIAM Summer Seminar

1984 – *Nonlinear systems of PDE in applied mathematics*, organized by BASIL NICOLAENKO of Los Alamos National Laboratories.

1985 – *Reacting flows: Combustion and chemical reactors*, organized by G.S.S. LUDFORD of Cornell University.

1987 – *Computational Aspects of VLSI Design with an Emphasis on Semiconductor Device Simulation*, organized by RANDOLPH BANK of the University of California, San Diego.

1988 – *Computational solution of nonlinear systems of equations*, organized by EUGENE ALLGOWER of Colorado State University.

1989 AMS Summer Institute

Summer institutes are intended to provide an understandable presentation of the state of the art in an active field of research in pure mathematics, and usually extend over a three-week period. Dates for a summer institute must not overlap those of the Society's summer meeting, which at the time of this printing have not yet been determined, there should be a period of at least one week between them. Proceedings are published by the Society as volumes in the series *Proceedings of Symposia in Pure Mathematics.*

Deadline For Suggestions: August 15, 1987

1989 AMS-SIAM Symposium Some Mathematical Questions in Biology

This one-day symposium is usually held in conjunction with the Annual Meeting of the AAAS. Papers from the symposia are published by the Society as volumes in the series *Lectures on Mathematics in the Life Sciences.*

Deadline For Suggestions: April 1, 1987

1989 AMS-SIAM Summer Seminar

The goal of the summer seminar is to provide an environment and program in applied mathematics in which experts can exchange the latest ideas and newcomers can learn about the field. Proceedings are published by the Society as volumes in the series *Lectures in Applied Mathematics.*

Deadline For Suggestions: August 15, 1987

1989 Joint AMS-IMS-SIAM Summer Research Conferences in the Mathematical Sciences

These conferences are similar in structure to those held at Oberwolfach, and represent diverse areas of mathematical activity, with emphasis on areas currently especially active. Careful attention is paid to subjects in which there is important interdisciplinary activity at present. Topics for the sixth series of one-week conferences, being held in 1987, are *Categories in computer science and logic, Hamiltonian dynamical systems, Graphs and algorithms, Geometry of group representations, The connection between infinite dimensional and finite dimensional dynamical systems, Geometry of random motion, Crystal growth and pattern formation in phase transitions, Complex analytic dynamics,* and *Statistical inference from stochastic processes.* If proceedings are published by the Society, they will appear as volumes in the series *Contemporary Mathematics.*

Deadline For Suggestions: February 1, 1988

Call for Topics for 1989 AMS Short Course Series

The AMS Short Courses consist of a series of introductory survey lectures and discussions ordinarily extending over a period of one and one-half days starting immediately prior to the Joint Mathematics Meetings held in January and August each year. Each theme is a specific area of applied mathematics or mathematics used in the study of a specific subject or collection of problems in one of the physical, biological or social sciences, technology or business. Topics in recent years have been *Moments in Mathematics* (January 1987), *Approximation Theory* (January 1986), *Actuarial Mathematics* (August 1985), *Fair Allocation* (January 1985), *Environmental and Natural Resource Mathematics* (August 1984). Proceedings are published by the Society as volumes in the series *Proceedings of Symposia in Applied Mathematics*, with the approval of the Editorial Committee.

Deadline for Suggestions: Suggestions for the January 1989 course should be submitted by July 1, 1987; suggestions for the August 1989 course should be submitted by December 1, 1987.

Submit suggestions to: Professor Stefan A. Burr, Chairman, AMS Short Course Subcommittee, Department of Computer Sciences, CUNY, City College, New York, New York 10031.

Special Meetings

THIS SECTION contains announcements of meetings of interest to some segment of the mathematical public, including *ad hoc*, local, or regional meetings, and meetings or symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. (Information on meetings of the Society, and on meetings sponsored by the Society, will be found inside the front cover.) All meetings listed here, to the best of our knowledge, are open meetings and the public is invited to attend.

AN ANNOUNCEMENT will be published in *Notices* if it contains the place, date, 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.

IN GENERAL, announcements of meetings held in North America carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on special meetings should be sent to the Editor of *Notices*, care of the American Mathematical Society in Providence.

DEADLINES for entries in this section are listed on the inside front cover of each issue. In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence SIX MONTHS prior to the scheduled date of the meeting.

1986–1987. **Academic Year Devoted to Algebraic Geometry**, Mittag-Leffler Institute, Djursholm, Sweden. (January 1986, p. 130)

1986–1987. **Special Year in Combinatorics and Complexity**, University of Illinois at Chicago, Chicago, Illinois.
Program: A series of graduate courses and seminars will be offered by regular faculty and special visitors, including R. Brualdi, A. Hajnal, P. Pudlak, G. Turan, and R. Wilson.
Information: W. Maass, U. Peled, or V. Pless, University of Illinois at Chicago, Department of Mathematics, Statistics, and Computer Science, Box 4348, Chicago, Illinois 60680, 312-996-2372, 312-996-4826, or 312-996-4828 respectively.

1986–1987. **Special Year in Modern Analysis**, University of Illinois at Urbana-Champaign, Urbana, Illinois. (October 1986, p. 840)

1986–1987. **Workshop for Academic Year**, University of Arizona, Tucson, Arizona. (January 1987, p. 131)

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

October 12, 1986–December 13, 1987. **Mathematisches Forschungsinstitut Oberwolfach** (Weekly Conferences), Federal Republic of Germany. (October 1986, p. 840)

January 12, 1987–June 20, 1987. **Research Program on Different Aspects of the Mathematical Theory of Evolution Equations**, University and the Scuola Normale Superiore, Pisa, Italy. (January 1987, p. 131)

September 14, 1987–June 25, 1988. **Program on Applied Combinatorics**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota.
Information: H. Weinberger, Institute for Mathematics and its Applications, University of Minnesota, 514 Vincent Hall, 206 Church Street S.E., Minneapolis, Minnesota 55455.

January–July 1988. **Symposium on Representation Theory and Group Theory**, Manchester, England.
Information: R.T.G.T., Department of Mathematics, University of Manchester Institute of Science and Technology, Post Office Box 88, Manchester, M60 1QD, England.

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MARCH 1987

19–21. **Twenty-first Annual Spring Topology Conference**, University of Alabama, Birmingham, Alabama.
Program: The conference is dedicated to R H Bing. A special focus of the conference will be topology and dynamical systems.
Invited Speakers: K. Alster, D. Bellamy, R. Daverman, J. Davis, R. Devaney, R. Edwards, J. Franks, G. Gruenhage, K. Kunen, R. Mauldin, and F. Van Engelen.
Information: L. Oversteegen, Spring Topology Conference, Department of Mathematics, University of Alabama at Birmingham, Birmingham, Alabama 35294, 205-934-2154.

20–21. **Southeastern Analysis Meeting**, University of Alabama, Tuscaloosa, Alabama.
Organizers: A. Hopenwasser, R. Moore, T. Trent.
Information: R. Moore, Department of Mathematics, University of Alabama,Tuscaloosa, Alabama 35487-1416.

22–25. **Institute of Mathematical Statistics Central Regional Meeting**, Dallas, Texas. (March 1986, p. 370)

22–26. **Computer Graphics '87**, Philadelphia Civic Center, Philadelphia, Pennsylvania.
Purpose: The Computer Graphics '87 conference gathers the industry's most widely known users, vendors, and academicians to review the past, explain the present and predict the future of computer graphics.
Information: Computer Graphics '87, National Computer Graphics Association, 2722 Merrilee Drive, Suite 200, Fairfax, Virginia 22031, 800-225-6242.

22–27. **Theorie de l'Approximation et Representation de Surfaces**, Marseille, France.
Information: A. Zeller-Meier, CIRM, Luminy Case 916, F-13288 Marseille Cedex 9, France.

22–29. **Fifth International Conference on Geometry**, University of Haifa, Haifa, Israel. (October 1986, p. 842)

23–26. **Workshop on Scientific Software**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota.
Speakers: F. Berman, B. Buchberger, C. de Boor, G. Farin, D. Gannon, C. Hoffmann, J. Hopcroft, E. Houstis, R. Jenks, L. Johnsson, R. McGehee, J. Rice, and L. Snyder.
Information: H. Weinberger, Institute for Mathematics and its Applications, University of Minnesota, 514 Vincent Hall, 206 Church Street S.E., Minneapolis, Minnesota 55455.

23–27. **Workshop on Galois Groups over Q and Related Topics**, Mathematical Sciences Research Institute, Berkeley, California. (October 1986, p. 842)

23–27. **Workshop on Scientific Software**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota. (August 1986, p. 654)

23–30. **NSF-CBMS Conference on Mathematical Statistics**, Ohio State University. (June 1986, p. 560)

25–27. **Conference on Information Sciences and Systems**, Johns Hopkins University, Baltimore, Maryland. (October 1986, p. 843)

27–28. **Eleventh Annual Southeastern Section–Society for Industrial and Applied Mathematics Conference**, University of Georgia, Athens, Georgia. (November 1986, p. 961)

28–31. **Eighteenth Iranian Mathematical Conference**, Birjand University, Iran. (November 1986, p. 961)

30–April 15. **Workshop and Conference on Number Theory and Dynamical Systems**, University of York, York, United Kingdom. (October 1986, p. 843)

31–April 3. **Schrödinger Centenary Conference**, Imperial College, London, England.
Information: P. Dolan, Mathematics Department, Imperial College, London, England.

APRIL 1987

2–3. **Conference on Applications of Functional Analysis to Differential and Integral Equations**, Idaho State University, Pocatello, Idaho. (January 1987, p. 132)

3–5. **Third Annual Geometry Festival**, University of Pennsylvania, Philadelphia, Pennsylvania.
Program: There will be seven talks on Differential Geometry and its interactions with Analysis, Physics, and Topology.
Invited Speakers: These will include R. Bryant, K. Burns, H. Karcher, J. Moser, and E. Witten.
Information: K. Sestak, Geometry Festival, Department of Mathematics, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6395, 215-898-8178.

6–8. **Conference on Combinatorial Optimisation**, University of Southampton, United Kingdom. (October 1986, p. 843)

8–10. **Charter Centenary Conference of the Royal Statistical Society**, Cambridge, United Kingdom. (November 1986, p. 961)

8–10. **Third Workshop on the Mathematical Foundations of Programming Semantics**, Tulane University, New Orleans, Louisiana. (October 1986, p. 843)

9–11. **Operators on Martingales**, Fayetteville, Arkansas. (January 1987, p. 132) (Note change of title)

10. **Symposium on Women in Geometry**, University of Pennsylvania, Philadelphia, Pennsylvania.
Invited Speakers: K. Uhlenbeck and J. Birman.
Information: L. Sibner, Department of Mathematics E1, University of Pennsylvania, Philadelphia, Pennsylvania 19104-3859, 215-898-8466.

10–11. **Mathematical Ecology Conference**, College of Charleston, Charleston, South Carolina.
Information: G. Harrison, Department of Mathematics, College of Charleston, Charleston, South Carolina 29424.

10–11. **Twentieth Small College Computing Symposium**, Macalester College, Saint Paul, Minnesota. (January 1987, p. 132)

11–12. **Twenty-first Meeting of the Midwest Partial Differential Equations Seminar**, University of Illinois, Chicago, Illinois. (January 1987, p. 133)

16–18. **Sacramento State Topology Conference**, California State University, Sacramento, California.
Program: T. Ingram will give two 1-hour talks. Also, there will be 20-minute talks on recent and current research; the emphasis will be on continuum theory, but there will be some talks on other aspects of general topology.
Information: M. Marsh or E. Vought, Mathematics Department, California State University, Sacramento, California 95819.

21–25. **Conference on Nonlinear Numerical Methods Based on the Use of Rational Functions**, University of Antwerp, Belgium. (August 1986, p. 654)

23–24. **The Eighteenth Annual Modeling and Simulation Conference**, Pittsburgh, Pennsylvania. (October 1986, p. 843)

23–25. **First Annual National Conference on Undergraduate Research**, University of North Carolina, Asheville, North Carolina.
Purpose: The major focus is on undergraduate students and on providing an unusual forum for undergraduate students to participate by presenting the results of their research in paper or poster sessions. The conference is for undergraduate research in the arts and sciences.
Program: Faculty and administrators will present papers at three special sessions and a panel discussion will follow each session. Students will also present papers and posters.
Information: National Conference on Undergraduate Research, Office of Undergraduate Research, 211A Rhoades Hall, UNCA, Asheville, North Carolina 28804-3299.

23–25. **John H. Barrett Memorial Lectures**, University of Tennessee, Knoxville, Tennessee.
Program: Lectures will be given by J. McLaughlin, Rensselaer Polytechnic Institute. In addition there will be sessions for contributed papers.
Information: D. Hinton, Mathematics Department, University of Tennessee, Knoxville, Tennessee 37996, 615-974-4317.

24–25. **Cincinnati Symposium on Probability Theory and Applications**, University of Cincinnati, Cincinnati, Ohio.
Program: The program will have three one-hour talks by invited speakers and six or seven half-hour talks by regional speakers.
Information: W. Bryc, J. Mitro, or M. Peligrad, Department of Mathematical Sciences, University of Cincinnati, Cincinnati, Ohio 45221-0025.

24–25. **Harald Bohr Centenary Symposium**, Copenhagen, Denmark.
Topic: The main topic will be almost periodic functions in a broad sense, their history, and applications.
Speakers: J. Bellissard, C. Berg, N. Bogolubov, T. Bohr, A. Fink, S. Helgason, E. Hewitt, and H. Tornehave.
Information: Danish Mathematical Society, The Harald Bohr Centenary, Universitetsparken 5, DK-2100 Copenhagen Ø, Denmark.

27–30. **Workshop on Mathematical Modeling in Combustion and Related Topics**, École Centrale de Lyon, France. (August 1986, p. 654)

27–May 1. **Espaces Fibrés: Leur Utilisation en Physique**, Trieste, Italy.
Information: J. Eells, International Centre for Theoretical Physics, Post Office Box 586, Miramare, Strada Costiera 11, 34100 Trieste, Italy.

27–May 2. **Combinatories and Computer Science**, Montréal, Québec, Canada.
Topics: Topics of interest include, but are not limited to, Computational geometry (and graphics, robotics), Automata theory and combinatories of words, Optimization, Posets and applications, and Data structures.
Information: G. Hahn or I. Rosenberg, Centre de Recherches Mathématiques, Université de Montréal, C.P. 6128 Succ. "A", Montréal, P.Q. H3C 3J7, Canada.

27–May 23. **Fluidodynamics**, Pisa, Italy.
Information: K. Nicotra, Evolution Equations Program, Scuola Normale Superiore, I-56100 Pisa, Italy.

28–May 1. **The Mathematics of Finite Elements and Applications 1987**, Uxbridge, United Kingdom. (October 1986, p. 843)

30–May 7. **AMS-SIAM Summer Seminar on Computational Aspects of VLSI Design with an Emphasis on Semiconductor Device Simulation**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota. (August 1986, p. 654) (*Note correction from August 1986 issue.)

MAY 1987

Mid-May. **Conference on Aspects of Analysis**, University College, Cork, Ireland.
Program: This two day conference will appeal to workers in Operator Theory and Operator Algebras.
Information: G. Murphy, Department of Mathematics, University College, Cork, Ireland.

4–6. **Research Conference in Geometric Design**, Wayne State University, Detroit, Michigan.
Program: Computer Aided design and (tentatively) geometric continuity as developed and used in academia and in industry will be the focus of this regional conference of the Institute for Mathematics and its Applications. Substantial participation from local industry is expected.
Speakers: R. Barnhill (Arizona State), W. Böhm (Braunschweig), C. deBoor (Wisconsin), G. Farin (Utah), K. Höllig (Wisconsin), and R. Sarraga (General Motors Research).
Information: C. Schochet, Geometric Design Conference, Mathematics Department, Wayne State University, Detroit, Michigan 48202, 313-577-3177.

4–8. **Conference on Nonlinear Diffusive Waves**, Provo, Utah.
Invited Speaker: P. Fife.
Information: P. Bates, Department of Mathematics, 292 TMCB, Brigham Young University, Provo, Utah 84602.

4–9. **Theorie des Nombres**, Marseille, France.
Information: A. Zeller-Meier, CIRM, Luminy Case 916, F-13288 Marseille Cedex 9, France.

10–16. **Fourth International Conference on Complex Analysis and Applications**, Varna, Bulgaria.
Activities: Invited lectures and short talks, seminars, problem and poster sessions on current problems in complex analysis and applications.
Information: T. Tonev, Fourth Conference on Complex Analysis, Institute of Mathematics, Bulgarian Academy of Sciences, BG-1090, Sofia, Bulgaria.

11–15. **Thirty-first Annual Meeting of the Australian Mathematical Society**, Deakin University, Geelong, Victoria, Australia. (August 1986, p. 654)

14–15. **Statcomp 87**, Melbourne, Australia.
Information: Conference Secretary, STATCOMP 87, Department of Statistics, La Trobe University, Bundoora, Victoria 3083, Australia.

15. **Ninth Nestor M. Riviere Memorial Lecture**, University of Minnesota, Minneapolis, Minnesota.
Invited Speaker: L. Caffarelli of the Institute for Advanced Study.
Information: E. Fabes, School of Mathematics, University of Minnesota, Minneapolis, Minnesota 55455, 612-625-9365.

18–20. **Journées de Statistique 1987**, Lausanne, Switzerland.
Information: M. Lejeune, Journées de Statistique, Université, CH-1015 Lausanne, Switzerland.

18–21. **Eighth Symposium on Computer Arithmetic**, Como, Italy. (October 1986, p. 843)

18–23. **Sous-Varietes Riemanniennes**, Marseille, France.
Information: A. Zeller-Meier, CIRM, Luminy Case 916, F-13288 Marseille Cedex 9, France.

20–23. **Combinatorial Matrix Analysis Conference**, University of Victoria, Victoria, British Columbia, Canada. (October 1986, p. 843)

1987 New Zealand Mathematics Colloquium, Hamilton, New Zealand.
Information: M. Jorgensen, Mathematics Department, University of Waikato, Private Bag, Hamilton, New Zealand.

21–22. **Ninth Symposium on Mathematical Programming with Data Perturbations**, George Washington University, Washington, District of Columbia.
Purpose: This symposium is designed to bring together practitioners, who use mathematical programming optimization models and deal with questions of sensitivity analysis, with researchers who are developing techniques applicable to these problems.
Information: A. Fiacco, George Washington University, Washington, District of Columbia 20052, 202-676-7511.

21–23. **Second Conference in Geometry and Topology**, Lehigh University, Bethlehem, Pennsylvania. (January 1987, p. 133)

25–26. **Foundations and Philosophy of Probability and Statistics, A Symposium in Honor of I. J. Good**, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. (November 1986, p. 962)

25–27. **Workshop on Nonlinear Hyperbolic Waves**, Berkeley, California.
Information: J. Glimm, Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley, California 94720.

25–29. **The Ninth International Symposium on Noise in Physical Systems**, Université de Montréal, Québec, Canada. (March 1986, p. 370)

25–30. **Seminaire Sud-Rhodanien**, Marseille, France.
Information: A. Zeller-Meier, CIRM, Luminy Case 916, F-13288 Marseille Cedex 9, France.

25–June 20. **Mathematical Models in Chemistry and Biology**, Pisa, Italy.
Information: K. Nicotra, Evolution Equations Program, Scuola Normale Superiore, I-56100 Pisa, Italy.

26–28. **Multiple-valued Logic**, University of Massachusetts, Boston, Massachusetts. (January 1987, p. 133)

26–28. **Workshop on Nonlinear Hyperbolic Waves**, Mathematical Sciences Research Institute, Berkeley, California. (August 1986, p. 654)

27–29. **Differential Equations Meeting**, Dublin, Ireland.
Program: There will be special sessions on nonlinear equations and on asymptotics for linear equations. Invited speakers include K. Brown, M. Eastham, H. Ockendon, J. Ockendon, and R. Paris.
Call for papers: Papers on any aspect of differential equations (pure or applied) are welcome. Please submit an abstract of less than 200 words to the address below by March 27, 1987.
Information: D. Reynolds, School of Mathematical Sciences, National Institute for Higher Education, Dublin 9, Republic of Ireland.

27–29. **Institute of Mathematical Statistics Eastern Regional Meeting**, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.
Information: R. Johnson, Department of Statistics, University of Wisconsin, 1210 Dayton Street, Madison, Wisconsin 53706.

27–30. **Fifth Biennial Conference of the Association for Christians in the Mathematical Sciences**, Calvin College, Grand Rapids, Michigan. (January 1987, p. 133)

27–30. **Seventh Great Plains Operator Theory Seminar**, University of Kansas, Lawrence, Kansas.
Invited Speakers: D. Voiculescu, B. Blackadar, S. Brown, K. Davidson, and S. Power.
Information: N. Salinas, Department of Mathematics, University of Kansas, Lawrence, Kansas 66045, 913-864-3909.

28–30. **Annual Summer Meeting of the Canadian Mathematical Society**, Queen's University, Kingston, Ontario, Canada.
Call for papers: Please send an abstract, ready for photocopying and including the author's name and the title, to the address below.
Program: There will be special sessions on Non-commutative rings, Theoretical computer sicence, Homotopy theory, Several complex variables, and Numerical Optimization.
Information: G. Orzech, Department of Mathematics and Statistics, Queen's University, Kingston, Ontario, Canada K7L 3N6, 613-545-2441.

28–June 1. **Fourth Southeast Asian Conference on Mathematical Education**, Singapore. (August 1986, p. 654)

31–June 3. **1987 Annual Meeting, Statistical Society of Canada**, Quebec City, Canada. (November 1986, p. 962)

JUNE 1987

1–4. **Second International Tampere Conference in Statistics**, Tampere, Finland. (November 1986, p. 962)

1–5. **Ramanujan Centenary Conference**, University of Illinois at Urbana-Champaign, Urbana, Illinois.
Program: Invited lecturers will speak on several areas of contemporary mathematics that have been initiated or influenced by Ramanujan's problems, conjectures, published papers, notebooks, and unpublished manuscripts. There will also be sessions for contributed papers.
Information: B. Berndt, Department of Mathematics, University of Illinois, 1409 West Green Street, Urbana, Illinois 61801.

1–6. **Theorie de Hodge**, Marseille, France.
Information: A. Zeller-Meier, CIRM, Luminy Case 916, F-13288 Marseille Cedex 9, France.

1–10. **Second Annual Meeting of the International Workshop in Analysis and Its Applications**, Dubrovnik-Kupari, Yugoslavia. (October 1986, p. 843)

4–6. **Computer Experimentation in Nonlinear Analysis**, University of Missouri, Columbia, Missouri. (January 1987, p. 133)

4–6. **Congress on Educational Computing in Mathematics**, Università di Roma I, Roma, Italia. (*Note change from August 1986, p. 654)

7–13. **Diskrete Geometrie**, Oberwolfach, Federal Republic of Germany.
Information: Mathematisches Forschungsinstitut Oberwolfach, Albertstrasse 24, D-7800 Freiburg, Federal Republic of Germany.

7–18. **Nonlinear Evolution and Chaotic Phenomena**, Noto, Sicily.
Invited Speakers: G. Bennetin, M. Berry, P. Collet, M. Derrida, H. Epstein, M. Feigenbaum, V. Franceschini, O. Lanford, E. Siggia, and H. Swinney.
Information: O. Muscati, Seminario Matematico, Citta Universitaria, Viale A Doria, 6-1, 95125 Catania, Italy.

8–12. **AI, Mathematics and the Microcomputer**, Salisbury State College, Salisbury, Maryland.
Purpose: To introduce college teachers to the mathematical basis of machine intelligence and to provide hands-on computer experience with a language such as PROLOG.
Information: B. Fusaro, Department of Mathematical Sciences, Salisbury State College, Salisbury, Maryland 21801, 301-543-6470 or 6471.

8–13. **Arithmetique des Systemes Codes**, Marseille, France.
Information: A. Zeller-Meier, CIRM, Luminy Case 916, F-13288 Marseille Cedex 9, France.

8–19. **Singapore Group Conference Theory**, National University of Singapore, Republic of Singapore. (March 1986, p. 370)

9–12. **Workshop on Nonlinear Hyperbolic Equations for Applied Sciences**, Torino, Italy. (January 1987, p. 133)

11–13. **Congress on Educational Computing in Mathematics**, Rome, Italy.
Information: M. Emmer, Dipartimento di Matematica, Università di Roma I, Piazzale A. Moro, 00815 Roma, Italy.

11–13. **Sixth Pacific Coast Resource Modeling Conference**, University of British Columbia, Vancouver, Canada. (January 1987, p. 133)

11–14. **Conference on Operator Theory and Functional Analysis**, Phoenix, Arizona.
Topics: Topics will range from general operator theory to complex variables, to operator algebras, to engineering applications.
Information: J. Helton, Department of Mathematics (C-012), University of California, San Diego, La Jolla, California 92093 or L. Rodman, Department of Mathematics, Arizona State University, Tempe, Arizona 85287.

14–21. **Number Theory, Trace Formulas and Discrete Groups**, Oslo, Norway. (January 1987, p. 133)

15–16. **NASECODE V SHORT COURSE: The Interfaces and Integration of Process, Device and Circuit Models—An Introduction**, Trinity College, Dublin, Ireland. (October 1986, p. 843)

15–19. **Conference on Combinatorics and Complexity**, University of Illinois at Chicago, Chicago, Illinois.
Program: Half-hour lectures by main speakers will be supplemented by shorter invited and contributed talks. Participants desiring to contribute a talk should send a paper or abstract to one of the organizers by April 15, 1987.
Organizing Committee: L. Babai, Z. Galil, L. Lovasz, W. Maass, U. Peled, V. Pless, and R. Wilson.
Invited Speakers: N. Alon, R. Brualdi, C. Dwork, A. Hajnal, P. Hanlon, W. Kantor, E. Luks, E. Szemeredi, and G. Turan.
Information: W. Maass (312-996-2372), U. Peled (312-996-4826), or V. Pless (312-996-4828), University of Illinois at Chicago, Department of Mathematics, Statistics, and Computer Science, Box 4348, Chicago, Illinois 60680.

15–19. **Conference on Maximum Principles and Eigenvalue Problems in Partial Differential Equations**, University of Tennessee, Knoxville, Tennessee.
Principal Speaker: M. Protter.
Information: P. Schaefer, Department of Mathematics, University of Tennessee, Knoxville, Tennessee 37996-1300, 615-974-6874.

15–19. **Conference on Parallel Architectures and Languages Europe**, Eindhoven, The Netherlands.
Information: F. Stoots, Philips Research Labs, Post Office Box 80000, NL-5600 JA Eindhoven, The Netherlands.

15–19. **Mathematical Association of America's North Central Section Summer Seminar on Graph Theory and Linear Algebra**, University of Minnesota, Duluth, Minnesota. (January 1987, p. 133)

15–19. **OR, Mathematics and the Microcomputer**, Salisbury State College, Salisbury, Maryland.
Purpose: To introduce college teachers to a heuristic approach to problems of routing and scheduling and to provide small technology solution methods.
Information: B. Fusaro, Department of Mathematical Sciences, Salisbury State College, Salisbury, Maryland 21801, 301-543-6470 or 6471.

15–19. **Research Conference on Probabilistic Analysis of Combinatorial Optimization Problems**, Johns Hopkins University, Baltimore, Maryland.
Program: Ten research-level lectures will be presented by R. Karp on the topic of Probabilistic Analysis of Algorithms. Also, additional speakers will present complementary material, and there will be time reserved for small group discussions and interactions.
Information: E. Scheinerman or R. Serfling, Department of Mathematical Sciences, Johns Hopkins University, Baltimore, MD 21218.

15–19. **Symposium on Mathematical Theory of Networks and Systems**, Phoenix, Arizona.
Information: J. Helton, Department of Mathematics (C-012), University of California, San Diego, La Jolla, California 92093 or L. Rodman, Department of Mathematics, Arizona State University, Tempe, Arizona 85287.

15–26. **Workshop and Short Course on Stochastic Networks**, University of Wisconsin, Madison, Wisconsin. (January 1987, p. 134)

15–July 3. **Microprogram on Commutative Algebra**, Mathematical Sciences Research Institute, Berkeley, California. (October 1985, p. 679)

15–July 24. **Workshop on Molecular Structure and Dynamics**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota.
Invited Speakers: J. Almlof, D. Kouri, P. Langhoff, R. Levine, C.A. Mead, T. Osborn, J. Paldus, W. Reinhardt, I. Shavitt, F. Stillinger, and W. van Gunsteren.
Information: H. Weinberger, Institute for Mathematics and its Applications, University of Minnesota, 514 Vincent Hall, 206 Church Street S.E., Minneapolis, Minnesota 55455.

16–19. **Second Annual Conference on Structure in Complexity Theory**, Cornell University, Ithaca, New York. (November 1986, p. 962)

17–19. **NASECODE V Conference: The Fifth International Conference on the Numerical Analysis of Semiconductor Devices and Integrated Circuits**, Trinity College, Dublin, Ireland. (October 1986, p. 843)

17–21. **Third International Conference on Discrete Mathematics: Graph Theory and Discrete Geometry**, Dortmund, Federal Republic of Germany.
Information: T. Zamfirescu, Department of Mathematics, University of Dortmund, 4600 Dortmund 50, Federal Republic of Germany.

17–23. **Symmetry Methods in Differential Equations**, Utah State University, Logan, Utah.
Program: This conference is devoted to the theory and applications of Lie group techniques in differential equations. There will be survey lectures also on a variety of topics.
Information: I. Anderson, Department of Mathematics, Utah State University, Logan, Utah 84322, 801-750-2809.

22–25. **Second Annual Symposium on Logic in Computer Science**, Cornell University, Ithaca, New York. (November 1986, p. 962)

22–27. **Mathematiques et Sciences Humaines**, Marseille, France.
Information: A. Zeller-Meier, CIRM, Luminy Case 916, F-13288 Marseille Cedex 9, France.

22–27. **Paul Levy Conference on Stochastic Processes**, Ecole Polytechnique, Palaiseau, France.
Program: The program will consist of general sessions devoted to 50 minute invited lectures aimed at a wide range of probabilists, thematic sessions of 40 minute invited lectures on more specific themes, and 15 minute free communications.
Call for papers: Summaries of proposed communications for the free communications should be sent to the program committee no later than April 15, 1987. Summaries should be a page or less and be on Gaussian processes, Processes and Markovian field, Martingales and stochastic calculus, Brownian analysis, Fine study of Brownian motion, or Isoperimetric inequalities and minimal surfaces.
Information: M. Metivier, Conference Secretary, Ecole Polytechnique, 91128 Palaiseau, France.

23–26. **Sixth IMACS International Symposium on Computer Methods for PDE's**, Lehigh University, Bethlehem, Pennsylvania. (January 1986, p. 134)

23–27. **International Conference on Generalised Functions, Convergence Structures and Their Applications**, Dubrovnik, Yugoslavia. (June 1986, p. 560)

28–July 3. **Bonn Workshop on Foundations of Computing**, Bonn, Federal Republic of Germany.
Invited Speakers: R. Karp, H. Lenstra, L. Lovász, A. Odlyzko, M. Rabin, and V. Strassen.
Information: M. Karpinski, University of Bonn, Wegelerstrasse 6, Bonn, 5300 Bonn 1, Federal Republic of Germany. Telephone: (0228) 733419 or 738720.

28–July 4. **Harmonische Analyse und Darstellungstheorie Topologischer Gruppen**, Oberwolfach, Federal Republic of Germany.
Information: Mathematisches Forschungsinstitut Oberwolfach, Albertstrasse 24, D-7800 Freiburg, Federal Republic of Germany.

29–July 3. **Première Conférence Internationale sur les Mathématiques Appliquées et Industrielles**, Paris, France. (August 1986, p. 654)

29–July 4. **First Joint International Conference on Industrial and Applied Mathematics**, Paris, France.
Information: Deputy Secretary, The Institute of Mathematics and its Applications, Maitland House, Warrior Square, Southend-on-Sea, Essex SS1 2JY, England.

29–July 4. **Fonctions Automorphes**, Marseille, France.
Information: A. Zeller-Meier, CIRM, Luminy Case 916, F-13288 Marseille Cedex 9, France.

30–July 4. **Third International Seminar on Random Graphs and Probabilistic Methods in Combinatorics**, Poznań, Poland. (October 1986, p. 844)

JULY 1987

July–August. **Low Dimensional Topology Symposium**, University of Sussex, Brighton, Great Britain. (August 1986, p. 654)

1–18. **Dix-septieme Ecole d'Ete de Calcul des Probabilites**, Saint-Flour (Cantal), France.
Invited Speakers: L. Elie, D. Elworthy, and E. Nelson.
Information: P. Hennequin, Boîte Postale 45, 63170 Aubiere, France. Telephone: (73) 26-41-10.

5–18. **Conference Internationale de Theorie des Nombres (CITN)**, Université Laval, Québec, Canada.
Program: General audience lectures on topics like factorization methods, Kloosterman sums in analytic number theory, arithmetic of modular forms, elliptic curves or abelian varieties. There will also be specialized lectures, contributed papers, and poster sessions.
Call for papers: Write to the address below if you want to give a lecture or contribute a paper.
Information: CITN, Département de Mathématiques, Université Laval, Québec, P.Q., Canada G1K 7P4.

5–25. **Research Workshop on Banach Space Theory**, University of Iowa, Iowa City, Iowa.
Program: Daily seminar for survey talks and research problems. Opportunities for cross fertilization of ideas that may lead to joint research projects. Formal presentation of papers will be limited.
Information: B.-L. Lin, Department of Mathematics, University of Iowa, Iowa City, Iowa 52242, 319-335-0784.

6–10. **Third Gregynog Symposium on Differential Equations**, University of Wales, United Kingdom. (October 1986, p. 844)

6–16. **A Research Symposium in Complex Analysis**, Imperial College, South Kensington, London, England. (October 1986, p. 844)

10–11. **Logic and Linguistics Conference**, Stanford University, Stanford, California. (January 1987, p. 134)

13–17. **Automata, Languages, and Programming**, Karlsruhe, Federal Republic of Germany. (August 1986, p. 654)

13–17. **Eleventh British Combinatorial Conference**, London, United Kingdom. (November 1986, p. 962)

13–17. **Inequalities: Fifty Years on From Hardy, Littlewood and Polya**, University of Birmingham, Birmingham, England. (October 1986, p. 844)

13–17. **Sixth National Conference on Artificial Intelligence**, Seattle, Washington.
Information: S. Taglio, American Association for Artificial Intelligence, 445 Burgess Drive, Menlo Park, California 94025-3496, 415-328-3123.

13–23. **Group Actions on Manifolds**, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.
Program: Ten lectures by S. Cappell of New York University and about twenty other invited hour lectures.
Information: F. Quinn or B. Floyd, Mathematics Department, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.

19–24. **Conference on Potential Theory**, Charles University, Prague, Czechoslovakia. (June 1986, p. 560)

27–29. **SLU-GTE Conference on Commutative Harmonic Analysis**, Saint Lawrence University, Canton, New York. (January 1987, p. 134)

27–31. **International Symposium on Information and Coding Theory**, State University of Campinas, Campinas, Brazil. (January 1987, p. 134)

27–August 1. **Second Siegen Topology Symposium**, Siegen, Federal Republic of Germany.
Topics: Topics of the symposium will include linking phenomena, vector fields, immersions and other topics of a (differential) topological nature.
Information: U. Koschorke, Mathematik V, FB 6, Universität-GH Siegen, Postfach 210209, D 59 Siegen, Federal Republic of Germany.

27–August 8. **K-theory and its Applications**, Ibadan, Nigeria.
Program: The following courses will be given: Higher algebraic K-theory and connections between algebraic and topological K-theories; The functors $K0$, $K1$, $K2$, $K-n$; K-theory, algebraic geometry and arithmetic; and K-theory and operator algebras.

31–August 3. **Boston Workshop for Mathematics Faculty**, Wellesley College, Wellesley, Massachusetts. (January 1987, p. 134)

AUGUST 1987

1–6. **Fifth Conference on Graph Theory of China**, People's Republic of China. (August 1986, p. 654)

3–7. **Georgia Topology Conference**, University of Georgia, Athens, Georgia. (January 1987, p. 134)

3–7. **Second Howard University Symposium on Nonlinear Semigroups, Partial Differential Equations, and Attractors.**, Howard University, Washington, District of Columbia.
Topic: The subject matter of this conference will consist of investigations of nonlinear partial and integrodifferential equations by the method of nonlinear semigroups and the new techniques developed in recent years for the investigation of these types of equations by considering them as infinite-dimensional dynamical systems.
Information: T. Gill, Department of Mathematics, Howard University, Washington, District of Columbia 20059, 202-636-6830, or W. Zachary, Naval Research Laboratory, Washington, District of Columbia 20375, 202-767-2572.

3–21. **Mathematical and Statistical Developments of Evolutionary Theory**, Université de Montréal, Montréal, Canada. (January 1987, p. 134)

3–28. **Four-week Program on Robotics**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota.
Information: H. Weinberger, Institute for Mathematics and its Applications, University of Minnesota, 514 Vincent Hall, 206 Church Street S.E., Minneapolis, Minnesota 55455.

4–7. **Sixth International Conference on Mathematical Modelling: An Interdisciplinary Integrative Forum for Researchers and Educators in Engineering, Economics, Biological, Medical, Environmental, Social and other Sciences**, Washington University, St. Louis, Missouri. (*Note change from October 1986, p. 844)

5–7. **Workshop on Generic Families of Vector Fields**, Montreal, Canada.
Invited Speakers: J. Bélair, J. Carr, C. Chicone, J. Guckenheimer, W. Langford, R. Roussarie, C. Rousseau, S. Schecter, D. Schlomiuk, J. Sotomayor, and F. Takens.
Information: J. Bélair or C. Rousseau, Centre de Recherches Mathématiques, Université de Montréal, CP 6128-A, Montreal, Quebec, H3C 3J7 Canada.

9–15. **International Conference on Abelian Groups**, Perth, Western Australia. (June 1986, p. 560)

9–22. **Harmonic Analysis on Real and p-adic Groups**, Bowdoin College, Brunswick, Maine. (October 1986, p. 844)

10–13. **Sixth International Conference on Mathematical Modelling**, Washington University, Saint Louis, Missouri.
Information: E. Rodin, Department of Systems Sciences and Mathematics, Box 1040, Washington University, Saint Louis, Missouri 63130.

10–21. **Set Theory and its Applications–Conference at York**, York University, Toronto, Canada. (January 1987, p. 134)

16–21. **Sixteenth Conference on Stochastic Processes and their Applications**, Stanford University, Stanford, California. (August 1986, p. 654)

16–22. **Twenty-fifth International Symposium on Functional Equations**, Hamburg, Federal Republic of Germany.
Information: W. Benz, University of Hamburg, Bundesstrasse 55, D-2 Hamburg 13, Federal Republic of Germany.

17–20. **International Conference on Computational Techniques and Applications**, Sydney, Australia.
Information: C. Fletcher, CTAC-87, Department of Mechanical Engineering, University of Sydney, NSW 2006, Australia.

17–20. **International Conference on Rings, Modules, and Radicals**, Hobart, Tasmania. (June 1986, p. 560)

17–22. **Eighth International Congress of Logic, Methodology and Philosophy of Science**, Moscow, Union of Soviet Socialist Republics. (January 1987, p. 134)

18–21. **Third Conference on Numerical Methods and Approximation Theory**, University of Niš, Niš, Yugoslavia. (January 1987, p. 135)

24–28. **Conference on Differential Equations "Equadiff '87"**, Democritus University of Thrace, Greece. (January 1986, p. 134)

24–28. **International Conference on Web Geometry and Related Fields**, Szeged University, Szeged, Hungary. (June 1986, p. 560)

24–28. **Second International Conference on Combinatorial Mathematics and Computing**, Canberra, Australia. (March 1986, p. 370)

24–28. **Sixth National Conference on Artificial Intelligence**, Seattle, Washington. (March 1986, p. 370)

24–29. **Meeting on Geometry of Banach Spaces**, Mons, Belgium. (August 1986, p. 655)

31–September 4. **First International Conference on Statistical Data Analysis Based on the L_1-Norm and Related Methods**, University of Neuchâtel, Neuchâtel, Switzerland. (January 1987, p. 135)

SEPTEMBER 1987

7–9. **Summer Conference on Category Theory and Computer Science**, University of Edinburgh, Edinburgh, Scotland. (January 1987, p. 135)

7–11. **International Symposium on Harmonic Analysis**, Centre Universitaire de Luxembourg, Luxembourg.
Information: J.-P. Pier, Séminaire de Matématique, Centre Universitaire de Luxembourg, 162 A, Avenue de la Faiencerie, L 1511 Luxembourg.

8–11. **Third International Conference on the Teaching of Mathematical Modelling and Applications**, University of Kassel, Kassel, Federal Republic of Germany. (January 1987, p. 135)

9–11. **Seventh Gesellschaft für Angewandte Mathematik und Mechanik Conference on Numerical Methods in Fluid Mechanics**, Louvain-la-Neuve, Belgium.
Subjects: Theory of numerical methods in fluid mechanics: finite difference methods, finite element methods, spectral methods, etc. The emphasis will be on the development of novelties in methods. Application of numerical methods in fluid mechanical problems in Aerodynamics, Hydrodynamics, Propulsion, Fluidmachinery, Nuclear Reactor Technology, Meteorology, Biomechanics, etc.
Information: M. Deville, Unité de Mécanique Appliquée 2, Place du Levant, B-1348 Louvain-la-Neuve, Belgium.

9–11. **Twelfth Symposium on Operations Research**, University of Passau, Passau, Federal Republic of Germany.
Call for papers: Presentation is limited to twenty minutes. Please write to the address below for further information. The deadline for submission of abstracts will be June 15, 1987.
Information: F. Radermacher, Lehrstuhl für Informatik und Operations Research, Universität Passau, Innstrasse 27, 8390 Passau, Federal Republic of Germany. Telephone: 0851/509-341.

9–12. **Internationale Konferens über Anwendungen und Modellbildung im Mathematikunterricht**, Kassel, Federal Republic of Germany. (June 1986, p. 560)

9–12. **Sixth Aachen Symposium on Signal Theory: Multidimensional Signals and Image Processing**, Aachen, Federal Republic of Germany.
Topics: Topics will include Theory of Multi-dimensional signals, Image Processing Methods, Image Processing Technology, and Applications.
Call for Papers: Submit 300-word abstracts by April 30, 1987, to address below.
Information: D. Meyer-Ebrecht, Lehrstuhl für Messtechnik, Aachen University of Technology, 5100 Aachen, Templergraben 55, Federal Republic of Germany.

10–12. **Advances in Computational Modelling and Numerical Analysis**, University of Chicago, Chicago, Illinois.
Invited Speakers: D. Arnold, I. Babuška, J. Bramble, F. Brezzi, C. Douglas, R. Glowinski, H. Keller, J. Lions, M. Luskin, E. Magenes, J. Nedelec, V. Thomée, M. Wheeler.
Information: D. Arnold, Institute for Mathematics and its Applications, Vincent Hall 514, 206 Church Street, Southeast, Minneapolis, Minnesota 55455, 612-624-5878, extension 6066.

13–19. **Journées Arithmétiques 1987**, Ulm, Federal Republic of Germany. (June 1986, p. 560)

14–18. **Workshop on Polyhedral Combinatorics and Geometric Complexity**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota.
Information: H. Weinberger, Institute for Mathematics and its Applications, University of Minnesota, 514 Vincent Hall, 206 Church Street S.E., Minneapolis, Minnesota 55455.

20–26. **DMV-Jahrestagung 1987**, Berlin, Federal Republic of Germany. (June 1986, p. 560)

29–October 2. **Fifth International Symposium on Data Analysis and Informatics**, Versailles, France.
Topics: The topics of the symposium will be methods, practice, software aspects, and applications.
Information: Institut National de Recherche en Informatique et en Automatique, Service des Relations Extérieures, Bureau des Colloques, Domaine de Voluceau, Boîte Postale 105, 78153 Le Chesnay Cedex, France. Telephone: 33 (1) 39 63 56 00.

OCTOBER 1987

October. **87 ICAR-International Conference on Advanced Robotics**, Paris or Nice, France. (August 1986, p. 655)

October. **Journées Méthodes Numériques en Méchanique des Fluides**, Sophia-Antipolis, France. (August 1986, p. 655)

16–17. **Third Eastern Small College Computing Conference**, Marist College, Poughkeepsie, New York.
Purpose: The Eastern Small College Computing Conferences are designed to promote a free exchange of information among small college personnel concerned with the use of computers in the academic environment. They are intended for faculty and students in all academic disciplines as well as for directors and managers of academic computer facilities.
Information: B. Sadowski, Director of Academic Computing, Division of Computer Science and Mathematics, Marist College, Poughkeepsie, New York 12601, 914-471-3240.

26–31. **Mathematical Methods in Operations Research**, Sofia, Bulgaria. (January 1987, p. 135)

NOVEMBER 1987

9–December 18. **College on Riemann Surfaces**, Trieste, Italy.
Information: J. Eells, International Centre for Theoretical Physics, Post Office Box 586, Miramare, Strada Costiera 11, 34100 Trieste, Italy.

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FEBRUARY 1988

7–11. **1988 Australian Applied Mathematics Conference**, Leura, Australia.
Information: R. Grimshaw or W. McKee, School of Mathematics, University of New South Wales, Box 1, Kensington, New South Wales 2033, Australia.

MARCH 1988

14–18. **Second International Conference on Hyperbolic Problems**, Aachen, Federal Republic of Germany.
Program: The aim of the conference is to bring together scientists in the field for a presentation of recent results and to discuss future research. The main topics will be the theory of nonlinear hyperbolic systems, numerical methods for solving these systems, and applications.
Information: R. Jeltsch, Institut für Geometrie und Praktische Mathematik, RWTH Aachen, D-5100 Aachen, Federal Republic of Germany. Telephone: (0241) 80 39 50.

APRIL 1988

17–30. **The First Canadian Number Theory Society Conference**, Banff, Alberta, Canada.
Information: R. Mollin, University of Calgary, Department of Mathematics and Statistics, 2500 University Drive N.W., Calgary, Alberta, Canada T2N 1N4. (*Note correction from January 1987 issue.)

JUNE 1988

20–24. **International Algebra Conference**, Lisbon, Portugal.
Program: The topics will be Universal Algebra, Lattices, and Subgroups. There will be a number of invited speakers as well as contributed papers.
Call for papers: Persons intending to contribute papers should write to the address below.
Information: Centro de Algebra, Universidade de Lisboa, Rua Ernesto Vasconcelos, Bloco C1, 30 Piso, 1700 Lisboa, Portugal.

JULY 1988

10–16. **Representation Theory and Group Theory**, Manchester, England.
Information: R.T.G.T., Department of Mathematics, University of Manchester Institute of Science and Technology, Post Office Box 88, Manchester, M60 1QD, England.

13–20. **Edinburgh Mathematical Society's 1988 Saint Andrews Colloquium**, St. Andrews, Fife, Scotland.
Program: There will be three main lecture courses, the E. T. Copson Memorial Lectures, and additional research seminars.
Information: J. Langley, University of St. Andrews, Mathematical Insitute, North Haugh, St. Andrews KY16 9SS, Fife, Scotland.

17–27. **Ninth Congress of the International Association of Mathematical Physics**, Swansea, Wales.
Information: A. Truman, University College of Swansea, Department of Mathematics and Computer Science, Singleton Park, Swansea SA2 8PP, Wales.

18–22. **Twelfth IMACS World Congress on Scientific Computation**, Paris, France.
Information: P. Borne, IDN, Boîte Postale 48, 59651 Villeneuve d'Ascq, France or IMACS Secretariat, Department of Computer Science, Rutgers University, New Brunswick, New Jersey 08903.

23–August 3. **Sixth International Congress on Mathematical Education**, Budapest, Hungary.
Information: E. Poiani, Chairperson, USCMI, Department of Mathematics, Saint Peter's College, Jersey City, New Jersey 07306.

AUGUST 1988

9–12. **International Symposium in Real Analysis**, University of Ulster, Coleraine, Northern Ireland.
Information: P. Muldowney, University of Ulster, Northland Road, Londonderry BT48 7JL, Northern Ireland. Telephone: Londonderry (0504) 265621.

21–27. **Seventeenth International Congress of Theoretical and Applied Mechanics**, Grenoble, France. (January 1987, p. 135)

The Theory of Gauge Fields in Four Dimensions

H. Blaine Lawson

(CBMS Regional Conference Series, Number 58
Supported by the National Science Foundation)

Lawson's expository lectures, presented at a CBMS Regional Conference held in Santa Barbara in August 1983, provide an in-depth examination of the recent work of Simon Donaldson, of especial interest to both geometric topologists and differential geometers. This work has excited particular interest in light of Mike Freedman's recent profound results: the complete classification, in the simply connected case, of compact topological 4-manifolds. Arguing from deep results in gauge field theory, Donaldson has proved the nonexistence of differentiable structures on certain compact 4-manifolds. Together with Freedman's results, Donaldson's work implies the existence of exotic differentiable structures in R^4–a wonderful example of the results of one mathematical discipline yielding startling consequences in another.

The lectures are aimed at mature mathematicians with some training in both geometry and topology, but they do not assume any expert knowledge; in addition to a close examination of Donaldson's arguments, Lawson also presents as background material the foundation work in gauge theory (Uhlenbeck, Taubes, Atiyah, Hitchin, Singer, et al.) which underlies Donaldson's work.

Contents

1. Introduction
2. The Geometry of Connections
3. The Self-dual Yang-Mills Equations
4. The Moduli Space
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Stephen G. Simpson, Editor
(Contemporary Mathematics, Volume 65)

In recent years, several remarkable results have shown that certain theorems of finite combinatorics are unprovable in certain logical systems. These developments have been instrumental in stimulating research in both areas, with the interface between logic and combinatorics being especially important because of its relation to crucial issues in the foundations of mathematics which were raised by the work of Kurt Gödel. Because of the diversity of the lines of research that have begun to shed light on these issues, there was a need for a comprehensive overview which would tie the lines together.

This volume fills that need by presenting a balanced mixture of high quality expository and research articles that were presented at the August 1985 AMS-IMS-SIAM Joint Summer Research Conference, held at Humboldt State University in Arcata, California. With an introductory survey to put the works into an appropriate context, the collection consists of papers dealing with various aspects of "unprovable theorems and fast-growing functions." Among the topics addressed are: ordinal notations, the dynamical systems approach to Ramsey theory, Hindman's finite sums theorem and related ultrafilters, well quasiordering theory, uncountable combinatorics, nonstandard models of set theory, and a length-of-proof analysis of Gödel's incompleteness theorem. Many of the articles bring the reader to the frontiers of research in this area, and most assume familiarity with combinatorics and/or mathematical logic only at the senior undergraduate or first-year graduate level.

Contents

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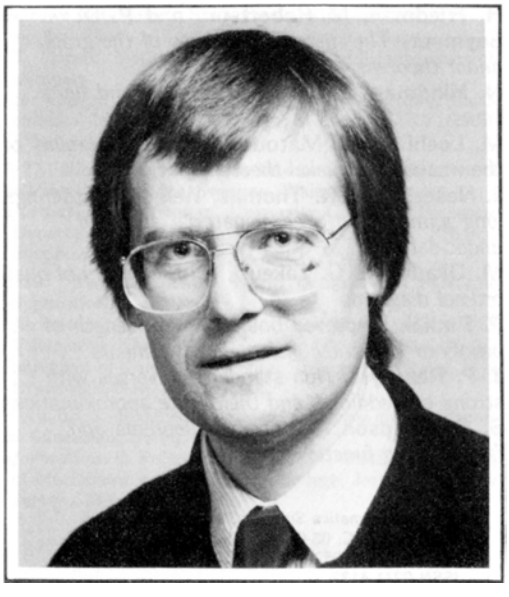
JORDAN ALGEBRAS IN ANALYSIS, OPERATOR THEORY, AND QUANTUM MECHANICS

Harald Upmeier

(CBMS Regional Conference Series, Number 67
Supported by the National Science Foundation)

This book is based on the CBMS Regional Conference held at the University of California, Irvine, on July 15–19, 1985. In recent years Jordan algebras have found interesting applications in seemingly unrelated areas of mathematics such as operator theory, the foundations of quantum mechanics, complex analysis in finite and infinite dimensions, and harmonic analysis on homogeneous spaces. The author describes some relevant results and puts them in a general framework, based on the concepts of JB-algebra and JB^*-triple.



BIOGRAPHY

Harald Upmeier is a Professor of Mathematics at the University of Kansas. After receiving his Ph.D. at the University of Tübingen, West Germany, in 1975, he taught at the University of Tübingen and the University of Pennsylvania. He also held a Senior Visiting Fellowship at the University of Edinburgh, Scotland, and was a Member of the Mathematical Sciences Research Institute in Berkeley. Professor Upmeier's field of research is operator theory and multivariable complex analysis. He is the author of the book, *Symmetric Banach Manifolds and Jordan C*-algebras*, published in 1985.

Contents

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Lieven LeBruyn
(Memoirs of the AMS, Number 363)

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Contents

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THE LIMITING ABSORPTION PRINCIPLE FOR PARTIAL DIFFERENTIAL OPERATORS

Matania Ben-Artzi and Allen Devinatz
(Memoirs of the AMS, Number 364)

This book is intended for those interested in scattering theory and the spectral theory of selfadjoint operators. It presents a unified abstract

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approach to limiting absorption principles for selfadjoint operators of the form $H = H_0 + V$, where the perturbation V is assumed to be "short range" with respect to H_0. Developing the abstract theory under a minimal number of assumptions, the authors prove the limiting absorption principle for H along with the discreteness and finite multiplicity of its eigenvalues embedded in the continuous spectrum. It is shown that a wide variety of concrete differential operators are easily subsumed under this theory including Schrödinger operators, generalizations of the Stark Hamiltonian, and simply characteristic differential operators. The authors' simple, unified approach leads to results not attainable by other techniques. The book assumes a knowledge of functional analysis, the classical theory of linear partial differential operators, and the simpler aspects of Fourier transform theory.

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E. F. Mishchenko, Editor-in-chief
(Proceedings of the Steklov Institute, Volume 169)

This collection contains surveys of work carried out at the Steklov Mathematical Institute in the areas of topology, ordinary differential equations and their applications, and dynamical systems. There is also a presentation of the history and creation of the mathematical theory of optimal processes and differential games. The collection is the second in a series published in connection with the fiftieth anniversary of the Institute.

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M. Enguehard and T. Peterfalvi
(Astérisque, Number 142–143)

Ce volume rassemble quatre textes qui rendent compte d'exposés faits au séminaire sur la théorie des groupes finis (Paris), en 1981, 1982, et 1983. Il s'agit d'une contribution au "programme de révision" dans les groupes finis, et on y traite des groupes simples finis du type de Lie de rang 1.

Dans "Obstructions et p-groupes de classe 3" (Michel Enguehard) est décrit un calcul élémentaire des obstructions dans un contexte assez général. Ce calcul est utilisé pour classifier certains p-groupes et leurs automorphismes, et parmi eux les normalisateurs des 3-groupes de Sylow des groupes de Ree.

Le second exposé est consacré à la caractérisation des groupes de Ree ${}^2G_2(q)$ par le centralisateur d'une involution, résultat obtenu grâce aux contributions de H. N. Ward, Z. Janko, J. G. Thompson, et E. Bombieri.

"Le théorème de Bender-Suzuki I" (Thomas Peterfalvi) expose la démonstration d'un théorème fondamental de H. Bender. Celui-ci classifie les groupes finis G qui possèdent un sous-groupe propre H d'ordre pair, tel que l'intersection de deux conjugués distincts de H soit d'ordre impair: les groupes simples qui satisfont cette condition sont les groupes du type de Lie de rang 1 en caractéristique 2. Cette démonstration s'appuie sur un théorème de M. Suzuki, qui donne la conclusion voulue dans le cas où G a une BN-paire scindée de rang 1. Le théorème de M. Suzuki est exposé avec certaines simplifications dans "le théorème de Bender-Suzuki II."

1980 *Mathematics Subject Classification*: 20
296 pages (softcover), 1986
Individual member $19, List price $27
To order, please specify AST/142/143N

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.

SUR LES COURBES INVARIANTES PAR LES DIFFÉOMORPHISMES DE L'ANNEAU, VOLUME II

M. R. Herman
(Astérisque, Number 144)

Ce volume 2 est consacré à de nouveaux théorèmes d'existence de courbes invariantes par les difféomorphismes de l'anneau qui sont des perturbations de difféomorphismes complètement intégrables déviant la verticale. Les nombres de rotations de ces courbes seront toujours de type constant. Classiquement, on considère des perturbations en topologie $C^{3+\beta}$, $\beta > 0$. Ce volume cherche à cerner l'étude en topologie C^3 ou dans des espaces de Besov. Ceci nécessite l'introduction systématique des espaces Sobolev.

Nous montrons au chapitre V la persistance des courbes invariantes par les difféomorphismes de classe C^3 préservant les aires, globalement canoniques, proches en topologie C^3 d'un difféomorphisme complètement intégrable. Au chapitre VI le théorème de la courbe translatée est généralisé aux perturbations dans des espaces de Besov et le chapitre VII contient une démonstration élémentaire de ce théorème pour les perturbations en topologie C^4. Le chapitre VIII permet d'expliquer mathématiquement l'existence de courbes invariantes pour certains homéomorphismes linéaires par morceaux du plan, préservant les aires, ce qui avait été constaté numériquement par l'astronome C. Froeschlé en 1968.

1980 *Mathematics Subject Classifications*: 57, 58
248 pages (softcover), 1986
Individual member $15, List price $22
To order, please specify AST/144N

SEMINAIRE BOURBAKI VOLUME 1985/86 EXPOSÉS 651-668

(Astérisque, Number 145–146)

Comme les précédents volumes de ce Séminaire, celui-ci contient 18 exposés de synthèse sur des sujets d'actualité: un de Géométrie, deux d'Algèbre, quatre de Géométrie algébrique, deux de Géométrie riemannienne, un de Géométrie analytique complexe, un de Géométrie symplectique, un de Théorie des nombres et deux d'Analyse.

On y fait, entre autres, le point sur le théorème de Torelli, sur les méthodes de Géométrie algébrique en théorie des nombres transcendants, les applications en Géométrie algébrique de l'application des moments, la finitude du nombre des cycles limites des champs de vecteurs quadratiques du plan et la décomposition des fonctions en séries d'ondelettes.

1980 *Mathematics Subject Classification*: 14
358 pages (softcover), 1986
Individual member $23, List price $33
To order, please specify AST/145/146N

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.

Unpublished Lecture Notes and Tapes

This section of *Notices* provides a forum for departments in the mathematical sciences, research institutes, and other organizations in the nonprofit sector to announce the availability of unpublished lecture notes. These may be in written form or in electronic form, i.e., audio and videotapes, videodiscs, etc. Readers are invited to submit material for this section and it will be published in the next available issue.

In addition to the initial listing of lecture notes and tapes, *Notices* will publish, in November, a complete list of material received during the year.

Items for inclusion in this section of *Notices* should be accompanied by the following information:

- Pertinent information regarding the medium in which the lecture notes are being presented;
- Name of author(s), title, year, number of pages or length of tape, price;
- Address for orders and information about payment (postal surcharge, if any, or whether postpaid, to whom checks should be made).

Items should be sent to the Providence office (*Notices* Lecture Notes and Tapes, American Mathematical Society, P.O. Box 6248, Providence, RI 02940).

Lecture Notes

The following lecture notes are available from the sources listed.

Queens College (CUNY)

1. Elliott Mendelson, "A First Course in Combinatorics and Probability," Lecture Notes of a Course for High School Teachers, Summer 1986 (128 pages), $11.
2. Elliott Mendelson, "First Steps in Logic," Lecture Notes of a Course for High School Teachers, Fall 1986 (approximately 140 pages), $12.

Checks or money orders should be made payable to Elliott Mendelson. Send orders to the author at the Department of Mathematics, Queens College, Flushing, New York 11367.

Middle East Technical University Bookstore

1. S. Friedberg, "Lectures on Modular Forms and Theta Series Correspondences," Middle East Technical University Foundation, 1985, $1 (postage not included).

Checks or money orders should be made payable to S. Friedberg. Send orders to the Middle East Technical University Bookstore, Ankara, Turkey.

University of Texas at Austin

1. Longhorn Notes, Texas Functional Analysis Seminar 1985–1986 (173 pages), $7 U.S./Canada/Mexico and $12 foreign.

Checks should be made payable to The University of Texas. Send prepaid orders to Longhorn Notes, Department of Mathematics, The University of Texas, Austin, Texas 78712.

CONTRIBUTIONS TO GROUP THEORY

Kenneth I. Appel, John G. Ratcliffe and Paul E. Schupp, Editors

This book, produced as a tribute to Roger Lyndon on his 65th birthday, contains five short articles on the man and his mathematics, and twenty-seven research papers on topics in combinatorial group theory, particularly those areas to which he himself had made important contributions (which is virtually no restriction at all). The more historical articles include an authoritative account by Saunders Mac Lane of the beginnings of the theory of spectral sequences. Among the topics which recur frequently in the research papers are cohomology, automorphism groups, the solubility of equations over groups, and connections with geometry, both classical and modern. Naturally, these papers vary in weight, but none is trivial, and some are important. Only the most determinedly finite of group theorists will want to ignore this book: most of us will enjoy it immensely.

– Graham Higman
University of Illinois, Urbana-Champaign

Contemporary Mathematics, Volume 33, November 1984, 519 pages (softcover)
Individual member $27, Institutional member $36, List price $45. To order, please specify CONM/33NA

Shipping/Handling: 1st book $2, each add'l $1, max. $25; by air, 1st book $5, each add'l $3, max. $100
Prepayment required. Order from American Mathematical Society, P.O. Box 1571, Annex Station Providence, RI 02901-9930, or call toll free 800-556-7774 to charge with VISA or MasterCard

Personal Items

F. Rudolf Beyl of Portland State University has been promoted from Assistant Professor to Associate Professor of Mathematical Sciences at that institution.

Peter L. Hammer director of RUTCOR (Rutgers University's Center for Operations Research at New Brunswick) was recently awarded the title of *Docteur es Sciences Honoris Causa* by the Swiss Federal Institute of Technology in Lausanne. The citation for the award reads: "In recognition to the dynamic researcher whose fundamental work in discrete mathematics has revealed profound connections between logic, computer science, and operations research."

Deaths

Gordon Chamness of Southern Illinois University at Edwardsville, died on August 7, 1986, at the age of 38. He was a member of the Society for 2 years.

Jerry L. Fields of the University of Alberta, Edmonton, Canada, died on October 28, 1986, at the age of 50. He was a member of the Society for 25 years.

Oscar Goldman of Bryn Mawr, Pennsylvania, died on December 17, 1986, at the age of 61. He was a member of the Society for 40 years.

Keet W. Halbert of Tallahassee, Florida, died on June 28, 1986. He was a member of the Society for 63 years.

Kurt A. Hirsch, Professor Emeritus of Queen Mary College, London, England, died on November 4, 1986, at the age of 80. He was a member of the Society for 37 years.

Walter Kaufmann-Bühler, Editor for Springer-Verlag, New York, died on December 22, 1986, at the age of 42. He was a member of the Society for 13 years.

Ralph W. Klopfenstein of Princeton, New Jersey, died on November 11, 1986, at the age of 63. He was a member of the Society for 28 years.

Geoffrey S. S. Ludford of Cornell University, died on December 11, 1986, at the age of 58. He was a member of the Society for 34 years. (See the News and Announcements section of this issue of *Notices*.)

Douglas C. McMahon of Arizona State University, died on January 3, 1987, at the age of 39. He was a member of the Society for 15 years.

Alexander M. Ostrowski of Certenago-Montagnola, Switzerland, died on November 20, 1986, at the age of 93. He was a member of the Society for 44 years. (See the News and Announcements section of this issue of *Notices*.)

Ernst Schwandt of the University of Wisconsin at Milwaukee, died on November 26, 1986, at the age of 61. He was a member of the Society for 26 years.

Thurston Shook of Thurston, Inc., Columbus, Ohio, died on January 22, 1987, at the age of 51. He was a member of the Society for 18 years.

Theodore N. Tracewell of California State University, Hayward, died October 6, 1986, at the age of 65. He was a member of the Society for 28 years.

Glenn G. Vogt of St. Louis, Missouri, died on September 21, 1986, at the age of 28. He was a member of the Society for 2 years.

Felix P. Welch, Cincinnati Professor Emeritus at Washington and Lee University, died on September 22, 1984, at the age of 78. He was a member of the Society for 47 years.

James H. Wilkinson, Chief Scientific Officer, National Physical Laboratory, Teddington, U.K., died on October 5, 1986, at the age of 67. He was a member of the Society for 24 years.

Visiting Mathematicians

(Supplementary List)

Mathematicians visiting other institutions during the 1986-1987 academic year have been listed in recent issues of *Notices*: August 1986, pages 672-673; October 1986, pages 851-852; November 1986, page 975; and January 1987, page 144. The listing below gives the name and home country, the host institution, period of visit, and field of special interest of additional visiting mathematicians.

Donald E. Myers (U.S.A.), Ecole Normale Superièure de Mines de Paris, France, January 1987 to June 1987, geology.

Svetlozar Rachev (Bulgaria), Wesleyan University, February 1987 to June 1987, probability.

Scott W. Williams (U.S.A.), Charles University, Prague, Czechoslovakia, August 1986 to June 1987, set-theoretic topology.

Yaochen Zhu (People's Republic of China), University of Southern Mississippi, January 1987 to May 1987, number theory.

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 12/15/86	Backlog of Printed Pages 5/31/86	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	6	5	6	7
Aequationes Math.	9	960	0	0	NR	14	16	21
Alg. Groups Geom.	4	600	0	0	7	8	14	15
Amer. J. Math.	6	1500	650	NR	9	19	25	29
Ann. of Math.	6	1200	800	100	18	14	16	21
Ann. Probab.	4	1600	650	700	18	17	20	23
Ann. Sci. Ecole Norm. Sup.	4	650	0	200	7	16	19	21
Ann. Statist.	4	1630	200	NR	15	12	13	14
Appl. Math. Optim.	6	600	400	NR	8	9	10*	10
Arch. Hist. Exact Scis.	8	800	0	0	10	9	10	11
Arch. Rational Mech. Anal.	16	1600	0	0	15-16	9	10	13
Bull. Austral. Math. Soc.	6	960	0	0	8	11	12	12
Bull. Soc. Math. France	4	NR	NR	NR	NR	16	18	19
Canad. J. Math.	6	1516	1400	256	24	15	19	26
Canad. Math. Bull.	4	NR	NR	230	NR	16	17	19
Comm. Algebra	12	2500	2575	927	12	14	16	16
Comm. Math. Phys.	20	3520	0	0	5	6	7	10
Comm. Partial Diff. Equations	12	1300	200	200	8–10	6	8	10
Computing	8	NR	NR	0	NR	8	10	12
Duke Math. J.	6	1100	250	100	10	9	11	18
Houston J. Math.	4	NR	NR	600	NR	24	33	33
Illinois J. Math.	4	NR	NR	645	NR	26	33	36
IMA J. Appl. Math.	6	700	0	100	9	8	9	10
IMA J. Math. Appl. Med. Biol.	4	350	80	0	6		NA	
IMA J. Math. Control Inform.	4	NR	NR	120	4–5	7	7	9
IMA J. Numer. Anal.	4	500	100	0	7	9	11	13
Indiana Univ. Math. J.	4	930	300	100	15	17	19	25
Inst. Hautes Etudes Sci. Publ. Math.	2	400	0	NA	12–18	24	36	39
Internat. J. Math. Math. Sci.	4	832	4	100	NR	11	14	18
Invent. Math.	12	2688	0	0	8.5	7	10	14
Israel J. Math.	12	1500		600	10	12	15	20
J. Algorithms	4	600	NR	NR	12	19	23	27
J. Amer. Statist. Assoc.	4	NR	NR	NR	NR	9	10	10
J. Assoc. Comput. Mach.	4	900	285	NR	24	10	11	16

Journal	Number Issues per Year	Approximate Number Pages per Year	Backlog of Printed Pages 12/15/86	Backlog of Printed Pages 5/31/86	Editor's Estimated Time for Paper Submitted Currently to be Published (In Months)	Observed Waiting Time in Latest Published Issue (In Months) Q_1	Observed Waiting Time in Latest Published Issue (In Months) M	Observed Waiting Time in Latest Published Issue (In Months) Q_3
J. Austral. Math. Soc. Ser. A	6	844	800	NR	22	19	21	23
J. Austral. Math. Soc. Ser. B	4	512	57	0	16	10	11	13
J. Comput. System Sci.	6	900	0	0	12–18	13	15	17
J. Differential Geom.	6	900	800	800	9	8	11	12
J. Math. Biol.	6	NR	NR	0	NR	7	7	9
J. Math. Phys.	12	3400	0	NR	7	7	8	11
J. Nigerian Math. Soc.	1	100	0	NR	12		NA	
J. Operator Theory	4	800	300	300	12	10	12	14
J. Symbolic Logic	4	1152	0	12	12–15	11	12	14
Linear Algebra Appl.	13	3900	600	NR	15	13	13	14
Manuscripta Math.	12	1536	0	0	5	5	7	7
Math. Ann.	12	2112	0	0	7	7	7	9
Math. Biosci.	10	NR	NR	150	NR	5	5	6
Math. Comp.	4	1500	60	100	12–15	10	12	15
Math. Oper. Res.	4	768	380	380	15	15	20	21
Math. Programming	9	1080	100	50	12	7	8	11
Math. Social Sci.	6	600	600	600	18		NA	
Math. Systems Theory	4	400	0	NR	6		NA	
Math. Z.	12	1824	0	0	11	12	15	16
Mem. Amer. Math. Soc.	6	2800	0	0	2	15	NA	19
Michigan Math. J.	3	480	0	0	16	13	14	18
Monatsh. Math.	8	NR	NR	0	NR	10	11	11
Numer. Funct. Anal. Optim.	12	1400	300	300	7	11	12	14
Numer. Math.	12	1416	0	0	6–8	8	8	8
Oper. Res.	6	1008	700	1725	24	18	21	24
Pacific J. Math.	10	2200	NR	0	11	13	14	18
Probab. Theor. Relat. Theor.	12	1920	0	0	9	8	9	13
Proc. Amer. Math. Soc.	12	2400	600	300	14	13	14	16
Proc. London Math. Soc.	6	NR	NR	300	NR	13	16	18
Quart. Appl. Math.	4	800	400	700	12	16	18	22
Quart. J. Math. Oxford Ser. (2)	4	512	100	60	14	11	13	16
Results Math.	2	768	0	NR	9	9	10	12
Rocky Mountain J. Math.	4	768	1100	900	28	23	24	33
Semigroup Forum	6	768	0	0	4	3	5	6
SIAM J. Algebraic Discrete Methods	4	650	0	NR	19	8	9	11
SIAM J. Appl. Math.	6	1380	320	NR	17	10	11	14
SIAM J. Comput.	6	1290	0	NR	17	13	14	16
SIAM J. Control Optim.	6	1686	457	NR	15	14	16	17
SIAM J. Math. Anal.	6	1878	593	NR	23	14	16	20
SIAM J. Numer. Anal.	6	1450	313	NR	18	12	15	16
SIAM J. Sci. Statist. Comput.	6	1500	250	NR	16	14	14	17
SIAM Rev.	4	620	155	NR	21	14	15	17
Topology Appl.	9	990	12	770	12		NA	
Trans. Amer. Math. Soc.	12	5000	0	200	10	12	15	17

NR means no response received.
NA means not available or not applicable.
* From date of acceptance.

Mathematical Sciences Assistantships and Fellowships

for Graduate Study at Universities in 1987–1988, Supplementary List

The entries below supplement the December 1986 Special Issue of the *Notices*

In the section on "number anticipated," the first number refers to the total number of assistantships and fellowships in the program. The second number following the colon is the number available to NEW students (first year or above). A dash is used to indicate "information not supplied by the department."

The number following "Faculty" is the number of faculty members in the department who are full time employees in the institution and at least half-time in the department; the number following "Published" is the number of those reported who have published a technical paper or book in the last three years.

The section on "Graduate Students" refers to the number of graduate students in the department who are full-time (including teaching assistants), full-time first year, and part-time. Information not supplied in any of these categories is indicated by a dash.

Under the DEGREES AWARDED column the following terms have been used:

Bachelor's by inst. . . . . Number of bachelor's degrees awarded by the institution
Bachelor's by dept. . . . . Number of bachelor's degrees awarded by the department
Master's by dept. . . . . Number of master's degrees awarded by the department
Ph.D. (83/86) . . . . . Doctoral degrees awarded during the last three years (1983–1984, 1984–1985 and 1985–1986)

Abbreviations used

ANT . . Algebra or Number Theory
AFA . . . Analysis or Functional Analysis
GT . . . Geometry or Topology
L . . . . . Logic
P . . . . . Probability
S . . . . . Statistics
CS . . . . Computer Science
OR . . . Operations Research
AM . . . Applied Mathematics
ME . . . Mathematics Education

Under the SERVICE REQUIRED column, hours per week section, "c" denotes contact hours.

TYPE OF ASSISTANCE (Total no. : no. anticipated)	STIPEND paid to student dollars	months	FEES paid by student ($)	SERVICE REQUIRED hours	type	DEGREES AWARDED Academic year 1985–1986

Alabama

Auburn University, Auburn University 36849

ALGEBRA, COMBINATORICS AND ANALYSIS
James R. Wall, Head
Applications due: 3/10/87*
Faculty 35; Published 27
Graduate Students: full-time 24; full-time first year 10; part-time 2

Bachelor's by inst. 3221
Master's by dept. 1
Ph. D. (83/86) ANT 3, AFA 1, L 1. Total: 5

Fellowship (1:1)	6000	9	1323		
Teaching Assistantship (20:8)	7020	9	1323	5[c]	Grading or teaching

*Late applications considered.

FOUNDATIONS, ANALYSIS AND TOPLOGY
George Kozlowski, Head
Applications due: 3/31/87*
Faculty 28; Published 17
Graduate Students: full-time 21; full-time first year 4; part-time 1

Bachelor's by inst. 3221
Bachelor's by dept. 37
Master's by dept. 11
Ph. D. (83/86) AFA 1. Total: 1

Fellowship (4:4)	1323–6000	9	1323		
Teaching Assistantship (23:6)	7020–14040	9	1323	5–10[c]	Teaching

*Late applications considered.

TYPE OF ASSISTANCE (Total no. : no. anticipated)	STIPEND paid to student dollars	months	FEES paid by student ($)	SERVICE REQUIRED hours	type	DEGREES AWARDED Academic year 1985–1986

Arizona

Arizona State University, Tempe 85287

MATHEMATICS
Philip A. Leonard, Acting Chair

Applications due: 3/15/87
Faculty 46; Published 28
Graduate Students: full-time 50; full-time first year 15; part-time 10

Bachelor's by inst. 4998
Bachelor's by dept. 19
Master's by dept. 3
Ph. D. (83/86) AFA 2, AM 1.
Total: 3

Teaching Assistantship (42:15)	7800–8500	9	1136	15	Teaching, grading

University of Arizona, Tucson 85721

MATHEMATICS
Alan C. Newell, Head

Applications due: 3/5/87
Faculty 52; Published 39
Graduate Students: full-time 60; full-time first year –; part-time 1

Bachelor's by inst. 3513
Bachelor's by dept. 23
Master's by dept. 7
Ph. D. (83/86) Other 8. Total: 8

Fellowship (2:2)	1000–2000	9	4260	
Teaching Assistantship (55:-)	7592–11388	9	1136	4[c]
Research Assistantship (5:5)	3487–8399	9	1136	10–20

Arkansas

Arkansas State University, State University 72467

COMPUTER SCIENCE, MATHEMATICS AND PHYSICS
J. L. Linnstaedter, Chairman

Applications due: 4/1/87
Faculty 24; Published 12
Graduate Students: full-time 20; full-time first year 10; part-time 3

Bachelor's by inst. 800
Bachelor's by dept. 60
Master's by dept. 11

Teaching Assistantship (13:7)	4250	9	*	3–10

*In-state tuition.

California

California Polytechnic State University, San Luis Obispo 93407

MATHEMATICS
T. Hale, Chair

Applications due: 4/1/87
Faculty 47; Published 13
Graduate Students: full-time 10; full-time first year –; part-time 5

Bachelor's by inst. 2828
Bachelor's by dept. 52
Master's by dept. 1

Part-time Instructor (9:5)	3736	9	*	3[c]	Teaching

*Registration fee: $234, nonresident: $94 quarter unit.

TUITION FELLOWSHIPS IN MATHEMATICS AT AUBURN UNIVERSITY

In addition to the Graduate Teaching Assistantships and the Fellowship announced in our regular department listing in this issue of the Notices, the Department of Foundations, Analysis, and Topology will award a number of Tuition Fellowships to qualified Graduate Teaching Assistants. These awards are funded by a grant from the TRW Foundation and will pay full tuition for the Fellows (approx. $1,323.00) for the '87–'88 academic year. Deadline for fellowship application is April 15.

The department offers programs leading to the Master's Degree and the Ph.D. in a number of areas of analysis, topology, set theory, and geometry. The department also offers programs in applied mathematics and has a number of faculty with experience doing applied mathematics at many of the most prestigeous scientific research installations in this country.

For more information and application forms, write to Dr. G. A. Kozlowski, Foundations, Analysis, and Topology, Division of Mathematics, Auburn University, AL 36849.

TYPE OF ASSISTANCE (Total no. : no. anticipated)	STIPEND paid to student dollars	months	FEES paid by student ($)	SERVICE REQUIRED hours	type	DEGREES AWARDED Academic year 1985–1986

Stanford University, Stanford 94305

COMPUTER SCIENCE — Applications due: 1/1/87 — Bachelor's by inst. 1649
Nils Nilsson, Chairman — Faculty 23; Published 20 — Master's by dept. 97
Graduate Students: full-time 331; full-time first year 110; part-time 82
Ph. D. (83/86) CS 38. Total: 38

Fellowship (49:–)	8325–12500	9	11358		Research
Teaching Fellowship (4:–)	8871	9	7068	20	Teaching
Teaching Assistantship (43:–)	8010–8595	9	7068	20	Teaching, grading
Research Assistantship (85:–)	8010–8595	9	7068	20	Research
Course Assistantship (2:–)	6600	9	7068	20	Grading

District of Columbia

Howard University, Washington 20059

MATHEMATICS — Applications due: 6/1/87 — Bachelor's by inst. 320
Isom Herron, Acting Chairman — Faculty 27; Published 15 — Bachelor's by dept. 5
Graduate Students: full-time 9; full-time first year 2; part-time 14 — Master's by dept. 1
Ph. D. (83/86) AM 1. Total: 1

Fellowship (1:–)	4500	12	2715		
Teaching Assistantship (9:–)	4493	9	3400		

Florida

Florida Institute of Technology, Melbourne 32901

MATHEMATICS AND COMPUTER SCIENCES — Applications due: Open — Bachelor's by inst. 432
Richard J. St. Andre, Chairman — Faculty 20; Published 6 — Bachelor's by dept. 39
Graduate Students: full-time 110; full-time first year 59; part-time 140 — Master's by dept. 80

Teaching Assistantship (15:8)	4050–6000	9	3900	20	Teaching

THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA

PROGRAM OF STUDY The department offers programs leading to the M.ED., M.A., M.S., and Ph.D. degrees. Our Ph.D. program is designed to provide students with the basic tools needed to initiate a research proposal leading to a thesis. We expect that those students entering our Ph.D. program will enroll in the year long courses dealing with algebra, analysis, geometry/topology Following this basic training a research topic is chosen and a program of research is developed in consultation with one or more members of the faculty.

The faculty, approximately 53, carry on a very active research program in the areas of algebra, algebraic geometry, analysis, combinatorics, computational number theory, differential equations, differential geometry, dynamical systems, mathematical physics, number theory, numerical analysis, probability and statistics, and many topics in applied mathematics. There is a separate committee on applied mathematics and an excellent inter-disciplinary program has been developed. A close relationship exists between the program in pure mathematics and applied mathematics allowing students a great deal of flexibility in planning their individual programs. **Prospective graduate students are encouraged to write to us and we will send them a summery of the research activities of the faculty.**

An important ingredient in any research program is the opportunity for the exchange of ideas. The department has a very active colloquia schedule. Besides these regularly scheduled weekly talks the department has also set aside "special years". During these special years several positions, both long and short term appointments, will be available for visiting faculty. During these special years, courses and workshops will be designed to efficiently make use of the many visitors who will be coming through and will provide a unique opportunity to learn the many facets of a subject area.

For the academic year, 1986–87, computational aspects of algebra and number theory, and of fluid dynamics has been emphasized.

Financial Aid The department plans to have approximately 70 teaching assistants for the academic year 1987–88. The teaching assistantship carries a stipend beginning at $7600 for 9 months plus full remission of out-of-state fees. The teaching load is 4 contact hours per week. Approximately 2-3 weeks before classes begin a program for new teaching assistants is offered by the department. This program is designed to prepare new graduate students to be effective teachers.

One fellowship is available with a stipend of $7600 plus remission of all registration fees. This carries no teaching duties. Approximately 2-3 graduate science fellowships are available for first year graduate students. These carry a stipend of $2000 and are in addition to the teaching assistantship.

Fees Out-of-state fees are waived for teaching assistants, but a registration fee of $568 is required each semester.

Tucson The Tucson metropoliten area has a population of 550,000. It is located in a valley surrounded by mountain ranges, some of which tower 7,000 feet above the city. The Mexican border is 65 miles south of the University. The winter climate is dry and mild; air conditioning makes the buildings pleasant in the summer. The surroundings lend themselves to various outdoor recreational activities. Classical concerts, theater, skiing, and mountain hiking are all readily available.

Applying Application forms for admission and financial assistance may be obtained from the department at the address given below. Credentials for admission are processed by the Graduate Committee of the department as they are received, and the student is notified as soon as possible. The Graduate Committee requests that the GRE scores also be submitted to the department. Applications for assistantships should be made prior to March 5, notification of awards is made by April 15.

Correspondence and Information Write to: William Yslas Vélez – Director of Graduate Studies
Department of Mathematics – University of Arizona – Tucson, AZ 85721

Equal Opportunity Employer/Affirmative Action

TYPE OF ASSISTANCE (Total no. : no. anticipated)	STIPEND paid to student dollars	months	FEES paid by student ($)	SERVICE REQUIRED hours	type	DEGREES AWARDED Academic year 1985–1986

University of Florida, Gainesville 32611

STATISTICS — Faculty 27; Published 25
Richard L. Scheaffer, Chairman — Graduate Students: full-time 43; full-time first year 14; part-time 7

Bachelor's by inst. 5728
Bachelor's by dept. 32
Master's by dept. 6
Ph. D. (83/86) S 2. Total: 2

Fellowship (1:–)					
Teaching Assistantship (–:10)	6318–9477	9	17/cr.hr.	13–20	Grading, teaching
Research Assistantship (–:2)	6318–9477	9	17/cr.hr.	13–20	Research

Hawaii

University of Hawaii, Honolulu 96821

PUBLIC HEALTH SCIENCES–BIOSTATISTICS — Applications due: 4/1/87
C. S. Chung, Chairman — Faculty 4; Published 4
Graduate Students: full-time 13; full-time first year 5; part-time –

Bachelor's by inst. 2680
Bachelor's by dept. 0
Master's by dept. 4
Ph. D. (83/86) S 4. Total: 4

Teaching Assistantship (1:1)	6918–7956	9	1110	20	Grading, teaching

Illinois

Northwestern University, Evanston 60201

ELECTRICAL ENGINEERING AND COMPUTER SCIENCE — Applications due: 1/15/87
Stephen S. Yau, Chairman — Faculty 38; Published 36
Graduate Students: full-time 220; full-time first year 80; part-time 17

Bachelor's by inst. 1481
Bachelor's by dept. 115
Master's by dept. 49
Ph. D. (83/86) CS 13, Other 5. Total: 18

Fellowship (14:12)	825–850*	9	Waived		
Teaching Assistantship (34:2)	800–850*	9	Waived	20	Teaching
Research Assistantship (40:–)	700–1000*	12	Waived	20	Research

*1986-1987 figures.

MATHEMATICS — Applications due: 1/1/87
R. Clark Robinson, Chair — Faculty 35; Published 22
Graduate Students: full-time 39; full-time first year 12; part-time 1

Bachelor's by inst. 1481
Bachelor's by dept. 27
Master's by dept. 5
Ph. D. (84/86) ANT 2, AFA 2, GT 1, P 1, S 1, CS 1, Other 8. Total: 16

Fellowship (12:12)	7110—7800	9	Waived	2–3[c]	Teaching
Teaching Assistantship (28:28)	7200–8000	9	Waived	2–3[c]	Teaching

Indiana

Purdue University, West Lafayette 47907

STATISTICS — Applications due: 2/1/87
Shanti S. Gupta, Head — Faculty 20; Published 19
Graduate Students: full-time 47; full-time first year 21; part-time 6

Bachelor's by inst. 5381
Bachelor's by dept. 8
Master's by dept. 8
Ph. D. (83/86) P 1, S 4. Total: 5

Fellowship (7:3)	6000–8500	12	304		
Teaching Assistantship (32:12)	5500–7500	10	304	6	Contract teaching
Research Assistantship (6:2)	6000–8000	12	304	15	Research

Maryland

Johns Hopkins University, Baltimore 21205

BIOSTATISTICS — Applications due: Open
Charles A. Rohde, Chairman — Faculty 12; Published 0
Graduate Students: full-time 23; full-time first year 8; part-time 2

Bachelor's by inst. 567
Bachelor's by dept. 0
Master's by dept. 4
Ph. D. (83/86) Other 4. Total: 4

School Scholarship (8:4)	3780	9	10400		

TYPE OF ASSISTANCE (Total no. : no. anticipated)	STIPEND paid to student dollars	months	FEES paid by student ($)	SERVICE REQUIRED hours	type	DEGREES AWARDED Academic year 1985–1986

University of Maryland Baltimore County, Catonsville 21228

APPLIED MATHEMATICS AND STATISTICS
James M. Greenberg, Chairman

Applications due: 2/15/87
Faculty 26; Published 20
Graduate Students: full-time 38; full-time first year 14; part-time 20

Bachelor's by inst. 1104
Bachelor's by dept. 9
Master's by dept. 5
Ph. D. (83/86) CS 1, Other 2. Total: 3

Teaching Assistantship (19:19)	7350–8300	9		15	Grading, teaching
Research Assistantship (2:2)	7350–8300	9		15	Research

Massachusetts

Boston University, Boston 02215

MATHEMATICS
Ralph B. D'Agostino, Chairman

Faculty 31; Published 27
Graduate Students: full-time 52; full-time first year 11; part-time 6

Bachelor's by inst. 3119
Bachelor's by dept. 33
Master's by dept. 15
Ph. D. (83/86) S 3, AM 1, Other 1. Total: 5

Fellowship (1:2)	6700–7000	9			
Teaching Fellowship (18:6)	6700–7000	9		20	Teaching, tutoring, grading
Research Assistantship (3:0)	6700–8000	9			Research

Minnesota

University of Minnesota, Minneapolis 55455

COMPUTER SCIENCE
David W. Fox, Head

Applications due: 2/1/87
Faculty 24; Published 14
Graduate Students: full-time 265; full-time first year 35; part-time 100

Bachelor's by inst. 5306
Bachelor's by dept. 118
Master's by dept. 43
Ph. D. (83/86) CS 21. Total: 21

Fellowship (7:7)	8000–14000	9			
Teaching Assistantship (80:15)	15200–18000	9	*	10–20	Teaching, research
Research Assistantship (55:varies)	15200–18000	9	*	10–20	Research

*Teaching and Research Assistantships are awarded a 25% or 50% appointment at the lower or high rate tuition. 50% at the low rate would pay $2533.33 per quarter.

Mississippi

University of Southern Mississippi, Hattiesburg 39406

COMPUTER SCIENCE AND STATISTICS
Jim Miller, Chairman

Applications due: 3/15/87
Faculty 17; Published 14
Graduate Students: full-time 50; full-time first year 20; part-time 25

Bachelor's by inst. 2170
Bachelor's by dept. 113
Master's by dept. 12

Teaching Assistantship (10:10)	5000	9	800	20	
Research Assistantship (4:4)	5000	9	800	20	

Missouri

University of Missouri–Kansas City 64110

MATHEMATICS
G. P. Barker, Chairman

Applications due: 4/15/87*
Faculty 14; Published 8
Graduate Students: full-time 9; full-time first year 7; part-time 7

Bachelor's by inst. 1988
Bachelor's by dept. 14
Master's by dept. 1
Ph. D. (83/86) ANT 2, AFA 1. Total: 3

Teaching Assistantship (5:5)	7500–7800	9	**	6[c]	

*To be sure of consideration.
**For students taking 9 credit hours per semester.

TYPE OF ASSISTANCE (Total no. : no. anticipated)	STIPEND paid to student dollars	months	FEES paid by student ($)	SERVICE REQUIRED hours	type	DEGREES AWARDED Academic year 1985–1986

New Jersey

Fairleigh Dickinson University, Teaneck 07666

MATHEMATICS AND COMPUTER SCIENCE
Richard Bronson, Chairman

Applications due: 3/15/87
Faculty 20; Published 5
Graduate Students: full-time 78; full-time first year 14; part-time 268

Bachelor's by inst. 1602
Bachelor's by dept. 35

Teaching Fellowship (7:4)	3600–4800	9		Varies	
Research Assistantship (1:1)	3600–4800	9		Varies	

Trenton State College, Trenton 08625

MATHEMATICS AND STATISTICS
Michael Iannone, Chairman

Applications due: 7/15/87*
Faculty 16; Published 5
Graduate Students: full-time 0; full-time first year 0; part-time 17

Bachelor's by inst. 800
Bachelor's by dept. 14
Master's by dept. 2

Teaching Fellowship (1:1)**	3000	10		15	Tutoring, proctoring
Part-time Assistantship (1:1)		10		7.5	Tutoring, proctoring

*Most such positions are filled during April and May.
**Tutoring only.

New York

Adelphi University, Garden City 11530

MATHEMATICS AND COMPUTER SCIENCE
William Steinmetz, Chairman

Applications due: 3/15/87
Faculty 14; Published 6
Graduate Students: full-time 11; full-time first year 5; part-time 51

Bachelor's by inst. 1410
Bachelor's by dept. 26
Master's by dept. 10
Ph. D. (83/86) ANT 1, AM 3, Other 1. Total: 5

Teaching Assistantship (5:–)	3600	9		20	Tutoring
Scholarship (6:–)	Full tuition			9	Note taking
Scholarship (9:–)	Half tuition			4	Note taking

City University of New York, Graduate Center, New York 10036

MATHEMATICS
Burton Randol, Executive Officer

Applications due: 2/1/87
Faculty 40; Published 40
Graduate Students: full-time 61; full-time first year 21; part-time 0

Ph. D. (83/86) ANT 7, GT 4, AM 2, Other 1. Total: 14

Fellowship (7:2)	2000–7000	9	Varies	Varies	Varies	
Teaching Assistantship (30:5)	2000–11000	9	Varies	3–8	Teaching	
Research Assistantship (8:3)	2000–7000	9	Varies	Varies	Research	

Cornell University, Ithaca 14853

COMPUTER SCIENCE
David Gries, Chairman

Applications due: *
Faculty 23; Published 23
Graduate Students: full-time 95; full-time first year 16; part-time 0

Bachelor's by inst. 4868
Bachelor's by dept. 83
Master's by dept. 20
Ph. D. (83/86) CS 22. Total: 22

Fellowship (23:–)	15000	9			
Teaching Fellowship (1:–)	7500	9			
Teaching Assistantship (32:–)	6000–6200	9		10–15	Teaching, grading
Research Assistantship (30:–)	6400	9		10–15	Research

*Fellowships: 1/15/87; assistantships: 3/15/87.

New York University, Courant Institute of Mathematical Sciences, New York 10012

COMPUTER SCIENCE
Cathleen S. Morawetz, Director, Courant Institute
Ralph Grishman, Chairman, Computer Science

Applications due: 12/16/86
Faculty 25; Published 25
Graduate Students: full-time 104; full-time first year 50; part-time 236

Bachelor's by inst. 1084
Bachelor's by dept. 103
Master's by dept. 83
Ph. D. (83/86) CS 14. Total: 14

Fellowship (4:3)	11500	12			
Teaching Assistantship (25:10)	11000	9	600	Individual	
Research Assistantship (40:10)	11000	9	600	Individual	

TYPE OF ASSISTANCE (Total no. : no. anticipated)	STIPEND paid to student dollars	months	FEES paid by student ($)	SERVICE REQUIRED hours	type	DEGREES AWARDED Academic year 1985–1986
MATHEMATICS				Applications due: 1/16/87		Bachelor's by inst. 1084
Cathleen S. Morawetz, Director, Courant Institute				Faculty 50; Published 50		Bachelor's by dept. 40
Henry P. McKean, Chairman, Mathematics				Graduate Students: full-time 124; full-time first year 36; part-time 46		Master's by dept. 19
Fellowship (15:3)	11500–13500	12				Ph. D. (83/86) ANT 4, AFA 22,
Teaching Assistantship (32:9)	9500	9	400		Teaching	GT 3, P 1, AM 14. Total: 14
Research Assistantship (20:6)	9500	9	400	Individual		

State University of New York at Albany 12222

COMPUTER SCIENCE				Applications due: 3/15/87		Bachelor's by inst. 1800
Richard E. Stearns, Chair				Faculty 15; Published 14		Bachelor's by dept. 101
				Graduate Students: full-time 63; full-time first year 24; part-time 51		Master's by dept. 26
Fellowship (1:–)	8000	9			Research	
Teaching Assistantship (23:4)	6150–7200	9		20	Grading, teaching	
Research Assistantship (2:1)	7000–9000	10–12		20	Research	

State University of New York at Binghamton 13901

MATHEMATICAL SCIENCES				Applications due: 3/15/87		Bachelor's by inst. 2011
David L. Hanson, Chairman				Faculty 29; Published 22		Bachelor's by dept. 164
				Graduate Students: full-time 51; full-time first year 21; part-time 15		Master's by dept. 17
Teaching Assistantship (34:10)	6000–8500	9	Waived	5–15	Teaching, grading	Ph. D. (83/86) ANT 1, GT 3,
Research Assistantship (3:0)	6500–8500	9	Waived	15	Research	S 1, CS 1. Total: 6
Special Teaching Assistantship (1:1)	10000	12	Waived	5–15	Teaching	

Syracuse University, Syracuse 13210

COMPUTER AND INFORMATION SCIENCE				Applications due: 3/1/87		Bachelor's by inst. 2633
Ernest Sibert, Dean				Faculty 16; Published –		Bachelor's by dept. 44
				Graduate Students: full-time 78; full-time first year 27; part-time 149		
Fellowship (5:Varies)	6800	9				Ph. D. (83/86) CS 9. Total: 9
Teaching Assistantship (21:6)	7400	9		20	Teaching, grading	
Research Assistantship (15:4)	14000	12		20–40		

North Carolina

North Carolina State University, Raleigh 27695

OPERATIONS RESEARCH				Applications due: 2/15/87		Bachelor's by inst. 3193
Salah E. Elmaghraby, Director				Faculty 4; Published 4		Bachelor's by dept. 0
				Graduate Students: full-time 41; full-time first year 15; part-time 15		Master's by dept. 2
Fellowship (2:2)	3000–12000	9				Ph. D. (83/86) OR 8. Total: 8
Teaching Assistantship (12:14)	5500–7500	9	810	20		
Research Assistantship (6:8)	8250–10500	12	810	20		

Ohio

Ohio State University, Columbus 43210

COMPUTER AND INFORMATION SCIENCE				Applications due: 2/1/87		Bachelor's by inst. 6769
Mervin E. Muller, Chairman				Faculty 38; Published 38		Bachelor's by dept. 421
				Graduate Students: full-time 186; full-time first year 61; part-time 34		Master's by dept. 40
Fellowship (8–10:8–10)	8505*	12				Ph. D. (83/86) CS 28. Total: 28
Teaching Assistantship (80:–)	8505–9180	9		20	Teaching, grading	
Research Assistantship (–:–)	11340–12240	12		20	Research	

*Supplemented by Department to $11,340.

TYPE OF ASSISTANCE (Total no. : no. anticipated)	STIPEND paid to student dollars	months	FEES paid by student ($)	SERVICE REQUIRED hours	type	DEGREES AWARDED Academic year 1985–1986

Pennsylvania

Lehigh University, Bethlehem 18015

MATHEMATICS — Applications due: 2/28/87 — Bachelor's by inst. 925
Eric P. Salathé, Chairman — Faculty 32; Published 30 — Bachelor's by dept. 9
Graduate Students: full-time 36; full-time first year 12; part-time 3 — Master's by dept. 3

Fellowship (6:6)	4500–8000	9				Ph. D. (83/86) AFA 1, Other 1.
Teaching Assistantship (–:26)	6800–7200	9		4[c]		Total: 2
Research Assistantship (–:1)	7000	9		16		

Wilkes College, Wilkes-Barre 18766

MATHEMATICS AND COMPUTER SCIENCE — Applications due: 2/1/87 — Bachelor's by inst. 475
Richard E. Sours, Chairman — Faculty 14; Published 2 — Bachelor's by dept. 25
Graduate Students: full-time 0; full-time first year 0; part-time 10 — Master's by dept. 0

Teaching Assistantship (2:2)	2500	9	1050	6–8	Teaching

Rhode Island

University of Rhode Island, Kingston 02881

MATHEMATICS — Applications due: 4/15/87 — Bachelor's by inst. 2225
John T. Montgomery, Acting Chairman — Faculty 21; Published 18 — Bachelor's by dept. 37
Graduate Students: full-time 22; full-time first year 9; part-time 15 — Master's by dept. 3

Fellowship (1:0)	5500–6000	9	200		Research	Ph. D. (83/86) AM 1. Total: 1
Research Assistantship (15:8)	6000–7000	9	200	3–6[c]	Teaching	

South Carolina

Medical University of South Carolina, Charleston 29425

BIOMETRY — Applications due: 3/31/87 — Master's by dept. 5
M. Clinton Miller III, Chairman — Faculty 14; Published 14
Graduate Students: full-time 21; full-time first year 4; part-time 15

Fellowship (6:3)	6552	12		Ph. D. (83/86) S 3, CS 2.
Research Assistantship (1:1)	9000–9600	12		Total: 5
Assistantship (8:8)	9000	12	450	

Tennessee

University of Tennessee, Knoxville 37996

COMPUTER SCIENCE — Applications due: 3/1/87 — Bachelor's by inst. 3357
Jesse Poore, Chairman — Faculty 12; Published 6 — Bachelor's by dept. 51
Graduate Students: full-time 102; full-time first year –; part-time – — Master's by dept. 27

Fellowship (1:1)	4000	10	68		
Teaching Assistantship (23:23)	6300–7000	9	68	20	Grading, teaching

MATHEMATICS — Applications due: 3/1/87* — Bachelor's by inst. 3357
John S. Bradley, Head — Faculty 44; Published 38 — Bachelor's by dept. 23
Graduate Students: full-time 52; full-time first year 8; part-time 5 — Master's by dept. 15

Teaching Fellowship (2:2)	9000**	9***	195	4[c]	Teaching	Ph. D. (83/86) AFA 1, GT 3,
Teaching Assistantship (33:13)	7000–7900**	9***	195	6–8[c]	Teaching	AM 3. Total: 7
Research Assistantship (2:0)	11500	12	2020	20	Research	
Science Alliance Teaching Assistantship (10:0)	9200–11236**	9***	195	4–8[c]	Teaching	
Science Alliance Associateship (3:3)	10000-10900**	9***	195	6–8[c]	Teaching	

*Late applications accepted.
**1986-1987 figure; increase expected for 1987-1988.
***Summer support normally available.

UNIVERSITY OF TENNESSEE, KNOXVILLE **** GRADUATE STUDY IN APPLIED AND PURE MATHEMATICS

PROGRAMS OF STUDY. The Department of Mathematics offers M.S., M.M., and Ph.D. degrees in a wide variety of areas. Broadly based programs are encouraged. Thesis and non-thesis options are available to M.S. candidates. The department is energetically engaged in research. Currently, it has 45 faculty and regularly hosts visiting faculty. Major fields of research include algebra and number theory, analysis (classical, functional, harmonic), applied mathematics, mathematical ecology, matrix theory, numerical analysis (linear algebra, ordinary and partial differential equations), integral, ordinary and partial differential equations, mathematical physics, probability and statistics, geometric topology, transformation groups, and topological algebra. Faculty and students are currently engaged in joint work in computer science, ecology, management science, education, electrical and nuclear engineering, and engineering mechanics. The Department maintains close contact with Oak Ridge National Laboratory and the Tennessee Valley Authority.

FINANCIAL AID. The department is offering to one or two outstanding candidates the Dryzer Teaching Fellowship, which for 1986-1987 carries support of $10,504 to $13,748, including tuition remission, and a reduced teaching load; the net stipend for a recipient is $9,000. Regular Teaching Assistantship support, ranging this year from $8,506 to $12,648, including remitted tuition, is available to qualified students; the net stipends to students range from $7,002 to $7,900. An increase in all stipends for 1987-1988 is anticipated. Because of its membership in a state-funded Center of Excellence program at UTK, the Department expects to have at least three Science Alliance Associateships for 1987-1988; see below for more details. For all awards, continuation of support, including assistantship and remitted tuition, is normal for students making satisfactory progress in their academic and teaching programs. The only fee for which the awardee is responsible is a $65/quarter maintenance charge. Teaching Assistants who wish to do so normally are able to teach a course during the summer for an additional stipend of at least $1,300. Other support, in the form of Research Assistantships through departmental grants or from the Oak Ridge National Laboratory, is often available.

ENVIRONMENT. The University of Tennessee, Knoxville, is located along the Tennessee River with the Cumberland Mountains to the north, the Cumberland Plateau to the west and southwest, and the Great Smoky Mountains to the east and southeast. many lakes, national forests and wilderness areas are nearby. Places to fish, water ski, canoe, sail, hike, rock climb, backpack, camp, and go caving or whitewater rafting are numerous. snow skiing is available at several sites within three hours driving time. University affiliated clubs participate in many of these activities.The population of the city of Knoxville is 175,045; the metropolitan area contains a population of 565,970. For January the average low temperature is 32°F. For July the average low is 68° and the average high is 88°F. University housing on or near campus is available for both single and married students. Bus service is available.

THE SCIENCE ALLIANCE CENTER OF EXCELLENCE

The Science Alliance is a strong working partnership between the resources of The University of Tennessee, Knoxville and the Oak Ridge National Laboratory. It provides an extraordinary concentration of people, facilities and funds to support scientific research, technological development, and educational excellence in a variety of disciplines. As a participant in the Science Alliance, the Department of Mathematics enjoys many benefits, some of which are described here.

The **Distinguished Scientist Program** attracts scientists of international stature, each of whom holds a tenured professorship at UTK and a distinguished research position at ORNL with total annual support in excess of $200,000. Mathematics already has attracted Dr. J. Alan George in Numerical Linear Algebra as a Distinguished Scientist and is actively seeking additional individuals.

Science Alliance funding permits the department to increase significantly its **visitor program.** A large number of outstanding research mathematicians regularly visit for several days to a year and interact with both faculty and students. Each year several areas of research are identified for special emphasis. There will be a **Special Year in Numerical Linear Algebra** in 1987-1988; several international leaders in that area already have agreed to participate.

In addition to having their educations enriched through interaction with Distinguished Scientists and visitors, mathematics graduate students benefit from the availability of Science Alliance funding for assistantship supplements which, for more advanced students, often are combined with reduced teaching loads. In summer 1986 and academic year 1986-1987 twenty-five such awards have been made.

For the 1987-1988 academic year the department anticipates awarding at least three **Science Alliance Associateships** to incoming students. Each of these consists of a standard teaching assistantship plus a $3,000 Science Alliance supplement. For 1986-1987 these awards carry support of $11,504 to $15,648, including tuition remission; the net stipend for a recipient $10,002 to $10,900. An increase in stipends for 1986-1987 is anticipated. **All applicants for teaching assistantships are considered automatically for these and all other special awards.**

FOR INFORMATION, write to: Dr. John S. Bradley, Head, Department of Mathematics, University of Tennessee, Knoxville, Tennessee 37996-1300.

TYPE OF ASSISTANCE (Total no. : no. anticipated)	STIPEND paid to student dollars	months	FEES paid by student ($)	SERVICE REQUIRED hours	type	DEGREES AWARDED Academic year 1985–1986	

Texas

Midwestern State University, Wichita Falls 76308

MATHEMATICAL SCIENCES — Applications due: 4/1/87 — Bachelor's by inst. 800
Louie C. Huffman, Director — Faculty 12; Published 5 — Bachelor's by dept. 20
Graduate Students: full-time 7; full-time first year 4; part-time 50 — Master's by dept. 5

Teaching Assistantship (4:4)	5000–5200	9		8[c]	Teaching	

Virginia

Virginia Commonwealth University, Medical College of Virginia, Richmond 23298

BIOSTATISTICS — Applications due: 4/1/87 — Master's by dept. 2
Walter H. Carter, Jr., Chairman — Faculty 11; Published 5
Graduate Students: full-time 12; full-time first year 5; part-time 5

Fellowship (3:–)	7500					Ph. D. (83/86) S 12. Total: 12
Teaching Fellowship (4:–)	7500	12		20		
Teaching Assistantship (4:–)	7500	12		20		

Virginia Polytechnic Institute and State University, Blacksburg 24061

STATISTICS — Applications due: 1/31/87 — Bachelor's by inst. 3689
Klaus Hinkelmann, Head — Faculty 20; Published 20 — Bachelor's by dept. 12
Graduate Students: full-time 56; full-time first year 23; part-time 0 — Master's by dept. 14

Teaching Assistantship (33:–)	7470–8055	9	*	20	Teaching, grading, consulting	Ph. D. (83/86) S 16. Total: 16
Research Assistantship (8:–)	7470–8055	9	*	20	Research, consulting	

*In-state: $846; out-of-state: $936. Out-of-state differential will be waived for students on support who are paid a minimum of $2000 per year.

Washington

University of Washington, Seattle 98195

APPLIED MATHEMATICS — Applications due: 2/1/87 — Bachelor's by inst. 4803
Frederic Y. M. Wan, Chairman — Faculty 8; Published 8 — Master's by dept. 6
Graduate Students: full-time 34; full-time first year 6; part-time 8

Fellowship*	7000	9	282			Ph. D. (83/86) AM 3. Total: 3
Teaching Assistantship*	6408–7398	9	282	20	Grading	
Research Assistantship*	6408–7398	9	282	20	Research	

*Competitive.

BIOSTATISTICS — Applications due: 4/15/87 — Bachelor's by inst. 4803
Gerald van Belle, Director — Faculty 24; Published 24 — Bachelor's by dept. 0
Graduate Students: full-time 72; full-time first year 18; part-time 0 — Master's by dept. 2

Fellowship (2:–)	6552	12				Ph. D. (83/86) S 5. Total: 5
Teaching Assistantship (2:–)	9168–9864	12	376	20	Grading, teaching	
Research Assistantship (10:–)	9168–9864	12	376	20	Research	

COMPUTER SCIENCE — Applications due: 2/1/87 — Bachelor's by inst. 4803
Paul Young, Chairman — Faculty 21; Published 21 — Master's by dept. 20
Graduate Students: full-time 135; full-time first year 24; part-time 15

Teaching Assistantship (15:10)	712–733	9	Waived	20	Office hours, grading	Ph. D. (83/86) CS 18. Total: 18
Research Assistantship (35:1–2)	712–733	9	Waived	20	Research	

TYPE OF ASSISTANCE (Total no. : no. anticipated)	STIPEND paid to student dollars	months	FEES paid by student ($)	SERVICE REQUIRED hours	type	DEGREES AWARDED Academic year 1985–1986

Wisconsin

University of Wisconsin-Madison, Madison 53706

INDUSTRIAL ENGINEERING
D. Gustafson, Chairman

Applications due: 1/15/87
Faculty 17; Published 17
Graduate Students: full-time 58; full-time first year 9; part-time –

Fellowship*	8329	9	**	half-time		

*Varies.
**Resident: $1128; nonresident: $3383.

Bachelor's by inst. 5743
Bachelor's by dept. 83
Master's by dept. 14
Ph. D. (83/86) Other 10.
Total: 10

Canada

Carleton University, Ottawa, Ontario K1S 5B6

MATHEMATICS AND STATISTICS
B. M. Puttaswamaiah, Chairman

Applications due: 3/1/87
Faculty 35; Published 24
Graduate Students: full-time 28; full-time first year –; part-time 21

Teaching Fellowship (29:–)	4844	9	1366–5747	2 sem.	
Teaching Assistantship (18:–)	1000–5500	12	1366–5747	10	Grading, teaching
Research Assistantship (16:–)	1000–6500	12	1366–5747		

Bachelor's by inst. 2487
Bachelor's by dept. 121
Master's by dept. 13
Ph. D. (83/86) ANT 5, AFA 1, P 2, S 3, AM 1. Total: 12

Lakehead University, Thunder Bay, Ontario P7B 5E1

MATHEMATICAL SCIENCES
C. F. Kent, Chairman

Applications due: Open
Faculty 15; Published 10
Graduate Students: full-time 2; full-time first year 2; part-time –

Teaching Assistantship*	4500	9	**	10	Grading
Scholarship (3:–)	1800				

*Unlimited.
**Canadian and landed immigrant: $1500 per year; visa students: $2500 per term.

Bachelor's by inst. 1073
Bachelor's by dept. 32
Master's by dept. 2

Université Laval, Québec, Québec G1K 7P4

MATHÉMATIQUES, STATISTIQUE, ET ACTUARIEL
Robert Côté, Directeur

Applications due: 2/1/86
Faculty 36; Published 28
Graduate Students: full-time 34; full-time first year 13; part-time 12

Students getting financial aid receive a minimum of $6000 for mixed duties. Knowledge of French required.

Bachelor's by inst. 3435
Bachelor's by dept. 60
Master's by dept. 10
Ph. D. (83/86) ANT 1, AFA 3, L 1, P 1, AM 4. Total: 10

Université de Montréal, Montréal, Québec H3C 3J7

MATHÉMATIQUES ET STATISTIQUE
Pierre Berthiaume, Directeur

Faculty 42; Published 34
Graduate Students: full-time 69; full-time first year 12; part-time 43

Teaching Fellowship (17:–)	1650–6600	8	*	1–4[c]	Teaching
Teaching Assistantship (68:–)	2172	8	*	2[c]	Teaching
Research Assistantship (19:–)	1800–6300	9	*		Grading, research
Scholarship (32:–)	3000–11800	12	*		Grading

*$555; visa students without agreement between their country and Québec: $8700.

Bachelor's by inst. 3609
Bachelor's by dept. 43
Master's by dept. 30
Ph. D. (83/86) ANT 3, AFA 6, S 6, AM 2. Total: 17

University of Saskatchewan, Saskatoon, Saskatchewan S7N 0W0

MATHEMATICS
R. Manohar, Head

Applications due: 3/1/87
Faculty 29; Published 20
Graduate Students: full-time 17; full-time first year 7; part-time 1

Fellowship (6:Unlimited)	9000–13000	12	1200		
Teaching Assistantship (8:3)	8200	12	1200	12	Tutorials
Research Assistantship (3:3)	8200	12	1200	12	Research

Bachelor's by inst. 2129
Bachelor's by dept. 24
Master's by dept. 3
Ph. D. (83/86) ANT 1. Total: 1

TYPE OF ASSISTANCE (Total no. : no. anticipated)	STIPEND paid to student dollars	months	FEES paid by student ($)	SERVICE REQUIRED hours	type	DEGREES AWARDED Academic year 1985–1986	

University of Western Ontario, London, Ontario N6A 5B7

COMPUTER SCIENCE
I. Gargantini, Chairman

Applications due: 4/30/87
Faculty 20; Published 19
Graduate Students: full-time 22; full-time first year 18; part-time 21

Bachelor's by inst.	4709				
Bachelor's by dept.	111				
Master's by dept.	7				
Teaching Assistantship (15:–)	8500–11500	12	10	Teaching	
Research Assistantship (2:–)	8500–11500	12	10	Research	
OGS (–:–)	8760	12			
NSERC (–:–)	11600	12			

Erratum

The number of full-time faculty members who have published a technical paper or book in the last three years at the UNIVERSITY OF COLORADO, BOULDER, Department of Mathematics, should have been 33.

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Critical, Historical, or Expository Theses

Supplementary List

The list below supplements the list published on pages 1120-1121 of the December 1986 *Notices*. These additional departments gave affirmative responses to the question: Will your department accept a critical, historical, or expository thesis of sufficiently high quality for the Ph.D. degree? D.A. degree? or other degree?

California

Stanford Univ
Computer Science — Ph.D.

Illinois

Northwestern Univ
Mathematics — Ph.D.

Massachusetts

Boston Univ
Mathematics — Ph.D.

New York

Adelphi Univ
Mathematics and Computer Science — D.A.
New York Univ, Courant
Mathematics — Ph.D.

Ohio

Ohio State Univ
Computer and Information Science — Ph.D.

South Carolina

Medical Univ of South Carolina
Biometry — Ph.D.

Postdoctoral Research Fellowships and/or Instructorships 1987-1988

Supplementary List

The list below supplements the list published on pages 1122-1123 of the December 1986 *Notices*. This data was collected from responses to a new question on the "Assistantships and Fellowships in the Mathematical Sciences 1987–1988" form. The first number refers to the total number in the department. The second number following the colon is the number available for 1987–1988. An asterisk is used to indicate that "no information was supplied" by the department.

California

Stanford Univ
Computer Science — 7:*

District of Columbia

Howard Univ
Mathematics — 1:*

Florida

Florida Inst of Tech
Mathematics and Computer Science — 2:2

Illinois

Northwestern Univ
Mathematics — 5:2

Indiana

Purdue Univ
Statistics — 1:1

Massachusetts

Boston Univ
Mathematics — 1:1

Minnesota

Univ of Minnesota
Biometry — 2:0

New York

New York Univ, Courant
Mathematics — 20:20
Syracuse Univ
Computer and Information Science — 4:2

Pennsylvania

Lehigh Univ
Mathematics — 1:1

South Carolina

Medical Univ of South Carolina
Biometry — 2:2

Washington

Univ of Washington
Biostatistics — 3:0

Canada

Univ of Saskatchewan
Mathematics — 4:*

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Applied Cryptology, Cryptographic Protocols, and Computer Security Models
Richard A. DeMillo, George I. Davida, David P. Dobkin, Michael A. Harrison, and Richard J. Lipton

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Southern Methodist University

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Recent Appointments

Committee members' terms of office on standing committees expire on December 31 of the year given in parentheses following their names, unless otherwise specified.

James G. Glimm (1988), William H. Jaco (1988), Irwin Kra (1988), Paul H. Rabinowitz (1988), Audrey Terras (1988), and William A. Veech (1988) have been appointed to the *Committee on Committees* by President George Daniel Mostow. Professor Jaco will serve as chairman.

S. Y. Cheng was appointed by Ex-President Irving Kaplansky to the *Committee on Translation from Chinese.* Other members of the committee are Sun-Yung Alice Chang, Tsit-Yuen Lam, chairman, Tai-Ping Liu, and Chung-Chun Yang.

President George Daniel Mostow has appointed Nagayoshi Iwahori, Tosio Kato, Shoshichi Kobayashi, Masayoshi Nagata, and Katsumi Nomizu to the *Committee on Translation from Japanese.* Professor Nomizu will serve as chairman.

Constatine M. Dafermos, David S. Kinderleher, Eduardo Daniel Sontag, and Jean E. Taylor have been appointed by Ex-President Irving Kaplansky to the ad hoc *Committee on Applied Mathematics.* Professor Taylor will serve as chairman.

Ronald L. Lipsman (1989), David A. Sanchez (1989), and William P. Thurston (1989) have been appointed to the *Committee on Science Policy* by President George Daniel Mostow. Ronald G. Douglas (1989) has been reappointed and appointed chairman. Continuing members of the committee are Hyman Bass (1987), Felix E. Browder (1987), Carl-Wilhelm R. de Boor (1988), Frederick W. Gehring (1987), James W. Maxwell (ex officio), Robert Osserman (1988), Judith D. Sally (1988), and Guido L. Weiss (1988).

Jean H. Bevis, Sylvia T. Bozeman, Frank J. Hall, Robert A. Leslie, Ray A. Kunze, Stephen L. Langston, Fred A. Massey, John D. Neff, Mary M. Neff, Charles R. Stone, and Thomas R. Thomson have been appointed to the joint AMS-MAA *Committee on Arrangements for the Annual Meeting in Atlanta, January 6–9, 1988,* by Ex-Presidents Lynn A. Steen (MAA) and Irving Kaplansky (AMS). W. Wistar Comfort, William J. LeVeque, and Kenneth A. Ross are ex officio members. Professor Massey will serve as chairman.

Open letter to the membership:

The AMS Committee on Committees, which acts as consultant to the President in filling appointed positions in the Society, is making an effort to broaden the input of suggested candidates for appointments.

Positions to be filled may be found in the *Professional Directory* (now being mailed) in the sections 5.4 and beyond. It is positions dated 1987 that are to be filled by appointment and reappointment.

If you have suggested candidates for appointed positions within the Society, we would appreciate having their names before us when we make our recommendations. If you would like to nominate a member, please feel free to suggest the most appropriate committee.

Suggestions should be sent to William Jaco, Department of Mathematics, Oklahoma State University, Stillwater, OK 74078, by April 15, 1987. Members of the Committee on Committees are: James G. Glimm, William H. Jaco (Chairman), Irwin Kra, Everett Pitcher, Paul H. Rabinowitz, Audrey A. Terras, and William A. Veech.

William H. Jaco

Reports of Past Meetings

The November 1985 Meeting in Columbia

The eight hundred and twenty-third meeting of the American Mathematical Society was held at the University of Missouri, Columbia, on November 1-2, 1985. There were 240 registrants, including 211 members of the Society.

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

ERIC M. FRIEDLANDER, Northwestern University, *Cohomology of groups and algebras*;

CARLOS E. KENIG, University of Chicago, *Compactness methods in nonlinear diffusions*;

ANDREW SOMMESE, University of Notre Dame, *A survey on hyperplane sections of projective varieties*;

MICHAEL TALAGRAND, Ohio State University, *Regularity of Gaussian processes.*

The speakers were introduced by Andy Magid, C. Ahlbrandt, Ira Papick, and Nigel Kalten, respectively.

Special Sessions. By invitation of the same committee, there were six special sessions of selected twenty-minute papers. The topics, and the names and affiliations of the organizers, were as follows:

Ordinary differential equations, CALVIN D. AHLBRANDT, University of Missouri, Columbia;

Differential geometry, JOHN KELLEY BEEM and PAUL EHRLICH, University of Missouri, Columbia;

Inverse scattering theory, BRIAN DE FACIO, University of Missouri, Columbia;

Commutative algebra, RICHARD FEDDER, JAMES HUCKABA, and IRA J. PAPICK, University of Missouri, Columbia;

Maximal functions in harmonic analysis, BJORN JAWERTH, Washington University, and ALBERTO TORCHINSKY, Indiana University;

Banach spaces and related topics, ELIAS SAAB, University of Missouri, Columbia.

Contributed Papers. There also were two sessions of contributed ten-minute papers.

The undersigned Associate Secretary takes this opportunity to thank Dennis Sentiles and Peggy George for conducting the meeting in his absence.

Robert M. Fossum
Urbana, Illinois — Associate Secretary

The April 1986 Meeting in Indianapolis

The eight hundred and twenty-sixth meeting of the American Mathematical Society was held at Indiana University-Purdue University in Indianapolis on April 11-12, 1986. There were 139 registrants, including 115 members of the Society.

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

STEVEN BELL, Purdue University, *Riemann mapping theorems in several complex variables*;

JEAN BOURGAIN, I.H.E.S. and University of Illinois, Urbana, *Recent results on convex sets and maximal operators*;

RICHARD MCGEHEE, University of Minnesota, Minneapolis, *Singularities in classical celestial mechanics*;

NIELS NYGAARD, University of Chicago, *Algebraic geometry over finite fields.*

The speakers were introduced by Eric Bedford, Earl Berkson, Warren Lous, and C. D. Aliprantis, respectively.

Special Sessions. By invitation of the same committee, there were four special sessions of selected twenty-minute papers as follows:

Geometry of Banach spaces and harmonic analysis, JEAN BOURGAIN;

Index theory and its applications, JERRY KAMINKER, Indiana University-Purdue University in Indianapolis;

Differential equations, T. K. PUTTASWAMY, Ball State University;

Several complex variables, E. J. STRAUBE, Indiana University, Bloomington.

Contributed Papers. There also were three sessions of contributed ten-minute papers.

The undersigned Associate Secretary takes this opportunity to thank Neal Rothman for conducting this meeting in his absence.

Robert M. Fossum
Urbana, Illinois — Associate Secretary

The October 1986 Meeting in Denton

The eight hundred and thirtieth meeting of the American Mathematical Society was held at North Texas State University in Denton, Texas, on Friday, October 31, and Saturday, November 1, 1986. There were 216 registrants, including 152 members of the Society.

Invited Addresses. By invitation of the Committee to Select Hour Speakers for the Central Sectional meetings, there were four invited addresses.

PAUL FONG of the University of Illinois at Chicago spoke on *Modular representations of finite groups.* He was introduced by Brian Parshall.

RAVI S. KULKARNI of Indiana University, Bloomington, spoke on *Geometric structures on manifolds.* He was introduced by Fred Gehring.

ALEXANDER NAGEL of the University of Wisconsin, Madison, spoke on *Nonisotropic matrices in real and complex algebras.* He was introduced by Dale Alspach.

MARY WHEELER of Rice University spoke on *Numerical simulation of microbial biodegradation of hydrocarbons in ground water.* She was introduced by Julio Cesar Diaz.

Special Sessions. By invitation of the same committee, there were seven special sessions of selected twenty-minute papers. The topics of the sessions, the names and affiliations of the organizers, and a list of speakers follow:

Banach spaces and related topics, ELIZABETH BATOR, RUSSELL BILYEU, and PAUL LEWIS, North Texas State University. The speakers were Dale Alspach, Kevin T. Andrews, N. L. Carothers, S. J. Dilworth, G. A. Edgars, Peter Greim, Nigel J. Kalton, N. T. Peck, R. R. Phelps, Haskell Rosenthal, Elias Saab, Paulette Saab, Mark A. Smith, Robert F. Wheeler, and J. H. M. Whitfield.

Connections between combinatorics, algebra, and geometry, NEAL BRAND and JOSEPH P. S. KUNG, North Texas State University. The speakers were Brian Alspach, Neal Brand, Joseph P. Brennan, Ronald Gould, Jerrold R. Griggs, W. Cary Huffman, Devadatta Kulkarni, Joseph P. S. Kung, Heinrich Neiderhausen, James Oxley, T. D. Parsons, Talmage James Reid, David R. Richman, Tom Trotter, Klaus Truemper, James W. Walker, and Thomas Zaslavsky.

Differential equations, ALFONSO CASTRO, Southwest Texas State University, and JOHN NEUBERGER, North Texas State University. The speakers were Ilya J. Bakelman, Alfonso Castro, Constantin Corduneanu, David Costa, Jerome A. Goldstein, Hans G. Kaper, Alan C. Lazer, Fred

R. Payne, William Ray, R. E. Showalter, Henry A. Warshall, Luther White, and Anton Zettl.

Mathematics for large scale computing, JULIO CESAR DIAZ, University of Oklahoma. The speakers were R. E. Ewing, Alan Genz, Andreas Griewank, Kirk E. Jordan, S. Lakshmivarahan, Brad Lucier, M. Minkoff, Jorge J. Moré, Paul Nelson, and D. C. Sorenson.

Computational mathematics, WARREN FERGUSON, JR., Southern Methodist University. The speakers were M. R. Celis, Julio Gaucaneme, Tien-Yien Li, Theresa A. Parks, Patrick J. Rabier, L. F. Shampine, William W. Symes, Kathryn Turner, and David Young.

Geometric structures on manifolds and Kleinian groups, RAVI S. KULKARNI. The speakers were Mark Baker, Robert Brooks, Mark Feighn, Frederick P. Gardiner, F. W. Gehring, Jane Gilman, William M. Goldman, J. Alfredo Jimenez, Linda Keen, Adam Koranyi, Gavin Martin, Bernard Maskit, B. Osgood, John Ratcliffe, Richard Skora, Christopher Stark, Peter Waterman, and Norbert Wielenberg.

Invariant theory, V. LAKSHMIBAI, Texas A&M University. The speakers were Kan Akin, Joseph Brennan, David Buchsbaum, V. V. Deodhar, S. Doty, A. Fauntleroy, Robert Fossum, Robert Gustafson, William Haboush, A. Helminck, Craig Huneke, R. Joshua, V. Lakshmibai, Andy Magid, Susan Montgomery, A. Neeman, Brian Parshall, Robert Proctor, A. Ramanathan, J. Stembridge, Berndt Ulrich, and J. Weyman.

Contributed Papers. There were two sessions of contributed ten-minute papers. One session was chaired by Frank Conner, and the other by Nick Vaughn.

The undersigned Associate Secretary thanks the Local Arrangements Committee consisting of John Ed Allen and Paul Lewis for its efforts in arranging this meeting.

Robert M. Fossum
Urbana, Illinois — Associate Secretary

The Council Meeting in San Antonio

The Council met on 20 January 1987 at 5:00 p.m. in the Alamo Ballroom A&B of the Marriott in San Antonio, Texas. President Mostow was in the chair.

The results of the election of 1986 were announced. In contested elections, Karen Uhlenbeck was elected vice-president for a term of two years. Five members-at-large were selected for terms of three years, namely H. Blaine Lawson, Yiannis N. Moschovakis, Linda A. Ness, Marc A. Rieffel, and Carol S. Wood.

All candidates in uncontested elections were indeed elected. George Daniel Mostow acceded to the position of President, having been chosen President Elect a year ago.

The Council was informed that when the term of John L. Selfridge as Editor of Mathematical Reviews came to an end, he was replaced by Robert G. Bartle, who had been a member of the Editorial Committee. That vacancy on the Editorial Committee was filled by the Council in the person of Leonard D. Berkovitz.

There were three vacancies on the Editorial Committee of the Proceedings that were filled by the Council, subject to approval by the Trustees. The persons chosen were Kenneth R. Meyer, Louis J. Ratliff, Jr., and William D. Sudderth.

The Council elected a slate of three persons to the Editorial Committee of *Notices*, namely Robert J. Blattner, Lucy J. Garnett, and Nancy K. Stanton.

The Council was informed that in the election of 1986, four candidates were elected to the Nominating Committee, namely M. Salah Baouendi, Paul C. Fife, Carl Pomerance, and William P. Ziemer.

The Chairman, appointed by then President Irving Kaplansky, is John T. Baldwin.

The Council was concerned about the possibility that repeated nomination of an individual by petition followed by rejection by the electorate is evidence of abuse of the petition process. In response, the Council passed the following resolution:

> Beginning with the interval 1987–1996, the Council intends to approve no more than two nominations by petition of the same individual in any ten year period.

The Council approved amendments to the bylaws by which the *Journal of the American Mathematical Society* becomes an official journal on a par with the *Bulletin*, *Proceedings*, *Transactions*, and *Mathematics of Computation*, with representation of its editorial committee on the Council. The amendment is to be presented to the membership for approval by mail ballot.

On recommendation of the Executive Committee, the Council passed the following resolution that arose in the Science Policy Committee:

> While appreciating new funding of mathematics through special initiatives and other innovative programs, the AMS is concerned that greater progress be made in restoring the strength of the traditional basic research programs, particularly those sponsoring individual nondirected research. The AMS strongly endorses the recommendation of the Packard-Bromley report for a major increase in the NSF budget.

The Packard-Bromley report to which reference is made is dated February 1986 and is more formally titled *A Renewed Partnership*. It is a report of the White House Science Council Panel on the Health of U.S. Colleges and Universities and was made to the Office of Scientific and Technical Policy of the Executive Office of the President.

The Council considered a recommendation from the Executive Committee of which this is the background. The Council of 4 January 1983 passed a resolution that "approved the principle of cooperation between and possible merger of *Mathematical Reviews* and *Zentralblatt*." Cooperation in a variety of ways has been going on and is scheduled to continue. With respect to merger, each side designated a negotiating team. The two teams corresponded and had face-to-face meetings in which American and German positions, close together but not identical, were produced. These covered principally the division of income from a possible merged paper product. A number of procedural matters concerning the production of a merged paper product were worked out. A great deal of ground was not touched in these two positions. The object of the negotiation was not merger itself but rather the definition of a position that the Trustees could examine and about which the Executive Committee could advise on scientific grounds. Enough was done that one could sense a variety of difficulties. One could see that the financial savings that one might expect could not in fact be realized. To the contrary, the Society deficit attributable to Society participation in the putative merged journal might increase.

The Executive Committee and the Board of Trustees examined the problem repeatedly as the negotiations proceeded. The most recent position of the Board of Trustees was that a motion to approve the negotiating position of the American team failed. At the same time, the Executive Committee recommended to the Council that it stop negotiations and not merge. The Council of 20 January 1987 passed a motion recommending to the Trustees that negotiations toward merger be terminated.

The Committee on Human Rights proposed a resolution that the Council amended and passed. It reads as follows:

> The American Mathematical Society affirms the right of all mathematicians to attend international professional meetings, especially international congresses. No mathematician should be prevented from attending such a meeting by either his/her own government or the government of the host country.

The Council approved in principle that the Society become involved as a sponsor of mathematics competitions. There is a pyramid of such competitions, with the U.S.A. Mathematical Olympiad at the top, through which the U.S. team in international competition is selected.

The Science Policy Committee was charged with the additional duty of arranging at each annual meeting a lecture or a panel discussion on a topic of social import in which mathematics, broadly interpreted, is concerned.

The Committee on Employment and Educational Policy was reconstituted as a joint committee of the Society and the Association. This followed a unanimous recommendation of AMS, MAA, and SIAM through the Joint Policy Board for Mathematics. A principal immediate effect is that data collection through the annual survey will become a joint venture.

The charge to the Committee on Human Rights was enlarged. It had been directed at violations of human rights of foreign mathematicians. The word "foreign" in various forms was deleted. This is closely related to the resolution on the right to travel mentioned above, where restrictions on travel abroad by Americans was a precipitating issue.

The Council authorized participation by the Society in a venture possibly to be called the AMS Scientists and Engineers Employment Registry. This is an enlargement of an existing employment service with no dollar cost for either the Society or the prospective employee. It reaches a segment of industrial employment not well covered by the Employment Register and the journal *Employment Information in the Mathematical Sciences.*

The Council nominated Robert M. Fossum as its sole candidate for the position of Secretary in the election of 1988.

The Council recessed for dinner from 6:30 to 8:00 p.m. and adjourned at 10:00 PM.

The Business Meeting in San Antonio

The Business Meeting was held in the Theater of the Convention Center in San Antonio on 22 January 1987, beginning at 4:55 p.m. immediately following the session for the award of prizes. President Mostow was in the chair.

The Secretary reported on actions of the Council of interest to the membership as detailed in the report of the Council meeting.

At the call for new business, Michael Shub moved that two motions be placed on the agenda of the Business Meeting of August 1987 in Salt Lake City. The text of the two motions is as follows:

> **Motion 1.** Many scientists consider SDI (commonly referred to as Star Wars) incapable of achieving its stated goals and dangerously destabilizing. Participation by universities and professional organizations lends a spurious scientific legitimacy to it. Therefore the AMS will lend no support to the Star Wars program. In particular, no one acting as a representative of the AMS shall participate in efforts to obtain funding for Star Wars research or to mediate between agencies granting Star Wars research money and those seeking to apply for it.

Motion 2. The AMS is concerned about the increasing militarization of support for mathematics research. There is a tendency to distribute this support through narrowly focussed (mission-oriented) programs which circumvent normal peer review procedures. This tendency, unless checked, may skew and ultimately injure mathematics in the United States. Therefore those representing the AMS are requested to direct their efforts towards increasing the fraction of non-military funding for mathematics research, as well as towards increasing total research support.

When the motion was seconded, there was a motion passed to recess into committee of the whole. The conclusions, reported to the Business Meeting, consisted of recommendations that each motion be placed on the agenda in Salt Lake City and that each motion be approved then. The Business Meeting passed the main motion that the two motions be placed on the Salt Lake City agenda.

There was a request that the Business Meeting in Salt Lake City be informed that the vote was "close." The President observed that the attendance was less than two hundred.

There was a motion by David Sanchez thanking the Committee on Arrangements for its superb efforts in hosting the meeting and for an excellent job well done. It was passed by acclamation.

The meeting adjourned at 6:05 p.m.

Election Results of 1986

The newly elected Vice-President of the Society is Karen Uhlenbeck. The newly elected Members-at-Large of the Council are H. Blaine Lawson, Jr., Yiannis N. Moschovakis, Linda A. Ness, Marc A. Rieffel, and Carol S. Wood.

All candidates in noncontested elections were elected to their respective offices.

The candidates elected to the Nominating Committee of 1987-1988 are M. Salah Baouendi, Paul C. Fife, Carl Pomerance, and William P. Ziemer. The composition of the Council for 1987 follows.

COUNCIL FOR 1987

President:	George Daniel Mostow
Ex-President:	Irving Kaplansky
Vice-Presidents:	Richard A. Askey
	Olga Taussky-Todd
	Karen Uhlenbeck
Secretary:	Everett Pitcher
Associate Secretaries:*	Frank T. Birtel
	W. Wistar Comfort
	Robert M. Fossum
	Hugo Rossi
Treasurer:	Franklin P. Peterson
Associate Treasurer:	Steve Armentrout

MEMBERS-AT-LARGE

James G. Arthur	Cora Sadosky
Hyman Bass	Jean E. Taylor
Daniel M. Burns	Chuu-Lian Terng
Jane P. Gilman	Audrey A. Terras
Joseph B. Keller	William A. Veech
H. Blaine Lawson, Jr.	David A. Vogan, Jr.
Yiannis N. Moschovakis	Robert F. Williams
Linda A. Ness	Carol S. Wood
Marc A. Rieffel	

COMMUNICATIONS COMMITTEE

Chairman, Committee to Monitor Problems in Communication: Marian B. Pour-El

PUBLICATIONS COMMITTEES

Bulletin Editorial Committee

Wu-chung Hsiang	Edgar Lee Stout

Colloquium Editorial Committee

Raoul H. Bott	Charles L. Fefferman

Proceedings Editorial Committee

Doug W. Curtis	Andrew Odlyzko
Richard R. Goldberg	Donald S. Passman
Irwin Kra	Louis J. Ratliff, Jr.**
Kenneth R. Meyer**	Daniel W. Stroock
Paul S. Muhly	William D. Sudderth**

Transactions and Memoirs Editorial Committee

Robert D. Edwards	Lance W. Small
Vaughan F. R. Jones	Joel A. Smoller

Mathematical Reviews Editorial Committee

Melvin Hochster	Morton Lowengrub

Mathematical Surveys Editorial Committee

M. Susan Montgomery	R. O. Wells, Jr.

Mathematics of Computation Editorial Committee

Walter Gautschi	Hugh C. Williams
Donald Goldfarb	

AMS Representatives, Board of Editors of American Journal of Mathematics

Spencer Bloch

Science Policy Committee, Chairman

Ronald G. Douglas

*Because of the recent changes in the bylaws, 1987 is a year of transition with respect to Council membership. Robert M. Fossum and Hugo Rossi are Council members in 1987 whereas Frank T. Birtel and W. Wistar Comfort are members only when also in charge of the scientific program or otherwise designated by the Secretary.

**These people were elected by the Council at the January 1987 Council meeting, subject to the approval of the Trustees.

Classified Advertisements

SUGGESTED USES for classified advertising are books or lecture notes for sale, books being sought, positions available, exchange or rental of houses, and typing services.

THE RATE IS $.75 per word with a minimum of $37.50. The same ad in 7 consecutive issues is $4.00 per word. Type will be set solid unless centering and spacing are requested. A centered line of any length or the equivalent in white space is $7.00. A word is defined as a group of characters with space at each end. Prepayment is required of individuals but not of institutions. For an additional $10.00 charge, announcements can be placed anonymously. Correspondence will be forwarded.

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U. S. LAWS PROHIBIT discrimination in employment on the basis of color, age, sex, race, religion or national origin. "Positions Available" advertisements from institutions outside the U. S. cannot be published unless they are accompanied by a statement that the institution does not discriminate on these grounds whether or not it is subject to U. S. laws. Details and specific wording may be found following the Classified Advertisements in the January and August issues of the *Notices*.

SITUATIONS WANTED ADVERTISEMENTS from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-556-7774 and speak to Wahlene Siconio for further information.

SEND AD AND CHECK TO: Advertising Department, AMS, P. O. Box 6248, Providence, Rhode Island 02940. Individuals are requested to pay in advance, institutions are not required to do so.

POSITIONS AVAILABLE

Tenure-track, possibly senior, positions anticipated to begin August 15, 1987. Outstanding research record and/or proven research potential and teaching excellence required. Preferred areas: statistics and numerical methods, but candidates in areas of global analysis, dynamical systems, control theory, probability and functional analysis will also be considered for junior positions. Women and minority groups candidates are especially encouraged to apply. Visiting positions most likely in the area of applications of probability and graph theory to chemistry. Send vita plus three letters of recommendations to professor W. A. Woyczynski, Chairman, Department of Mathematics and Statistics, Case Western Reserve University, Cleveland, OH 44106.

An affirmative action, equal opportunity employer.

Department of Mathematics
University of Kansas

Anticipate some instructorships beginning fall semester 1987, which are normally renewable for second and third year. Salary to be determined. Research interests should be in areas closely related to those of current staff. Ph.D. or dissertation accepted with only formalities to be completed. Send detailed resume and dissertation abstract; arrange for three letters of reference to be sent directly to C. J. Himmelberg, Chairman, Department of Mathematics, University of Kansas, Lawrence, KS 66045-2142. Deadline date: December 1, 1986, then monthly until August 1, 1987.

The University of Kansas is an Affirmative Action/Equal Opportunity Employer.

Department of Mathematics
John Jay College of Criminal Justice
The City University of New York

Assistant Professor, tenure-track position, 9/1/87. Requirements: Ph.D.; demonstrated potential for research; strong commitment to teaching. Computer science, numerical analysis or operations research background preferred. John Jay College of Criminal Justice, located in Manhattan, is a senior college in CUNY. Send resume, graduate transcript, relevant reprints, dissertation abstract and three letters of reference to Samuel Graff, Chairperson, Department of Mathematics, John Jay College of Criminal Justice, 445 West 59th Street, N.Y., N.Y. 10019 by April 1, 1987. AA/EOE Employer.

The University of Wyoming
Head—Department of Mathematics

The Department of Mathematics at the University of Wyoming invites applications for the position of Department Head. The University is the sole four-year institution of higher education in the state of Wyoming with an enrollment of 10,000 students. The mathematics program offers degrees in mathematics, applied mathematics, and several joint-degree options at the bachelor, master and doctoral levels. The department has a growing major research component in applied mathematics including a petroleum research institute with funding from major industrial supporters. Other active research areas in the department include numerical analysis, partial differential equations, functional analysis, optimization theory, dynamical systems, rigidity theory, and combinatorics.

Candidates should have a strong research record compatible with department interests and a commitment to excellence in instruction. Applicants should submit a current curriculum vita and the names of at least three suitable references to

Myron B. Allen, Chair
Search Committee
Mathematics Department
University of Wyoming
Laramie, WY 82070

Applications will be considered through January 31, 1987. The University of Wyoming is an equal opportunity employer.

University of California, Riverside

Applications are invited for a tenure-track or tenure position in Computer Science beginning Fall 1987. Candidates must have demonstrated excellence in research and teaching. Research specialties in all areas of Computer Science will be considered but we are particularly interested in research areas in Computer Systems or Computer Methodology and Applications. The position is open as to the level of appointment.

Applicants should send a curriculum vitae and see that at least three letters of recommendation are sent to:

Professor Theodore J. Barth, Chair
Computer Science Search Committee
Department of Mathematics and Computer Science
University of California
Riverside, CA 92521

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POSITIONS AVAILABLE

RICE UNIVERSITY
Department of Mathematical Sciences

The Department of Mathematical Sciences seeks applications for a tenure-track opening in Operations Research for Fall, 1987. Applications at all levels and in all areas of Operations Research will be considered, however preference will be given to junior applicants with interests in the combinatorial aspects of optimization. Candidates are sought with demonstrated potential in both teaching and research. Applications should be submitted to Professor John E. Dennis, Jr., Department of Mathematical Sciences, P. O. Box 1892, Rice University, Houston, Texas 77251. Application materials should include a statement of research interests and the names of at least three individuals to serve as references.

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MACALESTER COLLEGE

The Department of Mathematics and Computer Science is inviting applications for a tenure track position beginning in Fall, 1987. Applicants should have or be very near completion of a Ph.D in either Mathematics or Computer Science and will be expected to participate in the development and teaching of upper level courses in computer science.

Macalester is a four-year, residential liberal arts college of approximately 1700 students. The department offers majors in both mathematics and computer science. Applicants should be committed to excellence in undergraduate teaching and scholarship. Salaries and benefits are competitive. Macalester is an equal opportunity employer.

Applications should be directed to John Schue, Chairman; Department of Mathematics and Computer Science, Macalester College, St. Paul, MN 55105; providing a resume and three references. Applications will be accepted until the position is filled.

VALDOSTA STATE COLLEGE

Four tenure-track positions beginning Fall, 1987; (3) in mathematics at the Asst./Assoc. Prof. level and one in C.S. at the rank of Asst. Prof. Ph.D. required for math positions with special consideration given to applicants in algebra, probability or statistics, operations research, numerical methods, and applied math. Candidates for C.S. position should have a Ph.D. in C.S. Preferred areas: operating systems, data communications, software engineering, data base management, data structures, artificial intelligence. Applicants for either position should have a commitment to excellence in teaching and continued scholarly activity. Send vita to: John W. Schleusner, Head, Department of Mathematics and Computer Science, VSC, Valdosta, Georgia 31698. Application deadline is March 20, 1987. VSC is an AA/EOE.

DEPARTMENT OF MATHEMATICS
UNIVERSITY OF ROCHESTER

Applications are invited for positions at the tenure-track assistant professor level or higher, beginning September 1987. Significant research accomplishments or exceptional research promise, as well as evidence of good teaching ability, are required. Initial tenure-track appointment is for four years. There is no restriction as to field. In addition to a curriculum vitae, candidates should send a summary of research plans, available preprints or reprints, and have at least three reference letters sent to:

Chairman, Mathematics Department
University of Rochester
Rochester, NY 14627

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COLUMBIA UNIVERSITY
Department of Computer Science
Lectureships

Positions as Lecturer or Senior Lecturer will be offered to excellent teachers with superior research and academic backgrounds. Faculty of all ranks in other mathematical disciplines, as well as computer science, are encouraged to apply for these non-tenured term appointments, whose duration will typically be three to six years. Pay is comparable to professorial levels.

These lectureships provide an opportunity for teacher/scholars with some substantial prior computing experience to make a transition to computer science. Columbia University has an outstanding young research faculty and facilities, now working in a five-million dollar office and research-laboratory building. All of our "lecturer alumni" are presently in good positions at leading universities and colleges.

Lecturers will teach two undergraduate courses each semester. They must be able to make highly effective presentations to large classes. The University has several DEC 2060 computer systems dedicated to instructional use. Many terminals or students are in dormitories and other convenient locations. Knowledge of innovative uses of technology for teaching is desirable.

Send resume and names of three references by February 15, 1987, if possible, to Professor Jonathan Gross, Vice-Chairman, Department of Computer Science, Columbia University, New York, New York 10027. Please write "Re Lectureship" on the envelope of your letter of inquiry or application.

Columbia University is an Equal Opportunity/Affirmative Action Employer. We are interested in receiving applications from qualified women and minorities.

DEPARTMENT OF MATHEMATICS
KANSAS STATE UNIVERSITY

Subject to budgetary approval, applications are invited for several tenure-track and visiting positions at the assistant professorship level commencing August 18, 1987. All fields will be considered, but at least one position will be in computational mathematics. Candidates must have strong research credentials and a commitment to excellence in teaching. A Ph.D. in mathematics or a Ph.D. dissertation accepted with only formalities to be completed is required. Application, detailed resume with description of research and three letters of recommendation should be sent to: Louis Pigno, Head, Department of Mathematics, Cardwell Hall, Kansas State University, Manhattan, KS 66506. Deadlines: February 1, 1987 for first consideration, then monthly until August 1, 1987. AA/EOE.

DEPARTMENT OF MATHEMATICS
AND COMPUTER SCIENCE
CALIFORNIA STATE UNIVERSITY, LA
LOS ANGELES, CALIFORNIA 90032

Tenure-track positions, any rank. Ph.D. in Math, Math Ed or Ph.D. in Computer Science with a background in Mathematics required. Strong computer science background desirable and ABD toward Ph.D. in CS will be considered for one year temporary. One year visiting position also available in Math with Ph.D. and strong record. Starting date: September 1987 Salary: 28300–53500 with additional summer employment possibilities. Evaluation of applicants will begin February 1, 1987. Send inquiries to Wayne Bishop, Chair at the above address. An Equal Opportunity, Affirmative-Action, Handicapped, Title IX, Employer.

POSITIONS AVAILABLE

DUKE UNIVERSITY
Department of Computer Science

The Duke University Department of Computer Science, a 1983 recipient of an NSF CER Grant, has faculty positions available at all ranks. Applications are solicited from all areas of computer science. Applicants for senior positions must demonstrate excellence in research, while applicants for junior positions must exhibit the promise of excellence.

The Department currently has seventeen tenure track faculty, approximately 300 undergraduate majors and 50 graduate students pursuing master's and/or doctoral degrees.

The Department has major research efforts in scientific computing with emphasis on numerical linear algebra, the solution of PDEs, and VLSI simulation; computer systems with emphasis on computer architectures, modeling of fault-tolerant systems, systems performance, and communications; artificial intelligence, particularly in the areas of natural language interface, search methodologies, and expert systems; and theory and algorithms with emphasis on combinatorial and graph-theoretic studies. Special motivation for the research efforts comes from the areas of medical applications (in collaboration with the Duke Medical Center), and VLSI (in collaboration with the Microelectronics Center of North Carolina, of which Duke is a Participating Institution).

Interested applicants should send copies of their resumes and other supporting material to

Professor Donald J. Rose
Department of Computer Science
Duke University
Durham, NC 27706

Duke University is an affirmative action, equal opportunity employer.

EDUCATION — MILLERSVILLE UNIVERSITY OF PENNSYLVANIA—Department of Mathematics and Computer Science—Applications are invited for several full-time tenure track and temporary positions in mathematics beginning September, 1987. Teaching loads are 24 semester hours per year; released time for research is available on a competitive basis. Candidates must hold the Ph.D. degree in mathematics and a strong commitment to excellence in teaching and scholarship. Strength in probability and statistics is required for one of the tenure-track positions; interest in applied areas of mathematics is preferred for another. Candidates with any mathematical specialty will be considered. Rank and salary will be determined by qualifications and experience; salaries range from $21,951 to $43,461 with excellent benefits. The department consists of 26 full-time faculty serving approximately 175 mathematics majors and 350 computer science majors. Mathematical specialties among the faculty include statistics, algebraic topology, real & complex analysis, algebra, differential equations, graph theory and combinatorics. Millersville University maintains several VAX and IBM mainframe computer systems including a VAX-11/750 with ULTRIX and an IBM 4361 running VM/CMS. A VAX and ETHERNET network is expected to be available by Fall, 1987. The department maintains a VAX-11/730, a PDP-11, and numerous microcomputers. Millersville University enrolls more than 7,000 students and is located near Lancaster, PA, well-known for its rich agriculture, natural beauty, agreeable climate, and safe, pleasant lifestyle. Send vita, transcripts, and three letters of recommendation (at least one of which attests to your teaching effectiveness) to: Dr. Charles G. Denlinger, Search Committee Chairman, Dept. of Math & C.S., Millersville University, Millersville, Pa. 17551. Interviews begin on or about January 15, 1987. Millersville University is an Equal Opportunity Employer.

UNIVERSITY OF SOUTHERN CALIFORNIA
Department of Mathematics
Los Angeles, CA 90089-1113

Applications are invited for several tenure track Assistant Professorships, beginning September 1987, and for possible tenured positions at the ranks of Professor and Associate Professor. Visiting Professorships and Visiting Associate Professorships will also be available.

Assistant Professors are expected to teach two courses per semester, and must show strong research promise. Applicants for senior positions should have an outstanding record of research and scholastic achievement. Specialists in Statistics, Partial Differential Equations, Combinatorial Analysis and areas of Applied Mathematics such as Numerical Analysis are especially encouraged to apply, but other areas will be considered.

Applications should be addressed to: Chairman, Search Committee, Department of Mathematics-DRB 306, University of Southern California, Los Angeles, CA 90089-1113.

U.S.C. is an Equal Opportunity/Affirmative Action employer.

Department of Mathematics
Southern Methodist University

Applications are invited for a Professor and a tenure-track Assistant Professor beginning September 1987. Candidates for the senior position should be distinguished scholars providing leadership in one or more areas of research in applied mathematics. A successful grant record and the supervision of doctoral dissertations are desirable. Candidates for the junior position should have an outstanding research record or superior potential. A commitment to excellence in teaching is expected of all candidates.

The department has ten active applied mathematicians doing research in areas such as mathematical modeling, nonlinear wave phenomena, numerical analysis (differential equations and optimization), and scientific computation. Recently Lawrence Shampine has been appointed the first holder of the Betty Clements Chair in Applied Mathematics.

Applicants should send a vita and three letters of reference (for the senior position, names only) to Richard Haberman, Chairman, Department of Mathematics, Southern Methodist University, Dallas, Texas 75275, or call (214) 692-2506.

The university is an Equal Opportunity/Affirmative Action/Title IX employer.

FACULTY POSITION: MATHEMATICS

The University of Pittsburgh at Johnstown announces a tenure-track position in Mathematics at the Assistant or Associate Professor level for September 1, 1987. Applicants should have a background in statistics and/or quantitative science. A long-term commitment and interest in teaching all levels of undergraduate mathematics as well as a strong motivation for continuing professional development are expected. A doctorate in mathematics or a related discipline, or evidence of completing all requirements for a doctorate by Spring, 1987, is required.

Academic year is from September 1 to April 30 with limited spring or summer teaching. Salary and rank are negotiable and dependent on experience and academic qualifications.

Application deadline: April 2, 1987, or later, until the position is filled. Send resume and supporting documents to Dr. Ildefonso T. Cruz, Search Coordinator, Department of Mathematics, University of Pittsburgh at Johnstown, Johnstown, PA 15904.

UPJ is an Equal Opportunity/Affirmative Action Employer.

POSITIONS AVAILABLE

DEPARTMENT OF MATHEMATICS
UNIVERSITY OF CALIFORNIA
RIVERSIDE, CALIFORNIA

Applications are invited for one or more temporary positions beginning in September 1987. These positions are funded at the Assistant Professor level, but there is some slight flexibility in salary. They are open to applicants from all research areas within Mathematics and Computer Science with significant accomplishments or high potential in both research and teaching.

Candidates should send vita and arrange for at least three letters of recommendation to be sent to: Professor B. Wong, Chair, Search Committee, Department of Mathematics and Computer Science, University of California, Riverside, California 92521. The University of California is an Equal Opportunity/Affirmative Action Employer.

DEPARTMENT OF MATHEMATICS
University of Toronto

Applications are invited from recent Ph.D.'s for a tenure-track position in the field of Applied Mathematics at the level of Assistant Professor. The position is subject to budgetary approval and shall begin on July 1, 1987. Duties consist of research and teaching and candidates must demonstrate clear strength in both. The University of Toronto encourages both men and women to apply for this position.

Applicants should send their complete curriculum vitae, together with list of publications, and arrange to have at least three recent letters of reference sent directly to:

Professor D. K. Sen
Associate Chairman
Department of Mathematics
University of Toronto
Toronto, Canada M5S 1A1

To insure consideration, applications and letters of reference should be received by March 1, 1987. In accordance with Canadian Immigration requirements this advertisement is directed to Canadian citizens and permanent residents in Canada only.

HOWARD UNIVERSITY

Howard University expects to have two tenure track positions available at any level in the Department of Mathematics in August, 1987. Each position requires the teaching of undergraduate and graduate courses, particularly those in the Ph.D. program in Mathematics. One position demands a Ph.D in Mathematical Statistics, with some teaching obligations in this area. There is no restriction in the area of specialization for the second position. Please reply to Chairman: Department of Mathematics, Howard University, Washington, D.C. 20059.

Howard University is an Equal Opportunity Employer.

Department of Mathematics, Eastern Washington University. We invite applications for positions at the assistant professor level beginning September 1, 1987. We especially encourage applicants with a strong and broad background in theoretical mathematics. A Ph.D. in mathematics is required. Our small, democratic department seeks to strengthen both its Masters of Science and its undergraduate programs, as well as its ties to the local industry. To be considered for these positions, applicants should send, by March 1, 1987, a letter of application stating their objectives and philosophy in teaching and research, together with a curriculum vita with graduate transcripts and three letters of recommendation to: Professor Jack Swan, Chair, Department of Mathematics, Mail Stop # 32, Eastern Washington University, Cheney, WA 99004. An Equal Opportunity Employer.

State University of New York, College at Old Westbury, invites applications for a tenure-track faculty position at rank of assistant professor (Ph.D. required). Specialty in one of the following areas preferred: operations research, statistics, algebra, and mathematics education. Commitment to excellence in teaching undergraduate mathematics. The school located in a highly desirable suburban area in Long Island, 30 miles from New York City. Send resume and have 3 letters of reference sent to:

Search Committee (Mathematics)
State University of New York/College at Old Westbury
Old Westbury, NY 11568
Starting date: September 1, 1987
Application deadline: February 10, 1987

The State University of New York at Old Westbury is an AA/EOE.

UNIVERSITY OF TORONTO
DEPARTMENT OF MATHEMATICS

The Department has an opening (subject to budgetary approval) at the level of full Professor in the field of algebraic or differential geometry, commencing July 1, 1987. The duties consist of research and teaching undergraduates and graduates. Salary commensurate with experience.

Candidates should have established a leading international reputation for the originality and significance of their research. The Department seeks candidates whose research has already made deep and fundamental contributions to the central problems in the field. Candidates are asked to include a brief description of such contributions in their application. Men and women are encouraged to apply.

Applications should be sent to Professor T. Bloom, Chairman, Department of Mathematics, University of Toronto, Toronto, Canada M5S 1A1 and should include a complete curriculum vitae, the description of their research mentioned above and the names of six referees (two of whom can appraise the teaching of the candidate). The deadline is January 1, 1987.

In accordance with Canadian Immigration requirements, the advertisement is directed to Canadian citizens and permanent residents.

UNIVERSITY OF WISCONSIN-RIVER FALLS
MATHEMATICS FACULTY POSITIONS

Applications are invited for two tenure track positions in Mathematics beginning September 1, 1987. Qualifications are a Ph.D. and a genuine commitment to quality undergraduate instruction and continuing scholarly activity. The current teaching load is 12 hours per week. Appointments will be made at the assistant or associate professor level.

The University of Wisconsin-River Falls is located in west central Wisconsin 30 miles east of St. Paul and Minneapolis, Minnesota. Enrolling 5,200 students, the university offers bachelor's and master's degrees in the colleges of Agriculture, Arts & Sciences and Education, and in the Graduate School.

Applicants should submit resume, transcripts, and three letters of recommendation to:

Dr. J. R. Senft, Chairman
Search and Screen Committee
Department of Mathematics/Computer Systems
University of Wisconsin-River Falls
River Falls, WI 54022

The application deadline is MARCH 1, 1987 or until filled.

(UW-RF is an equal opportunity affirmative action employer.)

POSITIONS AVAILABLE

BUTLER UNIVERSITY
Department of Mathematical Sciences

The Department of Mathematical Sciences at Butler University invites applications for several tenure-track assistant or associate professorships in mathematics and computer science/information systems (CS/CIS). A PhD is preferred for the mathematics positions. A PhD in CS/CIS or a PhD in mathematics plus a master's degree in CS/CIS is preferred for the CS/CIS positions. However, a master's degree in CS/CIS plus significant teaching or industrial experience will be considered. All positions require demonstrated teaching ability.

Send a complete curriculum vitae, graduate transcripts and three letters of reference, one addressing teaching abilities to Dr. James P. Fink, Department of Mathematical Sciences, Butler University, 4600 Sunset Ave., Indianapolis, IN 46208. Closing date for applications is February 28, 1987.

Butler University is an Equal Opportunity/Affirmative Action employer.

WASHINGTON STATE UNIVERSITY
PURE & APPLIED MATHEMATICS
PULLMAN, WASHINGTON 99164-2930

The Department of Pure and Applied Mathematics has at least two openings, one tenure-track and one temporary position, starting August 1987. Applicants for the tenure-track position should have a Ph.D. with active research interests in COMPUTATIONAL MATHEMATICS, NUMERICAL ANALYSIS or OPERATIONS RESEARCH/COMBINATORIAL OPTIMIZATION. The area of research is more open for the temporary position. The University is an equal opportunity/affirmative action employer. Applications from members of minority groups, women, and handicapped persons are encouraged. Screening of applicants will begin February 15, 1987. Vitae and three (3) letters of reference should be sent to: Professor Duane W. DeTemple, Chairman, Search Committee.

HONG KONG BAPTIST COLLEGE is a public institution of higher learning fully funded by the Government. It has just begun offering degree courses in the areas of Combined Sciences and Social Work. Applications are now invited for the post of Lecturer/Senior Lecturer in Mathematics tenable in September 1987. Candidates should have a Ph.D. Degree in Mathematics with specialty in Numerical Analysis. Teaching ability in Operations Research, Discrete Mathematics and Computer Simulation is preferred. The successful candidate is expected to carry out research and to supervise final year student projects in applied/interdisciplinary areas. Salary Range US$29,423 to US$38,130 p.a. (for Senior Lecturer), US$15,892 to US$28,123 p.a. (for Lecturer). Fixed 2 years contract, 25% (for Senior Lecturer) or 15% (for Lecturer) gratuity of basic salary at end of contract. Other benefits include housing assistance and passage. Applications with complete curriculum vitae and the names and addresses of two referees should reach the Personnel Office, Hong Kong Baptist College, 224 Waterloo Road, Kowloon, Hong Kong by April 15, 1987.

YORK COLLEGE, CUNY
Department of Mathematics

Tenure-bearing position starting in September, 1987. Must have PhD in mathematics with some expertise in Computing, or PhD in Computer Science. Preferred specialties: Computing, Operations research, other applied areas. Salary and rank negotiable. Send resume to: C. Dixon, Department of Mathematics, York College (CUNY) Jamaica, N.Y. 11451. York College is an AA/EOE.

Pohang Inst of Science & Tech
Department of Mathematics
Pohang, 680 Korea

Positions at all levels are available for mathematicians holding a Ph.D. in Mathematics. Preference is given to candidates who can speak the Korean language, and have shown strong evidence of ability for doing original research in mathematics. Salaries are higher and teaching loads are lower than comparable institutions in Korea. Interested persons should write to Professor Jin-Ho Kwak at the above address, or Professor C. N. Lee, Department of Mathematics, University of Michigan, Ann Arbor, MI 48109. (Tel. 313-668-0330)

W. F. JAMES CHAIR OF STUDIES
In PURE and APPLIED SCIENCES
ST. F. X. UNIVERSITY

St. Francis Xavier University invites applications from candidates considering sabbatical leave in 1988-89 for tenure in its W. F. James Chair of Studies in Pure and Applied Science. Eligible departments are Biology, Chemistry, Geology, Mathematics and Computing Sciences, Physics and Psychology.

It is expected that the holder of the Chair will have an established record as a recognized scholar in one of the above disciplines. The individual's educational background, professional qualifications and work experience are expected to be commensurate with that normally required for a senior academic appointment at a university.

In addition to pursuing his/her normal research activities, the incumbent is expected to interact extensively with faculty and senior students, teach a maximum of one course or seminar plus present a maximum of three public general lectures a year.

Cognizant of the nature of the position the University has set the stipend level to provide for full salary replacement, based on actual salary at the time of application. The department in which the incumbent is located will have access to research support for the incumbent. The appointment will begin July 1, 1988 or September 1, 1988. However, applications are also invited from candidates proposing to spend one term or other fractions of a year in the Chair.

Applications should be mailed prior to March 1, 1987 to:

Dr. John T. Sears
Academic Vice President
St. Francis Xavier University
Antigonish, Nova Scotia
B2G 1C0

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM
DEPARTMENT OF MATHEMATICS

Applications are invited for the position of Associate Professor or Professor of Mathematics to begin September 1, 1987. The department is especially interested in establishing a group in Numerical P.D.E./Scientific Computation over the next five years. Other areas which will enhance our proposed Ph.D. in Applied Mathematics will be seriously considered. Demonstrated leadership in research is expected of applicants. 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.

POSITIONS AVAILABLE

UNIVERSITY OF WISCONSIN-OSHKOSH DEPARTMENT OF MATHEMATICS

The Department of Mathematics at the University of Wisconsin-Oshkosh anticipates having one or more entry level tenure track positions beginning September, 1987. The primary responsibility is undergraduate teaching with the usual teaching load being 12 credits per semester. Scholarly activity and departmental committee work are expected. Grant writing is encouraged. Good teaching is essential!

Candidates should have a Ph.D. or anticipate completing a Ph.D. by September 1987. All areas of specialization, including mathematics education will be considered. Send application letter, vita, a complete set of transcripts and three letters of recommendation to: Dr. Norbert J. Kuenzi, Chair, Department of Mathematics, University of Wisconsin-Oshkosh, Oshkosh, WI 54901. Screening of candidates will begin February 2, 1987. The University of Wisconsin-Oshkosh is an Affirmative Action Equal Opportunity Employer.

PRINCETON UNIVERSITY FACULTY POSITIONS IN MATHEMATICS

Applications are invited from persons with an established record of research accomplishment in combinatorics, complexity theory, applied mathematics, partial differential equations, topology, and analysis for senior faculty positions in the mathematics department. Inquiries, accompanied by vitae and publication record, should be addressed promptly to E. M. Stein, Chairman, Department of Mathematics, Fine Hall, Washington Road, Princeton, NJ 08544. Princeton University is an equal opportunity, affirmative action employer.

Mathematics: two tenure-track positions teaching, advising students, and assisting with curriculum development. Doctorate in Mathematics and teaching experience preferred. Areas of interest include algebra, geometry, mathematics education, and developmental mathematics. Application deadline: February 1, 1987 or until filled. Position available: August 1987. Send letter of application, resume, transcripts, and three letters of recommendations to: Director of Personnel, Northwest Missouri State University, Maryville, Missouri 64468. Affirmative Action, Equal Opportunity Employer. Northwest encourages women and minorities to apply.

COMPUTER SCIENCE FACULTY–Applications are invited for a tenure-track faculty position in Computer Science with duties commencing in August of 1987. Rank and salary are dependent on qualifications. Ph.D. in Computer Science is preferred. Applicants holding a Ph.D. in mathematics or a related field and having a strong interest in computer science will be considered. Potential for growth as a computer scientist is required. Duties will include teaching undergraduate and graduate students and research.

Please indicate your visa status when applying to: Dr. William A. Welsh, Jr., Head, Division of Science, Engineering and Technology, c/o Robert H. Hamill, Business Office, Box AMS, The Pennsylvania State University at Harrisburg, The Capital College, Middletown, PA 17057. Position open until filled.

The Pennsylvania State University at Harrisburg is an upper division college and graduate center located 8 miles southeast of the state capital at Harrisburg.

AN AFFIRMATIVE ACTION/EQUAL OPPORTUNITY EMPLOYER.

ASSOCIATE/FULL PROFESSOR: Tenure-track position in one or more of the following areas: algebra, analysis, geometry or topology. Applications at assistant professor level will also be accepted, but will not have as high a priority as applications at higher levels. Deadline: 3/13/87. Selection procedure will begin after 3/13/87. Send resume, 3 letters of recommendation to: Richard J. Griego, Chairman, Mathematics & Statistics, Univ. of NM, Albuquerque, NM 87131. AA/EOE.

THE GEORGE WASHINGTON UNIVERSITY DEPARTMENT OF MATHEMATICS

Applications are invited for a nontenure track position at the Instructor or Assistant Professor level beginning September, 1987. Duties include teaching two courses per semester, supervising graduate teaching assistants, and coordinating and monitoring the activities of the Math Lab, which is a workshop run on a tutorial basis. Candidates must have at least a Master's degree in Mathematics and a strong commitment to teaching. Send vita and three letters of recommendation to: H. D. Junghenn, Chairman, Department of Mathematics, George Washington University, Washington, D.C. 20052. Applications will be accepted until March 15, 1987. The George Washington University is an Equal Opportunity Educational Institution/Affirmative Action Employer.

THE UNIVERSITY OF NORTH CAROLINA AT ASHEVILLE
Department of Mathematics

Two tenure-track positions at the level of Assistant Professor, beginning August, 1987. Ph. D. required, preferably in analysis or related area. The University of North Carolina at Asheville is a small liberal arts college in the Blue Ridge Mountains of North Carolina. Department has 9 full-time faculty; half are active in publishing and research. Teaching load is 7 courses per year, with some release time available. The department welcomes minority applicants who meet qualifications. Deadline: Until positions are filled. Send vita and 2-3 letters of recommendation to:

Professor David C. Kay, Chairman
Department of Mathematics
One University Heights
Asheville, NC 28804-3299

TEMPLE UNIVERSITY DEPARTMENT OF MATHEMATICS

Senior level numerical analyst, Mathematics, Temple University. Tenure track position, beginning September 1987. The successful candidate will have background in the academic and the industrial-governmental sectors; He/she will have contributed significantly to the development and/or the usage of numerical analysis; He/she will be an interested, effective teacher and will be interested in working jointly with students and colleagues in a numerical analysis program. Salary is competitive subject to limitation by the Dean and/or Provost. Candidates should send C.V. and have 3 letters of recommendation sent by March 15, 1987 to:

Dr. L. Raymon, Chairman
Mathematics Department
Temple University
Philadelphia, Pa. 19122

Temple University is an Affirmative Action Equal Opportunity Employer.

POSITIONS AVAILABLE

College of Staten Island (CUNY)
Department of Mathematics

A tenure-track position in mathematics is available for Fall 1987. Requirements: Ph.D.; demonstrated potential for research; strong commitment to teaching. All mathematics research areas will be considered with special preference given to algebra, analysis, topology, combinatorics, probability and statistics. Rank and salary commensurate with qualifications. The College of Staten Island is a senior college in CUNY. Send resume and three letters of reference to: Dr. Michael Sormani, Mathematics Department, College of Staten Island, 715 Ocean Terrace, Staten Island, N.Y. 10301 by March 31, 1987. AA/EOE Employer.

SYRACUSE UNIVERSITY

Syracuse University invites applications for several anticipated tenure-track positions at the rank of assistant or associate professor. Excellence in teaching and research is required. Candidates in research areas currently represented here will have priority. One position is in the area of numerical analysis and at the rank of assistant professor. For the others, preference will be given in areas related to nonlinear pde's, algebra, or discrete mathematics. Applicants should send a curriculum vitae and have three letters of reference (and a transcript if recent Ph.D.) sent to L. J. Lardy, Chairman, Department of Mathematics, Syracuse University, Syracuse, New York 13244-1150. Syracuse University is an AA/EEO Employer.

OPENING IN TEACHER PREPARATION PROGRAM
DEPARTMENT OF MATHEMATICS
UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85721

The Department of Mathematics at the University of Arizona is seeking a person whose major contributions will be to the Department's teacher preparation program and to the enhancement of mathematics teaching at the precollege level. This tenured or tenure-track position will begin in the Fall of 1987. An interested candidate should send a letter and a resume plus a list of at least three references to Head, Department of Mathematics. The resume should include evidence of the candidate's involvement in projects related to the preparation for and nurturing of the teaching of mathematics at the precollege level. The closing date for applications is April 1, 1987, or whenever the position is filled. The University of Arizona is an Equal Opportunity/Affirmative Action Employer.

Department of Mathematics
University of Alberta
Edmonton, Alberta, Canada

Applications are invited for one tenure-track position in Ordinary Differential Equations at the Assistant Professor level starting July 1, 1987. Requirements are a Ph.D. and proven ability or demonstrated potential for research and teaching. Current salary range is from $31,612 (Canadian) per annum, depending upon qualifications. Send vitae and arrange for three letters of reference to be sent to: Professor H. I. Freedman, Acting Chairman, Department of Mathematics, University of Alberta, Edmonton, Canada, T6G 2G1. The University of Alberta is an equal opportunity employer, but in accordance with Canadian Immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada. Closing date for applications is April 3, 1987. Please refer to File AMD8 when responding to this advertisement.

Department of Mathematics
University of Alberta
Edmonton, Alberta, Canada

Applications are invited for one tenure-track position in Continuum Mechanics at the Assistant Professor level starting July 1, 1987. Requirements are a Ph.D. and proven ability or demonstrated potential for research and teaching. Current salary range is from $31,612 (Canadian) per annum, depending upon qualifications. Send vitae and arrange for three letters of reference to be sent to: Professor H. I. Freedman, Acting Chairman, Department of Mathematics, University of Alberta, Edmonton, Canada, T6G 2G1. The University of Alberta is an equal opportunity employer, but in accordance with Canadian Immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada. Closing date for applications is April 3, 1987. Please refer to File AMD9 when responding to this advertisement.

WAYNE STATE UNIVERSITY

Several tenure-track positions available for Fall, 1987. Ph.D. required. Higher rank or tenure possible for extremely qualified individuals with established research records and national or international reputation. There is also the possibility of a few lectureships or visiting positions.

Duties for all positions include undergraduate and graduate teaching and research. Demonstrated excellence in both teaching and research is required. Current areas of interest include statistics, algebra, combinatorics, functional analysis, geometry, analysis and topology.

Salary and rank to be negotiated. Applications should include a detailed resume and the names of three academic references. Arranging for letters of reference to be sent directly to the chairman will expedite consideration. Wayne State is an equal opportunity, affirmative action employer and encourages applications from women and minority candidates.

Clarence W. Wilkerson, Jr., Chairman
Department of Mathematics
Wayne State University
Detroit, MI 48202

CLARKSON UNIVERSITY
Department of Mathematics and Computer Science

The Clarkson University Mathematics and Computer Science Department is interested in hiring a faculty member in the area of Analysis. It is expected that some interaction will take place between him/her and the existing group of Physicists/Applied Mathematicians working on Nonlinear Phenomena. Teaching load is six hours/week. Rank and salary are open.

Interested applicants should send resume and three letters of recommendation to Professor Athanassios S. Fokas, Chairman, Department of Mathematics and Computer Science, Clarkson University, Potsdam, NY 13676.

Clarkson University is an Affirmative Action/Equal Employment Opportunity Employer MFVH (Minority, Female, Veteran, Handicap).

Anticipated tenure track positions in Math Dept. beginning September 1987. Appointments possible at all levels. Primary responsibility is undergraduate teaching, research and service to the college. Ph.D. in mathematics, statistics, or math education required. Apply to Dr. Robert Hofer, Chairman, Search Committee, Department of Mathematics, SUNY College at Plattsburgh, Plattsburgh, NY 12901. We will start to consider applications on March 1 and will accept applications until positions are filled. P.S.U.C. is a public 4-year college with approximately 5600 undergraduates and 130 math majors. Equal Opportunity/Affirmative Action Employer.

POSITIONS AVAILABLE

California State University, Hayward
Department of Mathematics and Computer Science

The department is now seeking applicants for entry level tenure track Assistant Professor positions in mathematics beginning Fall, 1987.

Applicants should hold the Ph.D degree in mathematics and should have a commitment to excellence in teaching and a willingness and an ability to participate in curriculum development. Applicants should also exhibit the competence and potential to engage in significant professional activities, including research and publication. All areas of specialization will be considered. The interests of the present faculty include a wide range of fields in mathematics and in computer science.

CSU, Hayward is located in the hills above, and overlooking, the eastern shore of the San Francisco Bay. More than 12,000 students attend this university, which has outstanding programs in arts, letters, science, and business. The Department of Mathematics and Computer Science enrolls nearly 1300 majors in its three degree programs: B.S. in Computer Science, B.S. in Mathematics, and M.S. in Mathematics. An M.S. in Computer Science is being planned.

Interested applicants should send a resume and the names of three references to

William R. Nico, Chair
Department of Mathematics and Computer Science
California State University, Hayward
Hayward, CA 94542

Applications received by February 15, 1987, will be assured full consideration. Applications will be accepted as long as positions remain available.

California State University, Hayward, is an Equal Opportunity/Affirmative Action employer and encourages applications from women and men of all ethnic backgrounds and physical abilities.

INSTITUTO DE MATEMÁTICA E ESTATÍSTICA DA UNIVERSIDADE DE SÃO PAULO, BRASIL

Positions and visiting appointments are available at the IME-USP. The IME has good facilities, a rich library, more than 90 microcomputers, and access to large computers. The campus is a large, nice, quiet place located in São Paulo. The faculty has more than 80 members working in algebra, analysis, geometry, logic, applied mathematics, computer science, statistics and probability. Send curriculum vitae, a letter describing past and present interest, and names of three or more references to Prof. Chaim S. Hönig, Dean, Instituto de Matemática e Estatística, Universidade de São Paulo, Caixa Postal 20570 CEP.01498 – São Paulo, SP, BRASIL.

Assistant Professor of Computer Science (tenure track-pending availability of funds). QUALIFICATIONS: Candidates with a Ph.D. in Computer Science are sought and individuals with a Master's degree in Computer Science plus 30 credits toward the terminal degree will also be considered. START September 1, 1987. SALARY RANGE: $23,979–$27,576. GENERAL INFORMATION: Glassboro State College is a multipurpose institution with an enrollment of 6,000 undergraduate and graduate students and 3,800 part-time students. Send resume by April 1, 1987 to: Dr. Khaled Amer, Hiring Committee (Pool #3), Department of Mathematics and Computer Science, Glassboro State College, Glassboro, New Jersey 08028, Telephone: (609) 863-6053. Glassboro State College is an affirmative action/equal opportunity employer. Applications from women, minorities, and the handicapped are encouraged.

THE UNIVERSITY OF TENNESSEE AT CHATTANOOGA ENDOWED CHAIR OF EXCELLENCE IN APPLIED MATHEMATICS

The University of Tennessee at Chattanooga is seeking candidates for a newly established Chair of Excellence in Applied Mathematics, funded by an endowment of one million dollars raised from both private and state funds.

The holder of the chair would be expected to offer seminars, conduct research in his or her major areas of interest, and stimulate and direct student research projects. In addition, the holder would be expected to promote mathematics and mathematics education in the community. Teaching duties would consist of an appropriate upper level mathematics course each semester.

The successful candidate will hold the Ph.D. with a specialization in an area of applied mathematics and will have an established record of research, publication, and excellence in teaching. Candidates will be considered for appointment at the full or associate professor level depending on qualifications and experience. Applications, nominations, or requests for further information should be addressed to:

Dr. John E. Trimpey, Dean
Chair Search Committee
College of Arts and Sciences
University of Tennessee
at Chattanooga
Chattanooga, Tennessee 37403

Applications should include a transcript of the highest degree held and/or letters designating honorary entitlements, current resume, and the names and addresses of five referees. Review of applications will begin March 1, 1987.

The University of Tennessee at Chattanooga is an equal opportunity employer.

DePaul University
Department of Mathematics
Chicago, Illinois 60614

Three tenure-track positions are available beginning in September 1987. Jobs will probably be at the assistant professor level, but associate professors may apply. A PhD in mathematics is required.

Candidates should show potential for continuing mathematical research and have a strong commitment to good teaching. The official teaching load is nine quarter courses/year, but a reduction to seven quarter courses/year for sustained research is typical. Summer teaching is often available.

Applicants should send a vita and 3–4 letters of recommendation at least one of which comments on their teaching to: Hiring Committee, Department of Mathematics, 2323 N. Seminary, Chicago, Illinois 60614. DePaul University is an AA/EOE.

STATE UNIVERSITY OF NEW YORK AT BINGHAMTON
Department of Mathematical Sciences

Invites applications at all levels for Fall 1987 and Fall 1988. Senior applicants must have an outstanding research record. Junior applicants must show great promise. All areas will be considered. The department's special needs are: (a) a senior analyst of international reputation to lead the development of an analysis group; (b) a junior or senior statistician to join an already prominent group; (c) a probabilist; (d) expertise in mathematical computer science. The department has a healthy doctoral program and an attractive future. Vita and letter to: David L. Hanson, Chairman, Dept. of Math. Sciences, SUNY-Binghamton, Binghamton, NY 13901. An AA/EO employer.

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Applications are invited for a tenure-track or tenure position in Mathematics beginning Fall 1987. Candidates must have demonstrated excellence in research and teaching. Research areas of particular interest to our department are Algebraic Geometry, Mathematical Physics, Lie Theory, and applied areas of Analysis. Applicants should send a curriculum vitae and see that at least three letters of recommendation are sent to:

Professor Bun Wong, Chair
Mathematics Search Committee
Department of Mathematics and Computer Science
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Riverside, CA 92521

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University of Toledo Department of Mathematics Toledo, Ohio 43606

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The Division of Mathematics, Computer Science and Systems Design invites applications for tenure-track positions in applied mathematics in the fall of 1987 at the level of Assistant or Associate professor. Strong candidates who can interact with local research laboratories are encouraged to apply. Preference will be given to those candidates whose research complements the interests of our current faculty. A Ph.D. is required.

Send vita and 3 letters of recommendation to: Dr. David Eberly, Search Committee, Division of Mathematics, Computer Science, and Systems Design, The University of Texas at San Antonio, San Antonio, Texas 78285-0664. UTSA is an Equal Opportunity/Affirmative Action Employer.

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Applicants should send resume, transcripts and three letters of reference to: Rev. Robert A. Haus, S. J., Chairman, Department of Mathematics, Canisius College, Buffalo, New York 14208. AA/EOE.

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Department of Mathematics/Computer Science, Eastern Connecticut State University, invites applications for tenure track mathematics assistant/associate professor, expertise in applications and/or Computer Science. Mathematics Ph.D., verification of successful undergraduate teaching, evidence of scholarly activity required. Duties: mathematics/computer science undergraduate teaching, advising students, departmental committee participation. Send resume, letter of interest, names, addresses, telephone numbers of four references to Dr. John Sharlow, Chair, Department Mathematics/Computer Science, E.C.S.U., Willimantic, CT 06226 by May 1, 1987. E.C.S.U. is an AA/EOE.

Department of Mathematics and Statistics
McGill University

Subject to budgetary approval, the Department of Mathematics and Statistics at McGill University is seeking to fill two tenure track Assistant Professorships in September 1987 and a further two in September 1988. Candidates should have a Ph.D. and a solid record of achievement in research.

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Professor M. Herschorn, Chairman
Department of Mathematics and Statistics
McGill University
805 Sherbrooke Street West
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Please include a statement of research accomplishments and plans along with your letter of application, and arrange for 3 letters of recommendation to be forwarded. McGill University is an equal opportunity employer, but in accordance with the Canadian Immigration requirements priority will be given to Canadian citizens and permanent residents.

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BOOKS WANTED

I am trying to locate a copy of the following book: GIKHMAN/SKOROKHOD-*Introduction to the Theory of Random Processes* (Saunders, 1969). Will gladly pay any reasonable amount. Please contact: Jacob Salamon, 1228 Georgian Terrace, Lakewood, New Jersey 08701.

PUBLICATIONS

Journal of Number Theory

The Journal of Number Theory appears in 3 volumes per year (9 issues) beginning January 1987.

The time between submission of a manuscript that has been accepted by the editors without reservations and its publication in the Journal is now already less than a year. Further reduction of the lead time is expected. Submission of research papers on number theory and allied fields (including automorphic functions and computational number theory) is invited.

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Math/Stats Library: List from R. Chesters, Suite 1900, 2 First Canadian Place, Toronto, Canada M5X 1E3.

HELDERMANN VERLAG, Nassauische Str. 26, D-1000 Berlin-West 31. Just published: W. H. Cornish, Antimorphic action, Categories of algebraic structures with involutions or anti-endomorphisms, $24. W. Taylor, The clone of a topological space, $20. S. Wolfenstein (ed), Algebra and order, Proc. First Int. Symp. Ordered Algebraic Structures, Luminy-Marseilles 1984, $36.

NOTES ON ABSTRACT AND LINEAR ALGEBRA
E. H. Connell

These notes are written with the philosophy that abstract algebra should preceed linear algebra, and that a course in abstract and linear algebra should stand along with calculus at the base of the curriculum. The present courses in cookbook linear algebra and discrete mathematics are educational disasters, and would best be replaced by a year course which presents a coherent theory. These notes are not designed to teach the course, but rather to give a tightly organized presentation of the basic material. They are intended for students in mathematics, science, and computer science, and may be used as a text or as a supplement to a conventional text. There are chapters on groups, rings, matrices, and linear algebra. For course use, they may be reproduced at your local Kinko's. To order, send $7.75 to Kinko's, 1212 South Dixie, Coral Gables, FL 33146.

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David Mitzman

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NONCOMMUTATIVE HARMONIC ANALYSIS
Michael E. Taylor

This book explores some basic roles of Lie groups in linear analysis, with particular emphasis on the generalizations of the Fourier transform and the study of partial differential equations. It began as lecture notes for a one-semester graduate course given by the author in noncommutative harmonic analysis. It is a valuable resource for both graduate students and faculty, and requires only a background with Fourier analysis and basic functional analysis, plus the first few chapters of a standard text on Lie groups.

The basic method of noncommutative harmonic analysis, a generalization of Fourier analysis, is to synthesize operators on a space on which a Lie group has a unitary representation from operators on irreducible representation spaces. Though the general study is far from complete, this book covers a great deal of the progress that has been made on important classes of Lie groups.

Unlike many other books on harmonic analysis, this book focuses on the relationship between harmonic analysis and partial differential equations. The author considers many classical PDEs, particularly boundary value problems for domains with simple shapes, that exhibit noncommutative groups of symmetries. Also, the book contains detailed work, which has not previously been published, on the harmonic analysis of the Heisenberg group and harmonic analysis on cones.

Contents
Some basic concepts of Lie group representation theory; The Heisenberg group; The unitary group; Compact Lie groups; Harmonic analysis on spheres; Induced representations, systems of imprimitivity, and semidirect products; Nilpotent Lie groups; Harmonic analysis on cones; $SL(2, R)$; $SL(2, \mathbf{C})$, and more general Lorentz groups; Groups of conformal transformations; The symplectic group and the metaplectic group; Spinors; Semisimple Lie groups

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CONTRIBUTIONS TO GROUP THEORY
Kenneth I. Appel, John G. Ratcliffe and Paul E. Schupp, Editors

This book, produced as a tribute to Roger Lyndon on his 65th birthday, contains five short articles on the man and his mathematics, and twenty-seven research papers on topics in combinatorial group theory, particularly those areas to which he himself had made important contributions (which is virtually no restriction at all). The more historical articles include an authoritative account by Saunders Mac Lane of the beginnings of the theory of spectral sequences. Among the topics which recur frequently in the research papers are cohomology, automorphism groups, the solubility of equations over groups, and connections with geometry, both classical and modern. Naturally, these papers vary in weight, but none is trivial, and some are important. Only the most determinedly finite of group theorists will want to ignore this book: most of us will enjoy it immensely.

– Graham Higman
University of Illinois, Urbana-Champaign

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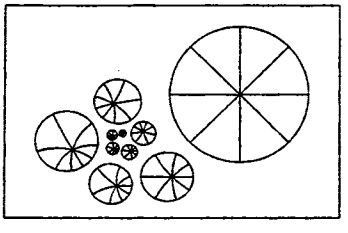

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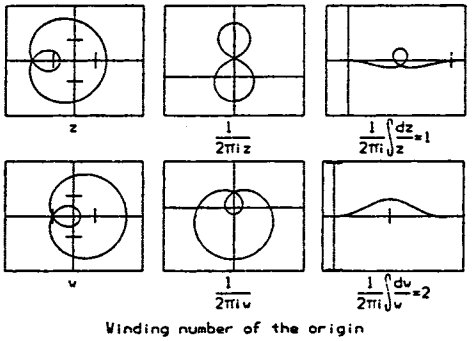

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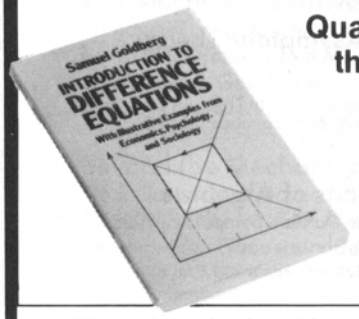

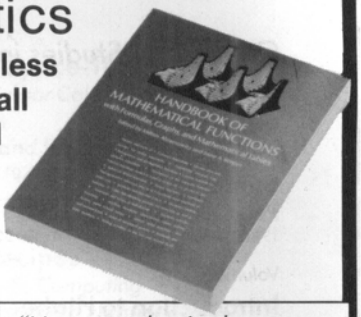

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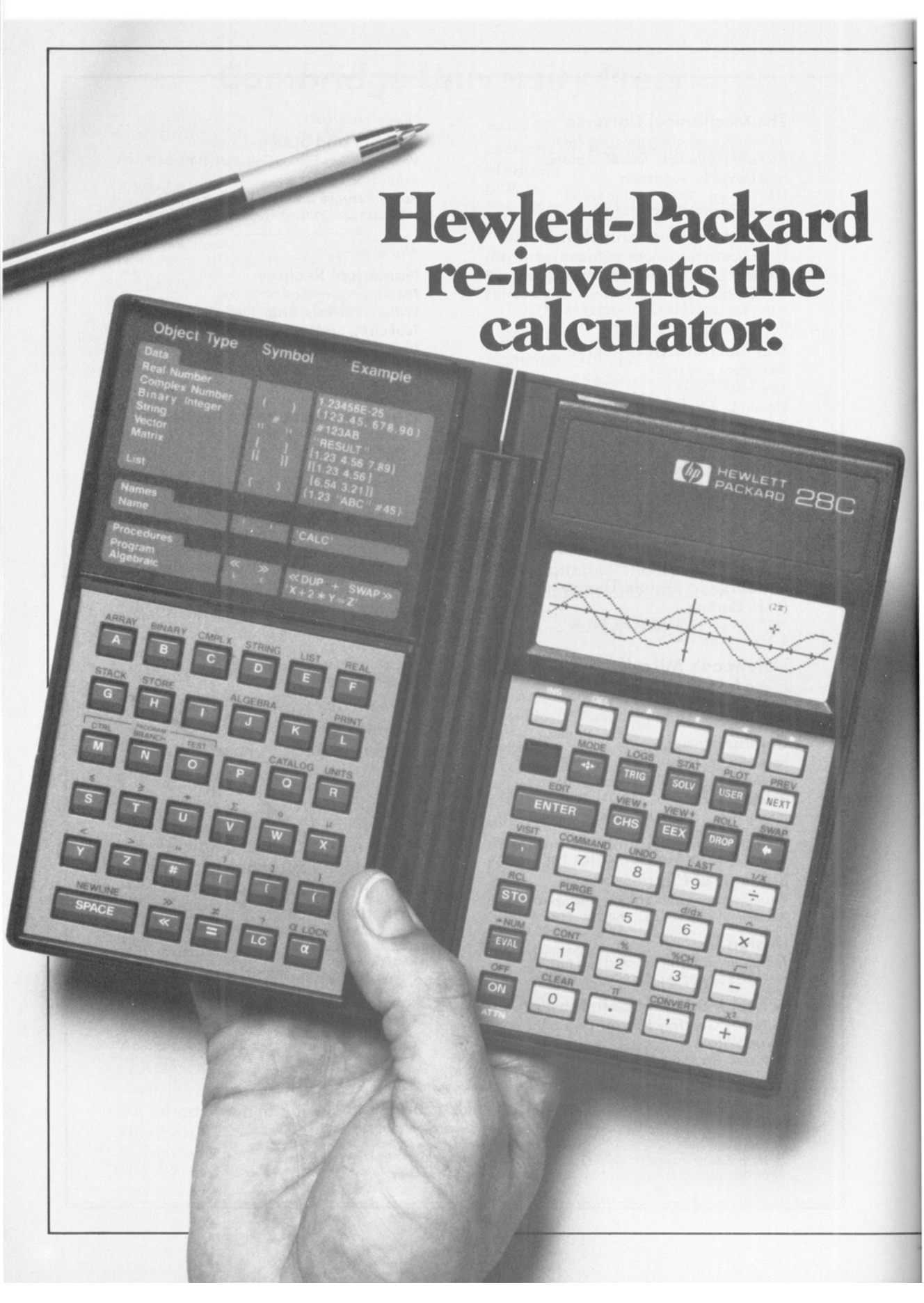
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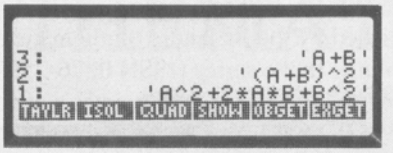

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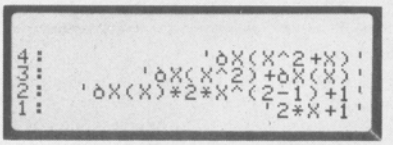

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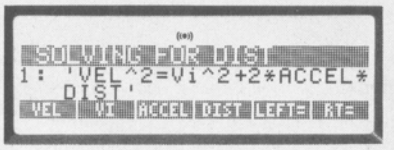

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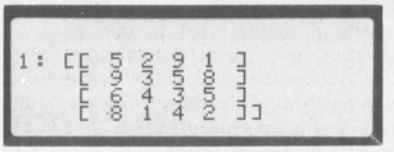

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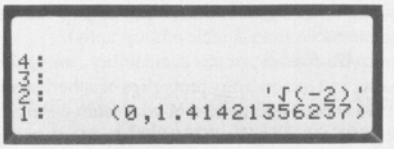

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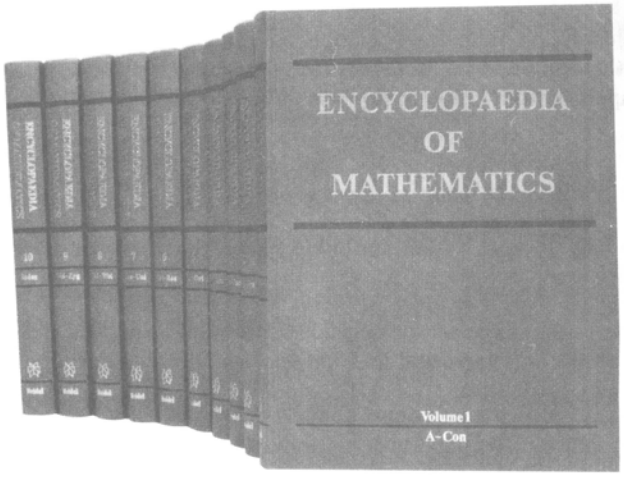

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