Calendar of AMS Meetings and Conferences

This calendar lists all meetings and conferences approved prior to the date this issue went to press. The summer and annual meetings are joint meetings of the Mathematical Association of America and the American Mathematical Society. The meeting dates which fall rather far in the future are subject to change; this is particularly true of meetings to which no numbers have been assigned. Programs of the meetings will appear in the issues indicated below. First and supplementary announcements of the meetings will have appeared in earlier issues. Abstracts of papers presented at a meeting of the Society are published in the journal Abstracts of papers presented to the American Mathematical Society in the issue corresponding to that of the Notices which contains the program of the meeting, insofar as is possible. Abstracts should be submitted on special forms which are available in many departments of mathematics and from the headquarters office of the Society. Abstracts of papers to be presented at the meeting must be received at the headquarters of the Society in Providence, Rhode Island, on or before the deadline given below for the meeting. The abstract deadlines listed below should be carefully reviewed since an abstract deadline may expire before publication of a first announcement. 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 special sessions.

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(96th Summer Meeting)

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(100th Annual Meeting)

(101st Annual Meeting)

(102nd Annual Meeting)

* Please refer to page 337 for listing of Special Sessions.

Conferences

June 13–July 4, 1992: Joint Summer Research Conferences in the Mathematical Sciences, Mount Holyoke College, South Hadley, Massachusetts.

July 6–24, 1992: AMS Summer Research Institute on Quadratic forms and division algebras: Connections with algebraic K-theory and algebraic geometry, University of California, Santa Barbara.

July 26–August 1, 1992: AMS-SIAM Summer Seminar in Applied Mathematics, Exploiting symmetry in applied and numerical analysis, Colorado State University, Fort Collins, Colorado.

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

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286 The NSF Budget Request for Fiscal Year 1993
The NSF budget request for 1993 contains flat funding for disciplinary research in mathematics and a hefty increase for several cross-disciplinary initiatives. Allyn Jackson reports on some of the strong reactions from the mathematics community. Also included is budget information prepared by NSF staff for the mathematics division, some computer science divisions, and the education directorate.

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This article contains excerpts of an address delivered by Walter E. Massey at the Joint Mathematics Meetings in Baltimore.

FEATURE COLUMNS

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311 Inside the AMS
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317 Washington Outlook
Lisa A. Thompson examines the mathematical sciences in the FY 1993 Budget.
From the Executive Director . . .

WHAT IS THE MESSAGE?

Many pages of this issue of the Notices are devoted to reporting and commenting on federal funding of mathematics, particularly on the National Science Foundation (NSF) budget request for fiscal year 1993. There has to be serious concern about the amount requested for big project development, and at what cost to basic science, as well as the amount slated for directed research in pursuit of specific goals and objectives. Particularly alarming to mathematics is the FY93 request from the Division of Mathematical Sciences at NSF, which contains zero increment in undirected research support for the mathematical sciences. Is there a message in this request about the future of federal funding of science? of mathematics?

This column (December 1991) reported on a mood in federal circles that the government is funding enough basic, undirected research. This mood is related to efforts to encourage technological solutions to societal problems and technological innovation for economic competitiveness. Hence, the federal government is increasingly directing civilian research toward solving the nation’s societal and economic woes. Since the majority of undirected research is conducted in academia, the academic community is especially affected by this trend. In particular, some believe that academic researchers have not provided the leadership and initiative necessary to fuel economic growth and address serious societal issues. This view has been expressed specifically toward academic mathematics faculty.

The argument for integration of mathematical sciences into interdisciplinary research, connections with industry, and solutions to problems in mathematics education is one that must be examined. Will new monies in directed research make a difference? Some researchers may move toward the initiatives being promoted, but any major change must come from our community itself. And, if federally directed research is to engage the power of mathematics to help solve societal and economic problems, then the government must recognize the role of mathematics in science and technology and make a serious commitment to the support of applications of mathematics. Mathematics, so far, has been at best an afterthought to federal research initiatives. The new monies for mathematics at NSF were not easily come by.

We must continue to make the case for the connections of mathematics to its applications and to education. However, there is another message we must deliver. We must make the case for mathematics. We must show that, in the long run, neglect of basic, undirected research in mathematics will be detrimental to all science and technology and to society. How much support is needed for mathematics? There must be enough to guarantee diversity, for no one is able to predict with any reliability which mathematical discoveries will be important or applied. There must be enough support to protect the essential infrastructure and to provide adequate training for future students of mathematics and future mathematicians. It is important to recognize that responsibility for support of mathematics does not rest with the federal government alone. Colleges and universities must recognize that they have been exploiting the mathematics community and it is now time to pay the bill. Mathematics faculty must recognize their responsibilities for facilitating the understanding and uses of mathematics and for reforming mathematics education. Our professional organizations must provide the discipline with leadership and collective representation on behalf of these efforts.

William Jaco
The Frank Nelson Cole Prize in Algebra is awarded every five years for a notable research memoir in algebra which has appeared during the previous five years. This prize, as well as the Frank Nelson Cole Prize in Number Theory, 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-Fourth Cole Prize was awarded jointly to Karl Rubin of Ohio State University and Paul Vojta of the University of California at Berkeley. The prize was awarded at the Society’s ninety-eighth Annual Meeting in Baltimore. The Cole Prize was awarded by the Council of the American Mathematical Society, acting through a selection committee consisting of Gerd Faltings, Wilfried Schmid, and Harold Stark (Chair).

The text below includes the Committee’s citations, the recipients’ responses to the award, and a brief biographical sketch of each of the recipients.

Karl Rubin

Citation
To Karl Rubin for his work in the area of elliptic curves and Iwasawa Theory with particular reference to his papers “Tate-Shafarevich groups and L-functions of elliptic curves with complex multiplication” and “The ‘main conjectures’ of Iwasawa theory for imaginary quadratic fields.”

Response
I would like to thank the American Mathematical Society for this award. It is also a great pleasure on this occasion to acknowledge the work of Francisco Thaine and of Victor Kolyvagin. Without their wonderful new ideas, the two papers of mine which were cited by the Cole Prize Committee could not have come about.

During the past few decades, there has been a great deal of research on elliptic curves defined over the rational numbers. One of the fundamental questions in this area is the conjecture of Birch and Swinnerton-Dyer. This conjecture, which grew out of computer calculations in the late 1950s and early 1960s, relates the arithmetic of an elliptic curve with the behavior of its L-function at the point 1. The first important breakthrough in the direction of this conjecture was made by Coates and Wiles in 1977. They proved that if an elliptic curve over the rational numbers has complex multiplication, and its L-function does not vanish at 1, then the curve has only finitely many rational points. My work is a natural outgrowth of theirs, obtained by combining their techniques with the methods of Thaine and Kolyvagin. Under the same hypotheses, I showed that the Tate-Shafarevich group is finite and has the order predicted by the Birch and Swinnerton-Dyer conjecture, to within powers of 2.
and 3. Further, if the $L$-function instead has a simple zero at 1, then the group of rational points has rank one as predicted by Birch and Swinnerton-Dyer. Most of these results have now been proved by Kolyvagin for the larger class of modular elliptic curves, without the assumption of complex multiplication. Combined with work of Gross and Zagier, these results go a long way toward settling the Birch and Swinnerton-Dyer conjecture when the $L$-function of the elliptic curve has a zero of order at most one at the point 1. The current great mystery of this subject is that almost nothing is known about the cases where the $L$-function has a zero of order greater than one.

In closing, I would also like to thank my colleagues in the Ohio State University mathematics department for the support they have shown for my research and for going to great lengths to provide me with a productive research environment.

**Biographical Sketch**

Karl Rubin was born on January 27, 1956 in Urbana, Illinois. After attending Washington, D.C. public schools, he received an A.B. degree from Princeton University in 1976 and M.A. (1977) and Ph.D. (1981) degrees from Harvard University. He has been on the faculty of Ohio State University since 1984, first as an Assistant Professor and, since 1987, as a Professor. In the academic year 1988–1989 he was a Professor at Columbia University.

In 1990 and 1991 Professor Rubin was a member of the AMS Centennial Fellowship Committee. He gave invited hour addresses at AMS meetings in East Lansing (March 1988) and Worcester (April 1989) and he spoke in the Special Session on Algebraic Geometry and Number Theory in Muncie (October 1989).

Professor Rubin was a National Science Foundation Postdoctoral Fellow (1981–1984), a Sloan Fellow (1985–1987), and an Ohio State University Distinguished Scholar (1987–1990), and is a Presidential Young Investigator (1988–1993). He has held one-year visiting positions at the Institute for Advanced Study in Princeton and the Mathematical Sciences Research Institute in Berkeley, and has visited for shorter periods at the Institut des Hautes Études Scientifiques (Paris), the Max-Planck-Institut für Mathematik (Bonn), and the Nankai Institute (Tianjin).

**Paul Vojta**

**Citation**

To Paul Vojta for his work on Diophantine problems with particular reference to his paper "Siegel's theorem in the compact case."

**Response**

I would like to express my warmest thanks to the American Mathematical Society, and to the Cole Prize Committee in particular, for granting me this honor. I also thank numerous colleagues and former teachers for their assistance and encouragement.

The diophantine problems considered in my paper are systems of polynomial equations for which one searches for solutions in either rational numbers or integers. In the case of integral solutions, Siegel proved in 1929 that certain one dimensional systems of equations have only finitely many solutions. Siegel's proof was based on work of Thue in 1909: he constructed an auxiliary polynomial and used properties of that polynomial to derive a contradiction if there were too many solutions.
1992 Cole Prize in Algebra

The finiteness theorem for rational points on subvarieties of abelian varieties.

Biographical Sketch

Paul Vojta was born on September 30, 1957 in Minneapolis, Minnesota. He received his B.Math. in 1978 from the University of Minnesota and his Ph.D. from Harvard University in 1983. He wrote his thesis, "Integral points on varieties," under the direction of Barry Mazur.

Professor Vojta held the position of Gibbs Instructor at Yale University from 1983 to 1986, and spent the following year at the Mathematical Sciences Research Institute in Berkeley. During the years 1984–1987, he also held a National Science Foundation Postdoctoral Fellowship. He spent the next two years at the Berkeley campus of the University of California as a Fellow, supported by the Miller Institute for Basic Research in Science. Since 1989, he has been an Associate Professor of Mathematics at the University of California, Berkeley, during which time he spent 1989–1990 at the Institute for Advanced Study in Princeton.


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1992 Award for
Distinguished Public Service

Proper recognition for mathematicians who contribute valuable service to the profession is a matter of great importance to the Society. The continued growth and health of the discipline is greatly dependent on those individuals who contribute their time to public service activities in support of mathematics. To provide encouragement and recognition for such service, the Council of the American Mathematical Society, responding to a recommendation from the Society’s Committee on Science Policy, established the Award for Distinguished Public Service. The amount of the Award is $2,500.

The Award is to be presented every two years to a research mathematician who has made a distinguished contribution to the mathematics profession through public service during the preceding five years. The second Award for Distinguished Public Service was presented to HARVEY B. KEYNES of the University of Minnesota. The Award was made by the Council of the American Mathematical Society, acting through a selection committee consisting of William Browder, Ronald G. Douglas (Chair), Robert M. Fossum, John C. Polking, and David P. Roselle.

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

Harvey B. Keynes

Citation
For his multifaceted efforts to revitalize mathematics education, especially for young people. Keynes career encapsulates, in a single individual, the tripartite mission of the university: education, research, and service.

Response
I am very honored and deeply humbled to be chosen by my colleagues and the Society for the Award for Distinguished Public Service. It is very humbling to be linked with the first award winner, Ken Hoffman, and his outstanding work in Washington with the Mathematical Sciences Education Board (MSEB) and the National Academy of Sciences. Even in the relatively new area of public involvement in mathematics, one can already begin to stand on the shoulders of giants.

It is extremely gratifying and encouraging to realize the dramatic current changes in attitudes and activities within the Society and our profession towards education and public service. Just a very few years ago, it was difficult to find many mathematicians who would be willing to admit that they were seriously looking at issues in the public arena. It is truly impressive to see the growing levels of involvement of the Society and its newly formed Committee on Education, the continuing activities of the Mathematical Association of America (MAA) and the Society for Industrial and Applied Mathematics (SIAM), and the ongoing programs of MSEB and the State Mathematics Coalitions. The current wealth of activities has greatly helped to bring into full bloom some of my modest initial efforts with networks and coalitions.

I really became involved in public service during my stint at the National Science Foundation (NSF) from 1982–1983. A clear message for more involvement from the nation’s
scientists came from the then NSF Director, Ed Knapp. The exploding interest in education generated by A Nation at Risk contrasted with the reality that public service and an awareness of its impact was a difficult aspect for scientists to value. The mathematics community historically was among the least responsive. It was a challenge to me personally to see how I could work public service into my own career path. I have learned a great deal from the choice. One aspect is that it is really not very glamorous work. Indeed, public service is very public and requires lots of service to all sorts of constituencies to carry out even a very small change. Perseverance, political savvy, and a generous dose of luck are important ingredients. More frequently than not, some ideas which initially seem very catalytic just plain fizzle. This makes the Society’s Award even more meaningful to me, and hopefully will inspire more mathematicians to get involved in the public sector.

The mathematics community has leapfrogged ahead of most of the other sciences in identifying the issues and suggesting programs for major improvements in the ways we teach and communicate mathematics. The National Council of Teachers of Mathematics (NCTM) Standards are now widely accepted and as a K-12 curriculum framework, and the discussions engendered by Moving Beyond Myths as well as the rising number of collegiate curricular projects will surely have a major influence on undergraduate mathematics. Even in the thorny and complex issue of assessment, the mathematics community has identified good assessment models which nevertheless may be very difficult to sell to the public. But the major issue is time. The public, from the President downward, is supportive of mathematics reform and anxious to see some real changes soon. While we all know that institutionalizing real changes takes years and even decades, we need to start now, and with some bold moves. If the mathematics community moves too slowly, we could well lose the interest and support of the public sector.

The current economic climate will certainly challenge interest in the public arena and the ability to sustain momentum for important ideas and programs. One lesson that comes out very clearly in this fiscal mess is best illustrated by a Laurel and Hardy skit. Down to their last nickel and desperate for a drink, they decide to split a big glass of root beer. After 10 minutes of classical Laurel and Hardy dialogue, it is decided to let Hardy drink first. He proceeds to pick up the glass, and in one monstrous swig downs the entire glass. Outraged, Laurel demands to know what happened to his half. Hardy looks him squarely in the eye and says, “My half was the bottom half.” It is a growing art in the mathematics community to learn how to protect our highly visible and recognized top half of the fiscal well from the bottom-half drinkers.

It would be impossible to thank individually all of the members of our community who have helped me so much and who could very well be sharing this award. Many leaders in MSEB, the AMS, MAA, and NSF have provided professional and personal advice. Special recognition needs to be given to several individuals who have been particularly influential. My co-directors in various projects—Lynn Steen, Naomi Fisher, and Phil Wagreich—have provided wonderful support. The capabilities of the entire staff in the Special Projects Office at the University have contributed immensely to whatever successes our projects have enjoyed. Finally, the School of Mathematics has been highly supportive in allowing me the freedom to pursue these different and sometimes controversial directions.

What really motivates involvement in the public sector is a deep belief in the importance and impact of mathematics on the lives of many people. The acknowledgment of my peers and colleagues for my efforts is the highest form of honor and recognition that I could imagine. I thank the Selection Committee and Executive Committee for what surely must have been a difficult task, and hope that I can continue to represent the Society with the same level of distinction.

**Biographical Sketch**

Born in 1940 in Philadelphia, PA, Harvey B. Keynes received his B.A. (with honors) in 1962 and M.A. in 1963, both in mathematics from the University of Pennsylvania, and his Ph.D. in mathematics from Wesleyan University in 1966. After holding an assistant professorship at the University of California, Santa Barbara, from 1966–1968, he joined the faculty of the University of Minnesota in 1968. He was promoted to associate professor in 1971 and to full professor in 1978. He has also held numerous visiting appointments at the University of Maryland, University of California, Berkeley, Warwick University and the University of Sussex, England, and the University of Witwatersrand, South Africa.

Professor Keynes was Associate Head of the School of Mathematics from 1979–1982, and has been Director of Outreach Projects in the School since 1983. He is also currently the Director of Education at the NSF Geometry Center. He was a program director in the Modern Analysis program at the National Science Foundation from 1982–1983.

A long-standing interest of Professor Keynes has been the University of Minnesota Talented Youth Mathematics Program (UMTYMP)—an intense and accelerated mathematics program for highly talented mathematics students in grades 5–12. Program Director since 1980, Professor Keynes has overseen its growth from a small pilot project to its current enrollment of over 460 students at four sites throughout the state of Minnesota, and an annual budget of over $600,000. UMTYMP has developed special curricula at both the high school and collegiate level, supporting intervention projects, and a philosophy of education which enables it to direct the mathematics education of Minnesota’s most mathematically gifted students over a five to seven year period. Recent activities include a very successful major intervention project to increase the involvement and success of female students in UMTYMP, and a new technology-intensive alternative course designed to increase participation of students of color.
Professor Keynes has also been heavily involved in establishing mathematics networks and collaboratives. These programs bring together mathematicians and mathematics educators at all levels, business leaders, and government officials to discuss broad policy issues for mathematics education and actively advocate for reform and change. Although heavily focused on teaching and learning, these highly collaborative programs seek to increase involvement of all constituencies. Network projects directed or co-directed by Keynes include the National Mathematicians and Education Reform (MER) Network, the statewide Minnesota Mathematics Mobilization (M^3), and the local Twin Cities Urban Mathematics Collaborative. M^3 has served as a model project for the MSEB-directed State Mathematics Coalitions Project, and Professor Keynes has consulted with MSEB on this project.

Since 1985, Professor Keynes has served on a variety of panels and committees to look at programs and examine issues in mathematics and mathematics education. These include membership on the AMS Committee on Education, the MAA Science Policy Committee, the Sigma Xi Committee on Science, Mathematics, and Engineering Education, and the Advisory Board of the National Center for Research in Mathematics Sciences Education. Keynes was a member of both the Mathematics and Technology Panels of Project 2061, a member of the Kentucky NSF Experimental Program to Stimulate Competitive Research (EPSCoR) Advisory Committee, and a member of the American Mathematics Project Advisory Committee. He is currently a member of the Mathematical Sciences Education Board.

Keynes' main direction of mathematical interest is in the area of topological aspects of dynamical systems. His research concentrates on topological problems suggested by important aspects of measurable ergodic theory or smooth dynamics. This research includes extended studies of topological notions of mixing and prime flows, expansive properties and, most recently, cocycles and suspension flows. In addition to mathematics research publications, Professor Keynes has recently written several papers on a variety of topics in mathematics education.

Professor Keynes is a member of the AMS, the MAA, and the Association for Women in Mathematics. Keynes is also a member of the Executive Committee of the Geometry Center at the University of Minnesota.
1992 Citation for Public Service

Proper recognition for individuals who contribute valuable service to the mathematics profession is a matter of great importance to the Society. The continued growth and health of the discipline is greatly dependent on those individuals who contribute their time to public service activities in support of mathematics. To provide encouragement and recognition for such service, the AMS Council, in response to a recommendation of the Society’s Committee on Science Policy, established the Citation for Public Service. One to three $500 awards are presented each year to individuals who have made notable contributions to the mathematics profession through public service.

The second such award, the 1992 Citation for Public Service, was presented at the Joint Mathematics Meetings in Baltimore to MARCIA P. SWARD, Executive Director of the Mathematical Association of America. The Award was made by the AMS Council on the recommendation of a selection committee consisting of William Browder, Ronald G. Douglas (chair), Robert M. Fossum, John C. Polking, and David P. Roselle.

The text that follows contains the committee’s citation for the award, the recipient’s response on presentation of the award, and a brief biographical sketch of the recipient.

Marcia P. Sward

Citation
For her contributions toward establishing and directing the Mathematical Sciences Education Board (MSEB) from its inception in the fall of 1985 until August 1989. She blended a deep understanding of educational issues with vision, judgement, creative management, and unswerving optimism to transform the MSEB from an untested dream into what is widely recognized as one of the premier national leadership organizations in the country.

Response
I am pleased to accept the AMS Award for Public Service in recognition of my work in launching the Mathematical Sciences Education Board at the National Research Council. The concept of the MSEB was developed in 1984 by a committee of the Conference Board of the Mathematical Sciences (CBMS), chaired by Paul Sally. It was envisioned as a “national steering committee for mathematics education,” providing guidance to the mathematics community as well as federal and state government, the educational establishment, and the general public.

After much discussion, it was decided that the best “institutional home” for this new entity was the National Research Council, the action arm of the National Academies of Science and Engineering. Ken Hoffman, then serving as the “Washington Presence” for the mathematical sciences community, and I spent an extremely concentrated six weeks, working seven days a week, 12–14 hours a day, fleshing out the idea and preparing a formal proposal for presentation to the Governing Board of the Academy in February 1985.

The Governing Board considered our proposal and, with the strong support of Academy President Frank Press, approved the establishment of such a board on an experimental basis and provided modest start-up funds. I accepted the
position of Executive Director, a 33-member board was appointed with Shirely Hill as its chair, and we were launched on a promising, but extremely challenging, new enterprise.

From its modest beginnings, the MSEB has now grown into a major unit of the Academy, with a staff of over 30. Various activities, including conferences such as "Calculus for a New Century," and publications such as "Everybody Counts," moved the MSEB into the national spotlight and a position of considerable influence in the national politics of education.

Biographical Sketch
Marcia Sward obtained her B.A. degree (summa cum laude) from Vassar College with a major in mathematics and a minor in Russian, and she received her masters and doctoral degrees in mathematics from the University of Illinois. She served as assistant professor and associate professor at Trinity College in Washington, D.C. from 1968 to 1980 and also served as chairperson of the mathematics department (1979–1980). In addition, she held a position as assistant professor at Catholic University during the summers of 1968–1971. For one year she served as operations research analyst in the University Fellowship Program of the National Highway Traffic Safety Administration. In September 1980, she was appointed Associate Director of the Mathematical Association of America (MAA). During 1982–1985, she also served in a part-time capacity as Administrative Officer of the Conference Board of the Mathematical Sciences, located in MAA headquarters, until she moved to the MSEB position at the end of 1985. She served in this role for four years before returning to the MAA in September 1989 as Executive Director.
Alberto P. Calderón, University Professor Emeritus of Mathematics at the University of Chicago, received the National Medal of Science on September 16, 1991. The medal is the nation's highest award for scientific achievements. One of twenty medalists, Professor Calderón was cited "for his ground-breaking work on singular integral operators leading to their application to important problems in partial differential equations, including his proof of uniqueness in the Cauchy problem, the Atiyah-Singer index theorem, and the propagation of singularities in non-linear equations."

Commentary on Calderón's Research

The Managing Editor of the Notices solicited the following piece describing Calderón's mathematical achievements. The piece was written by Richard W. Beals, Ronald R. Coifman, and Peter W. Jones, all of Yale University.

The last forty years have seen remarkable progress in analysis, and much of this is a result of Calderón's seminal work and ideas. In long term collaboration with Antoni Zygmund, he established the so-called Calderón-Zygmund school of analysis. (Further background may be found in the article "The School of Antoni Zygmund," by Ronald R. Coifman and Robert S. Strichartz, which appears in A Century of Mathematics in America (AMS, 1989), vol. 3, pages 343-368.) His fundamental contributions to partial differential equations and concrete operator theory have profoundly affected modern mathematics.

The Zygmund program bucked the trend in the fifties toward abstract mathematics by concentrating on basic questions of real and complex analysis. It had as a goal the development of methods for understanding the structure of natural operations on functions, culminating in "Calderón-Zygmund Theory." Calderón, Zygmund, and their students developed tools for understanding the relations between differentiability properties of functions and the properties of their harmonic or holomorphic extensions (Hardy spaces and boundary value problems). For example, holomorphic functions \( f = u + iv \) on the upper half-plane \( \{ x + iy : y > 0 \} \) have the property that, on the boundary, \( v = Hu \), where \( H \) is the Hilbert transform:

\[
Hu(x) = \lim_{\varepsilon \to 0} \frac{1}{\pi} \int_{|y-x|>\varepsilon} \frac{f(y)}{x-y} \, dy.
\]

The Hilbert transform is now understood to be one of the most important operators in analysis. Prior to the work of Calderón and Zygmund, this operator was primarily studied via methods from complex analysis. Calderón and Zygmund, following previous work of Marcinkiewicz, Riesz, and Zygmund, provided the modern, real variable tools for understanding this operator and explained why the limit in the definition of \( Hu \) exists almost everywhere and is a bounded operator when \( u \) is in a suitable space (e.g. \( L^2 \)).

These questions tied in naturally to the study of various operators generalizing the Hilbert transform (Calderón-Zygmund operators) which permitted a detailed understanding of the size relations between partial derivatives of functions on \( \mathbb{R}^n \). In \( \mathbb{R}^n \) one natural generalization is the Riesz transform \( R_j f(x) = \lim_{\varepsilon \to 0} c_n \int_{|y-x|>\varepsilon} \frac{(y_j-x_j)f(y)}{|x-y|^{n+1}} \, dy. \) By
taking Fourier transforms one can derive many identities such as
\[ \frac{\partial^2}{\partial x^2} f = R_y R_x \Delta f, f \in C^2, \]
so the Calderón-Zygmund results imply \( L^p \)-boundedness of mixed partials when \( \Delta f \in L^p \).

An example of the power of this point of view is given by considering the existence problem for solutions in \( \mathbb{R}^2 \) of the Beltrami equation:

\[ \bar{\partial} F = \mu \partial F \]

where \( \mu \in L^\infty(\mathbb{R}^2), \|\mu\|_\infty < 1 \). The Calderón-Zygmund theory shows that solutions may be written in a Neumann series and thus vary analytically in \( \mu \). The solutions \( F \) are quasi-conformal mappings with a given dilatation \( \mu \). This fact is one of the central results in modern complex analysis.

Calderón and Zygmund, in a series of seminal papers, developed fundamental real variable tools and established a calculus of singular integral operators, currently known as pseudodifferential calculus, profoundly affecting partial differential equations and creating interactions between geometry and analysis as in the Atiyah-Singer Index Theorem.

The main impetus for acceptance of the singular integral calculus as a principal tool in partial differential equations came through Calderón’s elegant treatment of uniqueness of solutions to the Cauchy problem for hyperbolic equations, and more spectacularly through his very general existence and uniqueness results for linear equations and systems. This groundbreaking result illustrated the power and flexibility of the new methodology and quickly became part of modern “calculus.”

Calderón continued this work (again bucking the trend), pushing for a calculus with minimum regularity assumptions on coefficients of differential operators. He felt that the development of such a calculus would enable a better analysis of nonlinear partial differential operators. This work led to deep estimates on commutator integrals and the establishment of Calderón-Zygmund analysis in a nonlinear context. In particular, Calderón succeeded by ingenious analytic methods in proving the boundedness on \( L^2 \) of the Cauchy integral for Lipschitz curves (with small constant), which implied the so-called Denjoy conjecture in complex analysis. The Cauchy integral is defined on a rectifiable curve \( \Gamma \) by

\[ C_f(z) = \lim_{\epsilon \to 0} \frac{1}{2\pi i} \int_{|\zeta - z| > \epsilon} \frac{f(\zeta)}{\zeta - z} d\zeta \]

It is not even clear that the limit exists for continuous \( f \). A remarkable aspect of this work is that, after developing the (real variable) Calderón-Zygmund theory, Calderón was not reluctant to return to the methods of complex analysis. This view had fallen out of favor, mostly due to the power of Calderón-Zygmund theory! His philosophy that one should use the Cauchy integral formula (\( C(1) \equiv 0 \)) has led to our present understanding of necessary and sufficient conditions for \( L^2 \) boundedness of general singular integrals.

Calderón, like his teacher and collaborator Zygmund, has focused his energy on the development of analytical tools permitting a blend of the “miracles” of complex analysis with a deep understanding of real variable inequalities. His paper developing the complex method of interpolation is a beautiful illustration of these ideas. Here the main point is to prove hard inequalities by embedding them in a one complex parameter family of inequalities where the extremities are easier to prove, thereby enabling the use of the maximum principle to prove the desired intermediate results. (Formally, this is known as interpolation of Banach spaces with norms depending on the complex parameter.) The paper on interpolation also introduced (as a synthesis of Littlewood-Paley theory) the so-called Calderón identities (currently known as the continuous wavelet transform) as a main tool for describing function spaces and their approximation properties. The Calderón identity states that for a large class of functions \( \psi \), one has for any \( F \) which is continuous and of compact support,

\[ F(x) = \int_0^\infty F * \psi_t * \psi_t \frac{dt}{t}, \]

where \( \psi_t(x) = t^{-n} \psi \left( \frac{x}{t} \right), x \in \mathbb{R}^n, t > 0 \). This identity allows one to write many natural operators \( T \) as

\[ T = \int_0^\infty T_t \frac{dt}{t}, \]

where the operators \( T_t \) are “simple” pieces of \( T \) which are more amenable to analysis. Clever choices of \( T_t \) allow one to write \( T = \sum_{n=-\infty}^{\infty} T_n, T_n = \int T_t \frac{dt}{t} \), where the operators \( T_n \) are essentially spectral projections which are almost diagonal. This has proved to be of great significance in numerical analysis and signal processing.

Another example of interaction between complex and real analysis is provided by the method introduced by Calderón to reduce boundary value problems to the solution of boundary pseudodifferential equations through the Calderón operator. He discovered this by recognizing the “real variable” role played by the Cauchy projection in solving Dirichlet and Neumann problems in the unit disk.

Calderón’s influence on analysis and related areas is due in large part to the many methods that he invented and perfected. In modern Fourier analysis, theorems are usually much less important than the techniques developed to prove them. Calderón’s techniques have been absorbed as standard tools of harmonic analysis and are now propagating into nonlinear analysis, partial differential equations, complex analysis, and even signal processing and numerical analysis.

**Biographical Sketch**

Alberto P. Calderón was born on September 14, 1920, in Mendoza, Argentina. After completing his secondary
education at the state high school of his home town, he enrolled in the engineering school of the University of Buenos Aires, from which he graduated as a civil engineer in 1947. He had always been interested in mathematics and soon became a student of Alberto González Domínguez and Antoni Zygmund, who was a visiting professor at the University of Buenos Aires in 1948. He finally received his doctorate in Mathematics from the University of Chicago in 1950, which he attended as a fellow of the Rockefeller Foundation.

Professor Calderón began his academic career as an assistant to the chair of electric circuit theory at the engineering school of the University of Buenos Aires (1948). After graduation from the University of Chicago, he became visiting associate professor at the Ohio State University (1950–1953). He also was a member of the Institute for Advanced Study in Princeton (1954-1955) and served as an associate professor at the Massachusetts Institute of Technology (1955–1959). He then moved to the University of Chicago, where he served as professor of mathematics (1959–1968), Louis Block Professor (1968–1972), and chairman of the mathematics department (1970–1972). In 1972, he returned to MIT as a professor of mathematics, and, in 1975, he became University Professor of Mathematics at the University of Chicago until his retirement in 1985. Currently, he is professor emeritus with a post-retirement appointment at Chicago and an honorary professor at the University of Buenos Aires; he had held the latter position since 1975. He also was, for short periods of time, a visiting professor at several American and European universities such as Cornell University, Stanford University, National University of Bogotá (Colombia), Collège de France, University of Paris (Sorbonne), University of Madrid, University of Rome, and University of Göttingen.

Professor Calderón has received the following awards and honors (in chronological order): “Provincia de Santa Fe” prize (I.P.C.L.A.R.), Argentina (1969); Honorary Doctorate, University of Buenos Aires (1969); AMS Bôcher Memorial Prize (1979); Konex Prize, Argentina (1983); Union Carbide Prize, Argentina (1984); “Consagración Nacional” Prize, Argentina (1989); Wolf Prize in Mathematics, Jerusalem, Israel (1989); AMS Steele Prize (fundamental research work category) (1989); and Honorary Doctorate, Technion, Israel (1989).

Professor Calderón has been elected a member of the following academies: American Academy of Arts and Sciences, U.S.A. (1957); National Academy of Exact, Physical and Natural Sciences, Buenos Aires, Argentina (1959); National Academy of Sciences, U.S.A. (1968); Royal Academy of Sciences, Madrid, Spain (1970); Latin American Academy of Sciences, Caracas, Venezuela (1983); French Academy of Sciences, Paris, France (1984); and Third World Academy of Sciences, Trieste, Italy (1984).

Professor Calderón presented an AMS Invited Address in University Park in 1957 and delivered the American Mathematical Society Colloquium Lectures on Singular Integrals in Ithaca in 1965. He also gave an Invited Address at the International Congress of Mathematicians in Moscow (1966).

Professor Calderón has been a member of the AMS for forty years. He was a Member-at-Large of its Council (1965–1967) and served on several of its committees, such as the Transactions and Memoirs Editorial Committee, the Nominating Committee, the Colloquium Editorial Committee, etc. He has also served as an associate editor of the Duke Mathematical Journal, Illinois Mathematical Journal, Journal of Functional Analysis, the Journal of Differential Equations, and Advances in Mathematics.

Professor Calderón has published some seventy-six scientific papers on various topics such as: Real Variables, Harmonic Analysis, Functional Analysis, Singular Integrals, and Partial Differential Equations. A number of these papers, mostly on Singular Integrals, were written in collaboration with his teacher, Professor Antoni Zygmund, and made his initial reputation as a mathematician. He also has had some twenty-seven doctoral students. Some of them in turn became reputed mathematicians as, for example, Robert T. Seeley, whose extension of the work of Calderón and Zygmund to singular integral operators on manifolds became the foundation of the famous Atiyah-Singer index theorem.
The National Science Foundation
Budget Request for Fiscal Year 1993

This article is the 20th in an annual series of reports outlining the President's request to Congress for the NSF budget. Last year's report appeared in the April 1991 issue of the Notices, page 285.

The National Science Foundation (NSF) budget request for fiscal year 1993 has set rumbles of discontent rolling through the mathematics community. What is it that's gotten everyone so riled up? In the request for the NSF's Division of Mathematical Sciences (DMS), the line for disciplinary research in mathematics, which contains funds for undirected, individual investigator research, has no requested increase, not even to cover inflation. The entire requested increase for the DMS is earmarked for research connected with several government-wide initiatives and for increasing the number of postdocs and graduate students.

"What I consider to be the most important part of NSF support gets a zero, and what I consider to be the special doooda projects get increases," says Clifford Taubes of Harvard University, a member of NSF's Advisory Committee for Mathematical Sciences. "I think the DMS staff do a great job, and they have the right priorities. But they're not setting policy." He believes the NSF has become an entrenched bureaucracy that is out of touch with the community. Others take a less radical view, but are no less concerned. Says John C. Polking of Rice University, a former director of DMS, the zero for disciplinary research "indicates that NSF and the federal research funding people have decided that mathematics is getting its fair share and are cutting back on basic research to fund more applied, directed research...I think it's regrettable."

Change in Budget Presentation

The budget tables accompanying this article are the usual ones published each year in the Notices, giving information about the DMS budget over the past few years; information about the disposition of funds within the DMS for fiscal year 1993 may be found in the NSF-prepared material following this article. This year, the NSF changed the way it presents its budget request to Congress: instead of one line for each of the nine DMS programs (Classical Analysis, Algebra and Number Theory, and so on), the entries were collapsed into just three lines. NSF officials say the change is part of a Foundation-wide effort to streamline the budget request.

The DMS request shows "Disciplinary Research in Mathematics" flat at $48.2 million, "Cross-Disciplinary and Computational Research" jumping almost 32% from the current level of $15.6 million, and the Office of Special Projects rising nearly 10% to $16.2 million. Overall, the increase for DMS is about 8%. A budget "crosswalk" shows most of the increase going into Applied Mathematics, Statistics and Probability, and Computational Mathematics, with a small increase in Algebra and Number Theory.¹

Initiatives a Priority

Throughout the NSF budget request, there is heavy participation in such federal initiatives as High Performance Computing and Communications (HPCC), Advanced Materials and Processing, and Biotechnology. These initiatives are coordinated by the Federal Coordinating Council on Science, Engineering, and Technology through committees made up of managers and directors in the various government agencies participating in the initiatives. In addition, there are internal NSF initiatives in Manufacturing and in Environmental Science. The DMS budget request contains funds for participation in all of these initiatives.

"NSF has made the initiatives high priority, emphasizing core support for individual investigators through growth in the initiatives," explains DMS director Judith S. Sunley. "In some sense, NSF expected that those divisions that could respond to the initiatives would do so. So what you're seeing are the priorities of NSF and of the government at large. There is no intended message that disciplinary research in mathematics is not valued. But the emphasis in 1993 on initiatives had as a collateral result that the money was not available to provide a broad increase to the base of mathematics research support." Sunley pushed hard to secure the participation of mathematics in the initiatives, which is generally regarded as making sense scientifically and being a fiscal boon for mathematics. However, it is

¹ The information in the Notices tables is slightly different than that prepared by the DMS. Funds for the Science and Technology Centers had in previous years been listed as separate line items, but this year were folded into the budgets of the divisions having primary responsibility for the centers. The Notices tables continue this year to list the centers as a separate line item.
clear she didn’t expect DMS participation in the initiatives to result in all of the growth in the division budget coming through those initiatives. As she puts it, “participation in the initiatives was agreed upon and negotiated under somewhat different circumstances than we see now.”

Generally, those interviewed for this article believe Sunley made the right choice in participating in the initiatives. An element of political saleability is undoubtedly operating here, but that does not appear to have been an overwhelming factor. In addition, it’s impossible to tell whether or not DMS would have received an increase in its core budget had it not participated in the initiatives; it might simply have lost out on the chance at any kind of increase. “I think you’ve just got to follow these initiatives,” says Terry Speed of the statistics department at the University of California at Berkeley and a member of the Advisory Committee. “I wouldn’t criticize the DMS for that. There should be more for disciplinary programs. But if you say that the disciplinary programs are so important that you won’t contribute to the initiatives,” that would be a mistake.

A Constrained Budget
The Office of Science and Technology Policy (OSTP) and the Office of Management and Budget influence the NSF budget request, but decisions at the level of NSF divisions are ultimately made by the NSF assistant directors, who oversee directorates covering broad swatches of science and engineering funding. DMS is housed in the directorate of Mathematical and Physical Sciences (MPS), together with chemistry, physics, astronomy, and materials science (there is a fifth budget line in MPS for major research equipment). Heading MPS is assistant director David Sanchez, a mathematician and former provost of Lehigh University. Sanchez says the MPS budget was constrained due to funding for such major equipment as the Laser Interferometer Gravitational Wave Observatory, two eight-meter telescopes, and the National High Magnetic Field Laboratory at Florida State University. Construction had begun on some of these projects, and reductions in the 1992 appropriation meant that some 1993 funds would have to be committed to keeping the construction on schedule.

“When the budget came to me, after I’d honored previous commitments… there was almost nothing left for increases at all, not just in mathematics,” Sanchez explains. “The problem was that the budget was dictated by commitments to facilities and to the initiatives,” he continues, noting that the DMS had a share in the commitment to the initiatives. About $2 million would have been needed to keep the “Disciplinary Research” line of the DMS budget abreast of inflation. The total requested increase for MPS is just over $100 million. Asked if he thought mathematics fared badly in this request, Sanchez would answer only by describing the constraints his budget was under. Criticizing his own budget might be politically infeasible. “That’s my budget, I have to go to Congress with it, I have to support it,” says Sanchez. “I’m not working for mathematics. I’m working for NSF and five other divisions.”

Indeed, it is difficult for NSF staff to say anything that smacks of criticism of the budget request, though it is clear that the DMS is not happy with the zero in the disciplinary line. Robert Molzon, program director in the Geometric Analysis program in the DMS, did express some of his personal views on the subject. “I would like to see more emphasis placed on core research areas, and this budget doesn’t do that. That’s very disappointing.” The DMS has over the last few years been putting increasing emphasis on activities apart from the core research program, which he says is “cutting off the long-term health of mathematics” for short-term gain. “It’s not that different from what has been going on, it’s just more dramatic” this year, he explains. “It’s not a radical change.”

At this point, it is unclear exactly what kinds of research will be funded under the banner of the initiatives; Sunley says the DMS will try to “be as flexible as possible.” At the time of this writing, a “Dear Colleague” letter had been drafted and may have already appeared. A more formal announcement will follow later in the year. Molzon says he would encourage people to take advantage of the initiative funds. “Given the fact that this has happened and we’re stuck with it, go ahead and put something in the proposal to give the program director some ammunition to argue for some initiative money,” he suggested. For example, he speculated that people funded by Classical Analysis for wavelets or by Geometric Analysis for integral geometry might be able to take advantage of the initiative funds.

Schizophrenia in Science Funding
I. M. Singer of the Massachusetts Institute of Technology calls the NSF budget request a “disaster” for mathematics. He supports the participation of DMS in the initiatives, “but support for initiatives should not cripple basic research, which the present budget does.” Singer also notes a kind of “schizophrenia” in the current science funding scene. “Washington presently believes that budget limitations and our economic distress demand that we concentrate resources on research that has a quick payoff,” he observes. “This viewpoint emphasizes targeted research at the expense of basic research. If uniformly applied, then perhaps mathematics should bite the bullet along with all the other sciences. Yet at the same time, there is considerable federal support for science projects that have no known applications or applications possibly decades away. I am disturbed that politics or whim allows vast support for basic research in some areas, and at the same time a demand that basic research in other sciences be curtailed.”

Polking notes that the move toward initiatives marks a clear shift in science funding policy that has taken place over the last few years. “For forty or fifty years, since the end of the second World War, the government wanted to support only basic research,” he notes. “Anything to do with product or technology development was left to the private sector.” This situation began to change five or six years ago as the U.S. found it increasingly difficult to compete with industrial powerhouses like Japan. In trying to finance an industrial
### NSF Budget Request for 1993

#### Table I. National Science Foundation

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#### Table II. Directorate for Mathematical and Physical Sciences

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#### Table III. Compilation of the NSF Budget, 1988–1993

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*Current dollars are converted to 1982 dollars using the producer price index.
policy to improve the competitive position of U.S. industry, he says, the government is raiding the basic research side of the ledger. "We’re really seeing this trend come to the fore in this NSF budget and in the federal budget in general," he states. "I support an industrial policy, but funding it, even in part, by reducing support for basic scientific research, seems to me the wrong policy. We should argue that the investment in basic research has been hugely successful. Even if you increase funds to support an industrial policy, you still need basic research."

A Disparity in Standards?
The current budget request seems to have set aflame discontents with NSF policies that have been smoldering for some time now. Moving in the direction of these initiatives is fine, says Wilfried Schmid of Harvard University, but he objects to "the vastly exaggerated speed with which this is being done" and what he sees as an imbalance between core research and participation in initiatives. "What disturbs me is that some administrative people are trying very hard to push mathematics in a different direction," he declares. "I realize that when the U.S. government pays the bill, you have to respond to national needs... But I question if [the DMS staff] are the final arbiters of what directions are in the national interest."

Another common concern is that directing research is in the long run bad for mathematics. Taubes says the initiatives amount to "social engineering," which he sees as detrimental to basic research. "Anyone funding science would in the long run see much more return by just funding top people, and not asking what they’re doing," he says. "As soon as you try to control it, you’re hindering the scientific process.” He notes that the situation for science in the former Soviet Union has shown that “centralized planning for science is ultimately not such a good idea.” The federal agencies should simply “give out fishing licenses without telling people where to fish,” he says.

Can the Budget be Changed?
Can anything be done? The NSF budget request has already gone to Congress and can not be altered at this point. But, says Singer, "It’s entirely possible that we can convince the powers-that-be [within the NSF and the executive branch] that in discussions about the budget with Congress, that line item could be changed.” The leadership of the three mathematical societies, together with the Joint Policy Board for Mathematics (JPBM), are looking at various ways to proceed. However, one Washington observer says that it’s unlikely the NSF will go back on its own budget request to add more funds to DMS, but that funds may be reprogrammed within DMS or within MPS, without Congressional involvement.

"Looking ahead," says Singer, "I think JPBM ought to work on developing a broad-based initiative in mathematics. I think it would be supported by OSTP and the agencies. If it’s well-balanced, Congress will support it too. Mathematics is central to modern society, and if that’s reflected in the initiative, it will fly, and with it, a substantial increase in funding for mathematics.”

Allyn Jackson
Staff Writer
The following consists of excerpts of the text prepared by the staff of the Division of Mathematical Sciences of the NSF and submitted to Congress as part of the Administration's Budget Request for the Fiscal Year 1993.

Mathematical Sciences

Summary of Request
The FY 1993 Request for the Mathematical Sciences Subactivity contains an increase of 8.1% over the FY 1992 Current Plan. (Millions of Dollars)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Disciplinary Research in Math</td>
<td>$46.16</td>
<td>$49.57</td>
<td>$48.23</td>
<td>$48.23</td>
</tr>
<tr>
<td>Cross-Disciplinary and Computational Research in Mathematics</td>
<td>13.42</td>
<td>16.02</td>
<td>15.55</td>
<td>20.48</td>
</tr>
<tr>
<td>Special Projects</td>
<td>13.57</td>
<td>15.85</td>
<td>14.80</td>
<td>16.24</td>
</tr>
<tr>
<td>Total, Subactivity</td>
<td>$73.15</td>
<td>$81.24</td>
<td>$78.58</td>
<td>$84.95</td>
</tr>
</tbody>
</table>

Scientific Overview
The Mathematical Sciences Subactivity:

- fosters the creation and development of mathematical ideas, methods, and techniques;
- supports their synergistic interaction with theory and practice in the physical, biological, engineering, and social sciences; and
- encourages their diffusion into the infrastructure for education and human resource development and the technology base.

The core of the Foundation’s program in the mathematical sciences is the support of disciplinary and cross-disciplinary research projects carried out by individuals or small groups. Inclusion of graduate students and postdoctoral researchers and the use or development of computational equipment and techniques are encouraged where appropriate.

Excitement in mathematics stems from the interactions among various subdisciplines and with other fields.

- The tones and overtones created by striking pieces of metal of different size and shape provide a rough approximation to what mathematicians call the spectrum of the Laplacian of a plane figure. Understanding the relationship between the geometry and the spectrum may be important in design and testing of materials, where one method of determining flaws involves measuring the spectral response of the material. Mathematicians Carolyn Gordon and David Webb of Washington University and Scott Wolpert of the University of Maryland have shown that the spectrum of a planar region does not uniquely determine its shape, opening new areas of inquiry into the link between the analytic characteristics of the spectrum and the geometric idea of shape.

- 1985 Presidential Young Investigators David Donoho and Iain Johnstone, both of Stanford University, are integrating wavelet analysis into statistical modeling to allow a probability basis for models that handle complex phenomena subject to all kinds of changes (smooth, cyclic, abrupt, combinations) in the underlying processes. This blend of theoretical and computational development is important for the recovery of information from indirect, noisy, or sparse high-dimensional data.

These examples are typical of recent developments throughout mathematics and exhibit two related phenomena. First, many of the most fundamental advances are being made by people with deep understanding of a wide range of mathematical and scientific topics. Second, application and theoretical development are operating in symbiotic fashion, with the computer’s extension of the reach and power of mathematics as a driving factor. These observations have profound implications for the training of graduate students and for the continuing development of established researchers.

The Mathematical Sciences Subactivity supports research in the fields of classical analysis, modern analysis, geometric analysis, topology and foundations, algebra and number theory, applied mathematics, statistics and probability, and computational mathematics. The Subactivity also supports, through its Office of Special Projects, various efforts that cut across the mathematical sciences, including: research institutes or centers; postdoctoral research fellowships; research conferences, workshops and special years; shared scientific computing research equipment; and undergraduate programs managed in collaboration with the Education and Human Resources Activity. The Science and Technology Center for Computation and Visualization of Geometric Structures at the University of Minnesota (the “Geometry Center”) is supported within the Cross-Disciplinary and Computational Research in Mathematics program element.

- The award-winning computer graphics videotape “Not Knot” made its first appearance at the opening ceremonies of the Geometry Center. The tape allows its viewers to peer into the mind of a mathematician who imagines spaces with properties very different from ordinary physical space. The Geometry Center has developed written materials appropriate to various educational levels to be used in conjunction with the tape and has used the tape as a focal point in its educational programs.

During the last few years, support for the mathematical sciences has emphasized improving the pool of talent entering the field. Significant gains have been made through added support for graduate students, postdoctoral researchers, beginning research faculty, and undergraduate faculty and students. The Research Experiences for Undergraduates program and curriculum development in calculus, the traditional focus of the Subactivity’s support in undergraduate education, and now complemented by more varied approaches to student-oriented activities and curriculum development at the upper levels.
The chart below illustrates the crucial role played by NSF in the federal support of academic research in the mathematical sciences. In all areas of the mathematical sciences, Foundation-supported research involves a broader range of basic research topics than that sponsored by the mission agencies. Coordination among agencies is carried out through the Interagency Committee for Extramural Mathematics Programs.

### Mathematical Sciences

**Federal Research Support in FY 1991**

<table>
<thead>
<tr>
<th>Agencies</th>
<th>Millions of Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSF/DMR</td>
<td>$3</td>
</tr>
<tr>
<td>Other NSF</td>
<td>$8</td>
</tr>
<tr>
<td>Air Force (AFOSR)</td>
<td>$17</td>
</tr>
<tr>
<td>DARPA</td>
<td>$16</td>
</tr>
<tr>
<td>Navy (ONR)</td>
<td>$14</td>
</tr>
<tr>
<td>Army (ARO)</td>
<td>$14</td>
</tr>
<tr>
<td>DoE</td>
<td>$7</td>
</tr>
<tr>
<td>NSA</td>
<td>$3</td>
</tr>
<tr>
<td>Other Agencies</td>
<td>$1</td>
</tr>
<tr>
<td>Other Agencies</td>
<td>$73</td>
</tr>
</tbody>
</table>

The FY 1992 Current Plan is $78.58 million, a decrease of $2.66 million (3.3%) from the FY 1992 Budget Request, due to Congressional reductions. The Current Plan represents an increase of $5.43 million (7.4%) over the FY 1991 level. All areas of support have been reduced, but important initiatives, including the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET) High Performance Computing and Communications (HPCC) initiative, are proceeding.

### FY 1993 Budget Request

The FY 1993 Budget Request of $84.95 million is $6.37 million or 8.1% above the FY 1992 Current Plan. A significant portion of the increase will support the participation of new investigators in the Subactivity's programs.

**Summary of Request**

The FY 1993 Request for the Computer and Computation Research (CCR) Subactivity contains an increase of 23.5% over the FY 1992 Current Plan.

<table>
<thead>
<tr>
<th>Program Element</th>
<th>FY 1992 Current Plan</th>
<th>FY 1993 Request</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory of Computing</td>
<td>$7.92</td>
<td>$9.25</td>
</tr>
<tr>
<td>Numeric, Symbolic, and Geometric Computation</td>
<td>4.65</td>
<td>6.95</td>
</tr>
<tr>
<td>Computer Systems</td>
<td>3.16</td>
<td>4.33</td>
</tr>
<tr>
<td>System Software</td>
<td>11.51</td>
<td>12.55</td>
</tr>
<tr>
<td>Software Engineering</td>
<td>4.08</td>
<td>4.85</td>
</tr>
<tr>
<td>Total, Subactivity</td>
<td>$31.32</td>
<td>$37.93</td>
</tr>
</tbody>
</table>

### Scientific Overview

Computer and computation research is concerned with the fundamental scientific and engineering principles which govern the design, manufacture, and use of advanced computers. This research ranges from mathematical studies of problem-solving procedures to engineering studies of new, advanced computing systems which test and utilize the principles. Parallel and distributed computation has been a basic theme for much of the research supported in the...
Subactivity. New parallel and distributed architectures are key technologies for future advances in high performance computing. Realizing the potential of such systems requires further research progress in algorithms, languages, tools, and software systems. The development of these technologies, in turn, requires new research in theory, problem-solving, design, and implementation.

Topics for study include: strategies and algorithms for solving problems, methods of representing and transforming information, programs and software systems for solving large problems or controlling large systems, and computer architectures for executing programs.

Another basic theme is research on large software systems. Such research is of current national importance, since software is frequently cited as the major contributor to the cost and unreliability of critical, complex, computer-based systems. The Subactivity aims at fundamental issues in this area, including new methods of engineering safe, secure, failure-free software systems, advanced techniques for reducing the cost of software development, grand challenge tools and applications, and new technologies to make programming and using computers less costly and less error-prone.

Advances in both of these themes depend upon research on new languages for concurrent programming, fault tolerance, and operating systems for distributed computing. Models, theory, and experimental modes of research are involved. Work on the development and application of “problem solving environments”—that is, integrated and highly automated sets of computer-based tools to amplify the problem-solving abilities of scientists and engineers, is also a focus of the Subactivity. Included are methods for integrating numeric, symbolic, geometric, and expert systems, and mathematical foundations to enable the effective use of new architectures. Continuing attention is given to the search for theoretical insights that can impact day-to-day computing. For example, improvements in sorting efficiency would materially aid large-scale efforts such as the human genome project. Until recently, it was thought that there was a limit or “lower bound” to the sorting efficiency of programs. However, Michael Freedman of UC San Diego and Daniel Willard of SUNY Albany designed an “impossibly fast” sorting algorithm based on fusion trees. Besides the practical implications of this result, it opens the door to research on the ultimate limits of computer efficiency for many other important problems.

Both academic and industrial computer and computation research are supported by agencies of the federal government, which with the exception of NSF, support mostly mission-directed work. This Subactivity is the primary source for academic research in software and computing theory. Close collaboration is maintained with other federal agencies through the OSTP, formal interagency agreements and informal interaction of program officers.

**FY 1993 Budget Request**

This Request initiates a major effort directed at the problem of developing safe, secure computer systems within the context of the HPCC program. From air traffic control, to national defense, hospital patient monitoring and international banking, critical systems are dependent on reliable, secure hardware and software computer systems. Software technology has not kept pace with the increasing severity of such requirements with the result of significant risk to safety and security in commercial, scientific and military computing. Examples include the software-related recalls of medical devices that have tripled since 1984, and the failure of telephone systems.

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(Millions of Dollars)

<table>
<thead>
<tr>
<th>Old Program Elements</th>
<th>Disciplinary Research in Mathematics</th>
<th>Cross-Disciplinary and Computational Research in Mathematics</th>
<th>Special Projects</th>
<th>Total, Subactivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classical Analysis</td>
<td>$6.41</td>
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<td>$6.41</td>
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<tr>
<td>Modern Analysis</td>
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<td></td>
<td>6.42</td>
</tr>
<tr>
<td>Geometric Analysis</td>
<td>7.15</td>
<td></td>
<td></td>
<td>7.15</td>
</tr>
<tr>
<td>Topology and Foundations</td>
<td>7.68</td>
<td></td>
<td></td>
<td>7.68</td>
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<tr>
<td>Algebra and Number Theory</td>
<td>10.72</td>
<td>$0.40</td>
<td></td>
<td>11.12</td>
</tr>
<tr>
<td>Applied Mathematics</td>
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<td>4.80</td>
<td></td>
<td>9.34</td>
</tr>
<tr>
<td>Statistics and Probability</td>
<td>5.31</td>
<td>3.00</td>
<td></td>
<td>8.31</td>
</tr>
<tr>
<td>Computational Mathematics</td>
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<td>7.35</td>
<td></td>
<td>7.35</td>
</tr>
<tr>
<td>Special Projects</td>
<td></td>
<td></td>
<td></td>
<td>14.80</td>
</tr>
<tr>
<td>Total, Subactivity</td>
<td>$48.23</td>
<td>$15.55</td>
<td>$14.80</td>
<td>$78.58</td>
</tr>
</tbody>
</table>
Expanding the current NSF-DARPA initiative on formal methods, this Request provides an increment of $1.90 million for the development of technological safeguards aimed at preventing and detecting flaws and errors in computer software. An example of how new theoretical results may be of use is the recent work of Adi Shamir, Manual Blum, Richard Lipton, Lance Fortnow, and others, on the “IP=PSPACE” problem that could make feasible the unambiguous and automatic checking of the accuracy of supercomputer results, the building of secure computer systems, and the development of highly reliable computer applications.

HPCC ($4.75 million): fundamental research is increased in all program elements of this Subactivity. This includes support for research on operating systems and compilers for emerging high performance computer system designs, “power tools for computational science” to include tool integration and support for full-fledged problem-solving environments.

Biotechnology ($600,000): to support work on new computational algorithms and computing models such as those used in gene sequencing.

Materials-related ($200,000): to support software for real-time processing control.

Other basic research support will be increased ($750,000) with attention given to increasing the size and duration of individual investigator awards.

The following consists of excerpts of the text prepared by the staff of the Division of Information, Robotics, and Intelligent Systems of the NSF and submitted to Congress as part of the Administration’s Budget Request for the Fiscal Year 1993.

Information, Robotics, and Intelligent Systems

Summary of Request
The FY 1993 Request for the Information, Robotics, and Intelligent Systems (IRIS) Subactivity contains an increase of 36.5% over the FY 1992 Current Plan.

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge and Database Systems</td>
<td>$9.80</td>
<td>$12.17</td>
<td>$12.38</td>
<td>$17.13</td>
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<tr>
<td>Robotics and Machine Intelligence</td>
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<td>7.75</td>
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<td>8.65</td>
</tr>
<tr>
<td>Interactive Systems</td>
<td>3.03</td>
<td>4.00</td>
<td>3.30</td>
<td>5.00</td>
</tr>
<tr>
<td>Information Technology and Organizations</td>
<td>4.13</td>
<td>5.29</td>
<td>4.65</td>
<td>6.05</td>
</tr>
<tr>
<td>Total, Subactivity</td>
<td>$23.59</td>
<td>$29.21</td>
<td>$26.98</td>
<td>$36.83</td>
</tr>
</tbody>
</table>

Scientific Overview
In the complex environments in which we live and work, information takes many forms: language, speech, image, signal or sensory data, text, numbers, and symbols. This Subactivity supports research to:
- improve basic understanding and design of information and knowledge processing systems;
- provide the best computational structures and physical devices to facilitate the use of information and knowledge in a variety of forms and settings;
- enable the solution of grand challenge problems and applications in the HPCC initiative; and
- improve understanding of societal consequences of advanced information technologies in organizations and other distributed work environments.

This Subactivity is a primary source of federal support for interdisciplinary work in computing, biobehavioral sciences, and engineering disciplines dealing with both theory and experimental applications of information processing technology. Other federal agencies, particularly Department of Defense, provide the balance, concentrating on sharply defined and mission-oriented applications. Industrial laboratories play an important role as consumers of basic university research.

FY 1993 Budget Request
In the FY 1993 Budget Request, increases will emphasize research to integrate new high performance computing technologies (such as sensors, parallel computers, and high bandwidth communication networks) into research practice. These technologies, unavailable just a few years ago, are rapidly changing the way information from the physical environment is collected, stored, and used. An equally important emphasis this year will be to participate in several new cross-directorate initiatives including Biotechnology and Advanced Manufacturing.

Research support requested for this Subactivity is closely integrated with the HPCC initiative ($4.2 million), and participates in three other initiatives: Manufacturing ($3.7 million), Biotechnology ($800,000), and Advanced Materials and Processing ($400,000). The programmatic goals in each of these areas require new scientific advances in intelligent systems for complex information processing and knowledge-based engineering tasks. Each will emphasize and strengthen interdisciplinary team research. In addition, $750,000 will support increases in the size and duration of individual investigator awards.

The following consists of excerpts of the text prepared by the staff of the Division of Advanced Scientific Computing of the NSF and submitted to Congress as part of the Administration’s Budget Request for the Fiscal Year 1993.

Advanced Scientific Computing

Summary of Request
The FY 1993 Request for the Advanced Scientific Computing (ASC) Subactivity contains an increase of 24.5% over the FY 1992 Current Plan.
The Subactivity supports advanced research on new methods, algorithms, technologies, and applications for high performance research computing, as well as education and training at all academic levels. Four supercomputer centers are supported: San Diego Supercomputer Center at the University of California at San Diego, National Center for Supercomputing Applications at the University of Illinois, Pittsburgh Supercomputing Center, and Cornell National Supercomputer Facility at Cornell University.

The NSF Centers serve the U.S. academic research community by providing access to traditional vector supercomputers and new, high performance parallel computers to individual investigators in many disciplines. The Centers support software development, train users at all levels of sophistication, work closely with the computer and other high-technology industries, and lead in research on the use of supercomputing systems.

**FY 1993 Budget Request**

The FY 1993 Budget Request supports planned upgrades and new system acquisitions at the four national Centers, and enhances research activities in technologies supporting high performance computing. Computing services and resources and educational activities will be extended to a broader national constituency, and a wider spectrum of computational science and engineering research will be supported through the New Technologies program. Special attention will be given to topics in which the research domains of computer science and disciplinary computing intersect in advancing understanding of high performance computing methods, tools, and environments.

**HPCC ($8.7 million)** plans include accelerating the incorporation of emerging scalable parallel supercomputers into operations at the national Centers and providing the support necessary to bring these systems into general use. Scalable parallel systems, access, training, and education will be provided to the national community of researchers through the Advanced Software Technology and Algorithms component of HPCC. Research related to implementing promising applications on these new systems and enhancing parallel computing on conventional production supercomputer systems will be expanded.

New activities will be initiated in the New Technologies program element as part of HPCC to define and develop the high performance computing environments of the future. Supported areas will include research on mathematical and conceptual models of scientific problems and applications, software technologies for high performance heterogeneous computing environments, scientific visualization, system instrumentation, and performance evaluation. The program element will serve as the subactivity focus for Grand Challenge Application Groups interdisciplinary research ($6.1 million). Computational Science Postdoctoral Associates support will be increased to accelerate innovative use of parallel systems in large-scale disciplinary applications ($1.0 million).

**Biotechnology and Advanced Materials and Processing ($800,000)** support will stimulate the use of parallel systems in computational research in these areas. Cooperative efforts between the national Centers in such areas as development of on-line tools, the management of large databases, and scientific visualization and software development will be expanded.

The NSF Centers’ extensive education and training programs will be enhanced and extended to serve more users. Such programs will span the entire user base, with special emphasis on introducing the methods and experience of scientific computing to undergraduate and high school students through innovative curriculum and training programs ($500,000).

### Networking and Communications Research and Infrastructure

**Summary of Request**

The FY 1993 Request for the Networking and Communications Research and Infrastructure (NCRI) Subactivity contains an increase of 35.5% over the FY 1992 Current Plan.

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NetSNAP</td>
<td>$20.97</td>
<td>$32.59</td>
<td>$25.84</td>
<td>$37.09</td>
</tr>
<tr>
<td>Networking and Communications Research</td>
<td>8.83</td>
<td>9.65</td>
<td>9.65</td>
<td>11.00</td>
</tr>
<tr>
<td>Total, Subactivity</td>
<td>$29.80</td>
<td>$42.24</td>
<td>$35.49</td>
<td>$48.09</td>
</tr>
</tbody>
</table>

**Scientific Overview**

The Networking and Communications Research and Infrastructure Subactivity:
- supports development and operation of the NSFNED computer network for research and education;
- coordinates the National Research and Education Network activities of the HPCC initiative; and
supports fundamental scientific and engineering research on communications theory and data networks.

NSFNET, a network of computer networks, was created in 1986 to provide access to the NSF Supercomputer Centers for the nation’s computational science community. It has broadened in function and grown so that it now provides services to over 4,000 networks at academic, industrial, and governmental research institutions through more than twenty autonomous regional networks connected by forty-five megabits per second transcontinental backbone services. Through this network, investigators interact for research collaboration and gain access to unique resources such as advanced supercomputers, radio telescope arrays, and biotechnology databases. The traffic volume has increased by about 15% monthly over the past three years.

Use of the NSFNET backbone by the research and education community is divided almost evenly among mail and message communications, transfer of computer files (text, data, graphics), remote access to distant computers, and network addressing and management services. The NSFNET backbone accounts for about 30% of network use. Most traffic occurs within the regional networks and the connected campus networks, which are partners in the overall networking enterprise.

NSF leads the federal implementation of the National Research and Education Network through the coordinating activities of the HPCC program and the Federal Networking Council. NSF, working closely with other federal agencies to interconnect their cross-country research networks, has upgraded and extended the NSFNET backbone to accommodate substantial growth in usage and new applications not feasible at lower speeds.

Network research projects focus on basic research issues related to the transmission, storage, and access of information in single- and multiple-user situations. Information theory, communications theory, and the theoretical issues related to information networks, including communications protocols, communications efficiency, security and performance in fixed and mobile environments, are key areas.

**FY 1993 Budget Request**

The Subactivity plays a major role in the HPCC initiative ($10.80 million), and provides central support to the Manufacturing initiative ($1.80 million).

HPCC related activities will include the enhancement of NSFNET backbone services ($4.6 million) through the establishment of a routing coordinator, the recompetition for continued state-of-the-art NSFNET backbone services, and the management of the transition services. During the transition, NSF will support the continuation of the current NSFNET backbone services at 45 million bits per second, the world’s fastest network available to the general scientific community. Connected to other mission agency networks, NSFNET will be the principal vehicle for extending research and education networking to the broad national community of users.

Additional funding ($3.2 million) will be provided to regional networks to assist their capacity expansion in cases where scientific need is demonstrated. Funding will be increased for new network connections for predominantly undergraduate institutions. Increases will also be provided to improve the user interface to the network, and enhance network services, including the continued development of network information services such as national directories ($1.65 million). Network infrastructure will be strengthened to enhance education-community use of advanced networks and high performance computing resources in conjunction with Education and Human Resources Activity support. Close coordination in the upgrade will be maintained with other agencies supporting the research network.

In the framework of the National Research and Education Network component of the HPCC Program ($800,000), the coordinated interagency program of research and application demonstration in networks operating at speeds in excess of a billion bits per second will be expanded.

Manufacturing related efforts ($1.8 million) focus on strengthening the network, including installing required high-speed connections and special protocol work with special attention on requirements for distributed design and manufacturing.

The requested increase for the Networking and Communications Research program will include support for research in software security and safety ($550,000) as related to networking and communications issues.

The following consists of excerpts of the text prepared by the staff of the Directorate of Education and Human Resources of the NSF and submitted to Congress as part of the Administration's Budget Request for the Fiscal Year 1993.

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**Education and Human Resources**

**Summary of Request**

The FY 1993 Request for the Education and Human Resources (EHR) Activity contains an increase of 3.1% over the FY 1992 Current Plan (see table next page).

**NSF Role**

The responsibility of the Education and Human Resources (EHR) Activity is to define and fund programs and projects that support the educational aspects of the Foundation’s mission. The magnitude of the educational effort in the United States and the long lead times needed for new programs, materials, and methods require a continuing and significant involvement in this area. Sustaining this level of commitment, visibility, and continuity is responsive to the national concern with science, mathematics, and engineering education and will draw the best, most creative people into the process. EHR also plays a major role in developing human resources for science and engineering.
The present EHR activities, which have been the subject of regularly increasing budgets and expanding responsibilities, represent a cohesive and comprehensive set of education and human resources activities encompassing every level of education: elementary, secondary, undergraduate, graduate, and postgraduate. Augmented by informal science education experiences, these programs—focusing on all students—ensure the production of a cadre of excellently trained scientists and engineers and a scientifically literate citizenry. However, the convergence of a number of factors have led to an examination of the sufficiency and appropriateness of the present organizational structure to accommodate rapidly expanding science, engineering, and mathematics education responsibilities. External developments occasioning a re-examination of the EHR organization and education programs include:

• The January 1990 announcement by the President and the Governors’ Task Force on Education of six national education goals to be achieved by Year 2000;
• The establishment of the National Education Goals Panel;
• The Congressionally mandated National Council on Educational Standards and Testing;
• The America 2000 Strategy emphasizing increased accountability, restructured schools, and fundamental education reform mechanisms;
• The increased participation of NSF in the Committee on Education and Human Resources;
• Acknowledged linkage of the quality of K-12, undergraduate, and graduate science, engineering, mathematics, and technology education to quality of the scientific and technical workforce, and thereby to the Nation’s quality of life.

Changes in Budget Structure
The new organizational structure provides a clearer focus for EHR support by educational level. The new EHR Subactivities are [described below].

The Systemic Reform Subactivity includes Statewide Systemic Initiatives, systemic activities previously supported through Science and Mathematics Networks, Instructional Materials Development and components of Teacher Enhancement. The Experimental Program to Stimulate Competitive Research (EPSCoR) is also included. Management of EPSCoR was transferred to EHR in FY 1992 following the disestablishment of the Directorate for Scientific, Technological, and International Affairs. (For budget display purposes only, EPSCoR funding is shown in the EHR Activity, but not included in the total prior to FY 1993 because of Congressional repeal of transfer authority.)

The Elementary and Secondary Education Subactivity incorporates Instructional Materials Development (less the funds for systemic reform), Teacher Enhancement, Young Scholars, Presidential Awards for Excellence in Science and Mathematics Teaching, Informal Science Education, and Private Sector Partnerships.

The Undergraduate Education Subactivity includes Instrumentation and Laboratory Improvement, Course and Curriculum, Faculty Enhancement, and Teacher Preparation.

The Graduate Education and Research Development Subactivity combines Graduate Fellowships, Minority Graduate Fellowships, and Graduate Research Traineeships with Visiting Professorships for Women and Faculty Awards for Women.

The Human Resource Development Subactivity includes Career Access Opportunities in Science and Technology for Women, Minorities, and Persons with Disabilities; Research Careers for Minority Scholars; Alliances for Minority Participation; Research Improvement in Minority Institutions; and Minority Research Centers of Excellence.

The Research, Evaluation, and Dissemination Subactivity combines the former Studies, Evaluation, and Dissemination Activity with Research in Teaching and Learning, Applications of Advanced Technology (including funding transferred from Informal Science Education for linking museums and science centers), and Science and Mathematics Education Networks (less systemic reform support).

FY 1992 Current Plan
The FY 1992 Current Plan contains an increase of $75.00 million, 19.2% above the FY 1992 Request. This represents an increase of $143.04 million, or 44.4% over the FY 1991 level. The additional funds are directed to activities as specified by Congress. In FY 1992, the EHR Activity is reorganized and programs are renamed and combined with other programs.

Across the Subactivities in FY 1992:
• Systemic Reform totals $44.50, $11.00 million more than the FY 1992 Request (an increase of 32.8%). The increase is directed to Statewide Systemic Initiatives, including expanded efforts for teacher enhancement.
• Elementary and Secondary Education totals $192.35, $26.00 million more than the FY 1992 Request, due to increases for teacher enhancement and informal science education.
Undergraduate Education is funded at the requested level.

Graduate Education and Research Development totals $78.40 million, $23.00 million more than the FY 1992 Request (an increase of 41.5%), for initiation of graduate traineeships. The competition for traineeships will be initiated in FY 1992, with awards planned for fall 1992. Thus, funds appropriated for traineeships will be carried forward and obligated in early FY 1993.

Human Resource Development totals $46.60 million ($2.00 million more than the FY 1992 Request, a 4.5% increase), with additional funding for Summer Science Camps, as directed by Congress.

Research, Evaluation, and Dissemination totals $42.15 million ($13.00 million more than the FY 1992 Request, a 44.6% increase) for increased efforts in evaluation and uses of advanced technology for educational purposes (including informal science education).

Funding details of the FY 1992 Current Plan, showing Congressional additions to the FY 1992 Request in both the old and new budget structures, are provided in the following table.

**Congressionally Specified Additions to FY 1992 Request**

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Teacher Preparation and Enhancement</td>
<td>$139.00</td>
<td>$32.00</td>
<td>$171.00</td>
</tr>
<tr>
<td>State Systemic Initiative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materials Development, Research, and Informal Science Education</td>
<td>$82.00</td>
<td>$15.00</td>
<td>$97.00</td>
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<tr>
<td>Applications of Advanced Technology</td>
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<td></td>
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<tr>
<td>Undergraduate Science, Engineering, and Mathematics Education</td>
<td>$47.00</td>
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<td>$47.00</td>
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<tr>
<td>Research Career Development</td>
<td>$61.00</td>
<td>$23.00</td>
<td>$84.00</td>
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<tr>
<td>Human Resource Development</td>
<td>$50.00</td>
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<td>$52.00</td>
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<tr>
<td>Summer Science Camps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Studies, Evaluation, and Dissemination</td>
<td>$11.00</td>
<td></td>
<td>$14.00</td>
</tr>
<tr>
<td>Total</td>
<td>$390.00</td>
<td>$75.00</td>
<td>$465.00</td>
</tr>
</tbody>
</table>

| NEW STRUCTURE                                      |                  |                         |                      |
| Systemic Reform                                    | $33.50           | $11.00                  | $44.50               |
| Elementary and Secondary Education                 | $166.35          | $26.00                  | $192.35              |
| Graduate Education and Research Development        | $55.40           | $23.00                  | $78.40               |
| Human Resource Development                         | $44.60           | $2.00                   | $46.60               |
| Research, Evaluation, and Dissemination            | $29.15           | $13.00                  | $42.15               |
| Total                                              | $390.00          | $75.00                  | $465.00              |

**FY 1993 Budget Request**

The EHR Activity FY 1993 Request consolidates recent rapid growth in the EHR Activity and, through reorganization, focuses programs and streamlines management.

The Systemic Reform Subactivity will focus on the extension of the Statewide Systemic Initiatives effort to additional states and a broader range of activities (including additional attention to teacher enhancement), and will provide expansion of EPSCoR's advanced development competition.

The Elementary and Secondary Education Subactivity will continue to emphasize improving the effectiveness and content of elementary and secondary school science and mathematics instruction. Programmatic efforts will be maintained at essentially FY 1992 levels. The decrease results from a shift of funds from Teacher Enhancement and Development to the Educational System Reform program for support of expanded teacher enhancement activities in these state-based projects. All other programs within this Subactivity are maintained at their enhanced FY 1992 levels, consolidating recent rapid growth in these areas.

In the Undergraduate Education Subactivity modest enhancement is provided for Teacher and Faculty Development, primarily aimed at two-year college teaching faculty.

The Graduate Education and Research Development Subactivity will continue to focus on support for individuals preparing for, or at the beginning of, research careers. Graduate traineeships will be supported with funds carried over from FY 1992. Graduate fellowships will be sustained at approximately FY 1992 levels. Increased support is provided for special awards to women faculty, and a Foundation-wide competition will provide fifty new awards in FY 1993.

The Human Resource Development Subactivity will continue its focus on the barriers facing minorities, women, and persons with disabilities in the pursuit of science careers. A major emphasis in FY 1993 is alliances for minority participation, which promote a comprehensive, coordinated approach to increase the number and strengthen the preparation of minority students receiving baccalaureate degrees and subsequently entering graduate study in science, mathematics, and engineering.

In FY 1993, the Research, Evaluation, and Dissemination Subactivity will continue its efforts directed toward the evaluation of NSF's educational programs and toward the dissemination of NSF-supported curriculum/materials to school districts throughout the nation. Support for the National Research and Education Network and other technology applications such as distance learning will be increased.
Remarks of
Walter E. Massey, Director
National Science Foundation

It is certainly a pleasure to have this opportunity to address the joint meeting of the Mathematical Association of America (MAA) and the American Mathematical Society.

I think it is safe to say that the long-term health of science is very closely tied to the health of mathematics. And since the National Science Foundation is the single largest source of funding for basic research and innovative educational activities for the mathematical sciences, maintaining that health is a vital concern to me...

...[W]hen we consider the health of mathematics in America today, it is very important to place the discussion in an appropriate context. I would like to explore several contexts with you this evening, some of which will show the condition of mathematics in a very favorable light, and others which will emphasize some of the challenges we face...

In the past decade we have seen mathematicians respond to questions about priorities in teaching and research with careful study and quality analysis. The willingness of the mathematics community to undertake critical assessments of strengths and shortcomings is evident in the landmark work of the David Reports (one and two), and such publications as "Everybody Counts" and "Moving Beyond Myths."

I might add that I am aware that in its efforts on Capitol Hill, the various mathematics societies have not sought to advance narrow interests, but have advocated across-the-board support for mathematics, science, and engineering. For this help we at NSF are grateful.

Among the successes in mathematics at NSF are the efforts that are going into projects directed at improving mathematics teaching and curriculum development. I am particularly pleased with the excitement generated by our Calculus Curriculum Development program, which is jointly funded by the Division of Mathematical Sciences and the Education and Human Resources Directorate. In this endeavor, we have again been very impressed by the quality of advice provided by the mathematics community.

I think that any objective observer would give the mathematics community very high marks for its recognition of the need to improve mathematics education and its willingness to work toward this goal at every level, from kindergarten through graduate education. This effort must continue—as each of us has a personal stake in the success of K-12 education...

Now let me turn to the health of mathematics as a research activity. In any field of research, an active academic researcher has a ready-made metric for diagnosing the health of his or her field—it is the answer to the question "Am I, and/or my talented colleagues, currently getting funding?" If the answer is no, then the health of science is dismal. If the answer is yes, then things could be a lot better, but for the time being they are tolerable.

Unfortunately, this may be the wrong question. I feel that a specific field cannot be healthy if the university as a whole, where the research is carried out, is ailing. And I think that we have serious structural problems in our universities that must be addressed more broadly. I am concerned about the long-term health and vitality of the academic research and education enterprise, but that is a topic that must be addressed more fully at another time.

For the mathematician seeking funding today, the field may not seem as robust as it ought to be. It is clear that there are more qualified researchers seeking a share of the available federal funding than ever before. Based on a recent survey, over 70% of doctoral mathematicians employed in academic institutions are engaged in research—and among mathematicians receiving Ph.D.s in the past seven years the rate approaches 90%. There are also 30% more math doctorates engaged in academic research than there were only ten years ago. These facts are rather dramatic evidence of the squeeze that the profession is feeling. It is also worth noting, however, that over 40% of math doctorates active in academic research report federal support for their research—a figure that is higher than in any year since the survey began in 1973. [Science and Engineering Indicators 1991, Appendix Fig. 5-19, 5-20. Exact figure is 41.5%.]

The picture that I am presenting about the health of research in the mathematical sciences is a complex one.
Remarks of Walter E. Massey

We can, for example, take pride in the fact that the U.S. produced over a thousand doctorates in the mathematical sciences last year—but this is tempered by the report in [the AMS-MAA Annual Survey] that one in eight of these new Ph.D.s had not found employment as of last September.

We can also be pleased by the survey’s finding that the number of African American Ph.D.s in the mathematical sciences has increased over the previous year—but we must be somewhat disappointed that this means that only ten out of the 461 Ph.D. recipients who are U.S. citizens are black.

On the positive side, let me note that at NSF, the Division of Mathematical Sciences under the direction of Dr. Judith Sunley, has sought to maximize every opportunity to provide research funding for mathematics. This means working closely with the Education and Human Resources Directorate, increased participation in joint programs throughout the Foundation, and making certain that the mathematical sciences are included in funding for the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) initiative on high performance computing. Dr. Sunley has also actively sought opportunities to expand mathematics partnerships with other disciplines.

There are a number of agency-wide operational priorities that I have made as well. My highest priority is to increase the support to individual investigators through larger grant size and extended award duration. In this regard, I have asked each Division to develop plans to establish a norm of three years duration for research project support. I have also asked that restrictions on the page length of research proposals be enforced. Anything that will reduce unnecessary time spent on non-productive activities should also benefit researchers.

It does not require a mathematician to recognize that, in a time of slow growth in science funding, increasing either the size or the duration of grants will place pressure on the number of awards that we can make.

The trade-off between duration of grants, the size of grants, and the number of grants awarded is nothing new. By increasing duration and size, we increase the number of difficult and often unpleasant decisions that must be made. But it is important to convey to the entire community that these decisions are not made capriciously. There is no aspect of federal funding for research that is more important to its continued success than the perception by the scientific community that the system is fair, open, and merit-based.

I would be remiss if I were to leave the topic of trade-offs without a discussion of “big science” versus “little science.” At NSF, we currently allocate approximately 60% of our spending to projects initiated by a single investigator.

The percent that goes to large projects—those over $1 million—has been remarkably stable at about 30% over the past fifteen years. Funding for large projects actually peaked at about 40% just after Sputnik. It is very difficult to convey to the research community that, while centers or large projects may get a disproportionate share of the news coverage, they have not received an ever-growing share of NSF’s budget. NSF funded centers, for example, receive only 6% of our budget.

In this context it is also important to note that a number of individual mathematicians and their equipment, which requires a different scale of investment, are being supported at Science and Technology Centers, and at two centers mathematicians play a central role. Mathematicians are also recipients of support through the High Performance Computing and Communication program.

The fact that mathematics provides the tools for advances in virtually every field of science makes mathematics central to the future health of the scientific enterprise. Paradoxically, this also makes it more difficult to relate to both Congress and the public. By the time the mathematical contributions to science and technology reach public awareness, they are so imbedded in the technology that they are all but invisible to the consumer.

How many members of Congress or the general public realize that personal computers or CAT scans are possible only because of work that is directly traceable to mathematicians? Even if these contributions were recognized, would that translate into more funding for the field? Maybe, but not necessarily. I am an optimist by nature, but my optimism is tempered with sufficient realism to recognize that we will have to work very hard if federal funding for science is to grow during the next five years as rapidly as it has grown during the past five years.

This brings me back to the importance of demonstrating the value, the excitement, and the utility of mathematics to the public—whether they are students in introductory algebra courses or ordinary people learning about mathematics through the public media or members of Congress.

While we cannot expect that every student who takes a calculus course will become a mathematician, we can hope that our educational efforts will engender a greater appreciation of the importance of mathematics in advancing technology and improving our quality of life.

So, how is mathematics doing? From my perspective it is basically healthy but not always comfortable—which is certainly preferable to being complacent and rife with pathology. If your definition of healthy means full funding for every qualified researcher or every quality idea, no field is completely healthy. But then I submit this is an unrealistic expectation.

If, instead, we view the health of the field in terms of improving the overall quality of mathematics education, in terms of the quality of research being done, in terms of the concern expressed by the community for future generations, and in terms of a willingness of researchers to seek opportunities to grow and expand—if these are our criteria for health, then I think the field of mathematics is as robust as it has ever been.

I appreciate having the opportunity to address you tonight, and I look forward to the continued high level of participation and involvement of the mathematical sciences community in the work of the National Science Foundation. Thank you.
Forum

The Forum section publishes short articles on issues that are of interest to the mathematical community. Articles should be between 1000 and 2500 words long. Readers are invited to submit articles for possible inclusion in Forum to:

*Notices* Forum Editor
American Mathematical Society
P.O. Box 6248
Providence, RI 02940

or electronically to notices@math.ams.com

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**Plans, Budgets, and Operations in the Division of Mathematical Sciences**

*Judith S. Sunley, Director*

**Division of Mathematical Sciences**

In the February issue of the *Notices*, David Sanchez, Assistant Director for Mathematical and Physical Sciences (MPS), described some aspects of budgeting and planning at the National Science Foundation (NSF). He focused on the planning cycle at the Foundation level and current efforts within MPS to build a long-range plan. My comments will follow on his, describing the long-range thinking of the Division of Mathematical Sciences (DMS); how that thinking is reflected in recent budgets, both as requested of and approved by Congress; and how budgets and plans affect what the community sees in our management of programs.

Because NSF is part of the executive branch of the federal government, the principal focus of our planning is the President's Budget Request to the Congress. The process entails a mixture of priorities developed at different levels. Disciplinary priorities are articulated at the division level, filtered and coalesced at the directorate level, and refined at the agency level. At each step, the overlay of priorities developed outside the disciplinary context becomes stronger. The Office of Management and Budget and the Office of Science and Technology Policy have an impact on the shape of the Budget Request as well. And, of course, Congress may also influence the ultimate disposition of funds through the appropriation process. The DMS portion of the Fiscal Year 1993 (FY93) Budget Request to Congress is found elsewhere in this issue of the *Notices*. This describes both the plan for FY93 and the disposition of the Fiscal Year 1992 (FY92) Request.

Walter Massey, Director of NSF, spoke at the combined AMS/MAA meeting in Baltimore in January. The text of his remarks is also found elsewhere in this issue of the *Notices*. Those remarks help set the context within which DMS operates and would be useful background for reading this article.

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**The Long-Range Plan**

For the past two years, DMS planning has been guided by a long-range plan established in May 1990. We developed this plan in consultation with the Advisory Committee for the Mathematical Sciences and members of the mathematics community. It takes into account the recommendations of various groups that had evaluated the health of the mathematical sciences up to that time, and was modified slightly in the spring of 1991 to accommodate recommendations of more recent reports. A subcommittee of the Advisory Committee for the Mathematical Sciences is now looking at modifications of the long-range plan that might better address the current circumstances of the division.

The long-range plan aims toward a robust mathematical sciences research enterprise. Its greatest emphasis is on the disciplinary research base, using the recommendations of the original David Report as a guideline and taking into account the broader recommendations of the David Update. The plan stresses the role of the individual investigator as the principal source of ideas and accomplishment. It also recognizes the value of cooperative and group-oriented research efforts that provide a framework for discussion and communication within which the individual investigator can work. Coordinated approaches to graduate student support and postdoctoral support are also considered. Increasing the number of researchers with support for their work has very high priority.

While placing heavy priority on the disciplinary research base, the plan also encompasses expanded activity in cross-disciplinary and computational research and in education and human resource development. The movement into areas beyond the traditional disciplinary research base reflects both new responsibilities assigned to the division by the Foundation and increased levels of activity within the mathematical sciences research enterprise. Its greatest emphasis is on the disciplinary research base, using the recommendations of the original David Report as a guideline and taking into account the broader recommendations of the David Update. The plan stresses the role of the individual investigator as the principal source of ideas and accomplishment. It also recognizes the value of cooperative and group-oriented research efforts that provide a framework for discussion and communication within which the individual investigator can work. Coordinated approaches to graduate student support and postdoctoral support are also considered. Increasing the number of researchers with support for their work has very high priority.

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*The opinions expressed here are those of the author and do not represent National Science Foundation policy.*
The core of the long-range plan is clearly visible in the division’s FY92 Budget Request (published in the Notices in April 1991). Our requested increase in funding consisted of three basic parts: dedicated funding to increase the number of new investigators participating in DMS programs; funds to allow DMS participation in the interagency initiative in High Performance Computing and Communications; and funds to enhance existing activity and explore new directions in education and human resource development. The remainder of the requested increase was to go to increasing the size of existing awards. This request was a direct translation of the long-range plan into action, although the overlay of Foundation and federal priorities meant the level and balance of the request was not what the plan described as best for the mathematical sciences.

The outcome of this request is described briefly in the DMS portion of the FY93 Budget Request to the Congress found elsewhere in this issue of the Notices. The FY92 incremental request for DMS was cut by about 30% as a result of Congressional reductions in the NSF appropriation. We expect each of the directions described above to receive continued emphasis, with our participation in the High Performance Computing and Communications initiative being maintained at essentially the level originally requested.

[Note: It is a bit difficult to track the changes between the request as originally written and the outcome as shown this year. This is because two modifications were made in the presentation of the DMS budget. First, the FY92 Budget Request was prepared before the results of the most recent NSF-wide competition for Science and Technology Centers was announced. Funds for the Geometry Center at the University of Minnesota have been added into the DMS accounts for Fiscal Years 1991, 1992, and 1993 in the FY93 Budget Request. Second, the way in which the request is presented has changed dramatically. The various disciplinary research programs have been collapsed to a single line, while cross-disciplinary and computational activities have been pulled together and highlighted in a separate line. A crosswalk between the two forms of presentation is provided for the FY92 Current Plan.]

The FY93 budget process within NSF was dominated by the planning for major research facilities and for several large, interdisciplinary initiatives. The initiatives are the tangible outcome of federal and Foundation priority setting. In a very real sense, they provide the motivation for continuation of the exceptional increases the Foundation has received in recent years. They meld national interest with the purposes of the academic research community. The FY93 Budget Request for DMS represents a major success for the division in convincing the organizers of these initiatives that the mathematical sciences could make important contributions to these efforts.

The investments made by DMS over the past five years to build bridges with the biological sciences, the geosciences, and particularly High Performance Computing and Communications provided the base for a significant increase in funding aimed at interdisciplinary, collaborative basic research. Thanks are due to members of the DMS Advisory Committee and the DMS staff for positioning us to address these areas of national interest while expanding the range of mathematical research and enriching it through the real problems of other fields.

We expect the DMS contributions in these areas to be made through the support of research proposed by individuals and small groups. Outreach both within the mathematical sciences community and to other disciplines will be integral to the exchange of information that will allow meaningful collaborative activity. Similarly, education and human resource development have gained national attention in recent years. Added post-doctoral support for the mathematical sciences and the opportunity to address curricular issues at the upper undergraduate levels will benefit the discipline as a whole. The blending of interdisciplinary research opportunities with education and human resource development may provide the opportunity for new experiments with vertical integration that cut across disciplinary lines.

The priorities described above dictated that the base of funding in the broad categories of disciplinary research in the mathematical sciences be maintained at current levels. It is only by maintaining the base that new mathematics will be available for incorporation into interdisciplinary settings and to stimulate the educational environment.

The balance of the three categories as described above is not as suggested in the long-range plan. This is an inevitable outcome of staged priorities and the compromises inherent in any planning and budgeting process. We will continue to argue as strongly and effectively as possible the importance of disciplinary research in the mathematical sciences, while taking advantage of opportunities raised for support of interdisciplinary or educational activities.

**Putting the Funds to Work**

In the short-term, it is how we use the funds at our disposal that most directly impacts the mathematical sciences community. The intricacies of the planning and budgeting...
process are less visible. What the community sees are the decisions made by individual programs on disciplinary research proposals. When people in the community talk about NSF policies, what they frequently mean are the many "rules of thumb" that guide the division's practices in administering the review and decision process.

These rules of thumb are developed within the framework of NSF policies on issues ranging from what constitutes a conflict of interest to how various budget items are pulled together on an award. There are many such matters that are raised by members of the mathematical community with regularity (for example: indirect costs, calculation of fringe benefits, charges for graduate students) over which we in DMS have little control. How an institution computes such items is negotiated to apply to all federal grants and contracts and generally to all disciplines. These negotiations are normally conducted by organizations other than NSF.

We have much more control over the size, number, and character of DMS awards. There has been much discussion in the community in recent years about how to increase the number of investigators whose research is supported, with frequent suggestions that we decrease the size of awards if that is what it takes. Every Advisory Committee meeting in the past few years has addressed similar questions.

At the same time the mathematical sciences community is suggesting smaller awards, the Foundation is moving in different directions. Dr. Massey, in his Baltimore address, said, "... My highest priority is to increase the support to individual investigators through larger grant size and extended award duration ... " Building this priority into our thinking will be important to our arguments that we are making the best possible use of our funds. We need to think creatively about mechanisms that might effectively support the research of individual investigators, even though they may appear to be larger in scope.

The growth of the mathematical sciences community and the influx of new researchers into the competition for funds places additional strains on the system. We must constantly address issues of balance between continuity of funding for on-going research efforts and allowing newcomers access to research support. This was the subject of much discussion at the most recent Advisory Committee meeting in December.

All these factors require us to think seriously about how we use the funds at our disposal for the most positive, beneficial impact on disciplinary research. Coherence of action across several programs and on the order of 2000 reviewed proposals per year is not easy to come by. We have been discussing these questions both internally and with our Advisory Committee and expect to raise the issues more broadly with the community as we progress. It would take another article as long as this one to explore these matters fully. Such an article may well grow out of our upcoming Advisory Committee meeting, May 4-6.

In the meantime, it is critical to have the broadest possible input from the mathematical sciences community as we begin the next cycle of long-range plan, budget development, and review and funding of proposals. I encourage you to make your ideas known to me (jsunley@nsf.gov or Judith Sunley, Division of Mathematical Sciences, Room 339, National Science Foundation, Washington, DC, 20550), to other members of the DMS staff with whom you may interact, or to Jerry Bona (Mathematics Department, Penn State University, 215 McAllister Bldg., University Park, PA 16802; bona@math.psu.edu), the chair of the Advisory Committee. I cannot promise that all suggestions will be adopted; that simply may not be possible. But I can promise that all serious suggestions will be thoughtfully considered as we plan for the future.

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Proceedings of Symposia in Applied Mathematics

Vol. 44

Probabilistic Combinatorics and Its Applications

Béla Bollobás, Editor

Probabilistic Combinatorics and Its Applications reviews the classical results in the theory of random graphs and presents several of the important recent developments in probabilistic combinatorics, together with some applications.

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This month's column

In this month's feature article, a team of researchers at the Center for Applied Mathematics at Cornell University describe dstool, a dynamical system toolkit developed at Cornell and a descendant of the program kaos which Ian Stewart reviewed in this column last year. Following that article, Jim Northrup reviews the program Grapher.

Correction

Roy D. North has pointed out an error in David Stoutemyer's article "Crimes and Misdemeanors in the Computer Algebra Trade," Notices 38 (1991), 778-785. The expression at the bottom of the first column on page 780 should end with the digit 4 rather than 5, and the number near the top of the next column should have its units digit changed from 4 to 3. This error arose when the author edited his TeX source file; it was not caused by a computer algebra bug.

Two further errors that crept in during the publication process were: six lines before Experiment 10 on page 783, "to u, which" should be "to [u], which"; and three lines before Experiment 15 on page 784, "In u" should read "-In u".

dstool: Computer Assisted Exploration of Dynamical Systems

A. Back, J. Guckenheimer, M. Myers, F. Wicklin, and P. Worfolk*

Center for Applied Mathematics, Cornell University

Ian Stewart (Notices, December 1991) described a computer program, entitled kaos, that was developed at Cornell University by S. Kim and J. Guckenheimer. We describe here a "second generation" program, called dstool, with much the same functionality as kaos, but a substantially different implementation. From the user's point of view, the most obvious difference is that dstool uses the X11, rather than the SunView, windowing system. However, the distinguishing features of dstool pertain to its modular design. Dstool was built to promote extension and improvement of its capabilities.

Dstool (short for Dynamical System TOOLkit) is designed to aid researchers in the investigation of dynamical systems. Toward this goal, our ultimate objective is to construct a comprehensive, open "package" that provides an interactive interface for all computations involving dynamical systems. This objective is ambitious and is certainly not yet fully realized. Scientific libraries of numerical algorithms (e.g., LINPACK, EISPACK, ...) are extraordinarily valuable resources for building complex programs out of modular components. But the value of these individual units is greatly enhanced when they are integrated into a larger software package which uses shared data structures to connect the algorithms with a sophisticated user interface that provides interactive control. Such a package can increase our ability to use computers as tools for gaining insight by minimizing time wasted in repetitious programming and using clumsy schemes for manipulating data. Programs constructed to meet these goals have applications in the classroom as well, where they may enable students to uncover fundamental properties of dynamical systems through their own exploration. Our intent has been to create in dstool a program that can serve as the core of an evolving environment that effectively integrates a comprehensive computational library with a user interface, visualization tools, and utilities for examining and printing data.

An Equivariant Example

To install a dynamical system for exploration with dstool, the user modifies a set of template files that provide information about the system. The templates are used to define the variables, initial values, and coefficients of the system to be treated as parameters. A vector field or discrete time dynamical system is defined by a C-language procedure that specifies the right-hand side of a system of differential equations or a mapping of an n-dimensional space into itself.
Phase spaces of the form \( T^k \times R^{n-k} \) are supported in the current implementation; we hope that future versions will provide support for vector fields defined on more general manifolds. Additional subroutines may provide functions that can be used for display purposes, explicit inverses of discrete mappings, and Jacobian derivatives. The bulk of the dstool code resides in a collection of “libraries,” which is created when the program is installed. In a shared environment, each user maintains a collection of dynamical systems which can be linked with the remainder of dstool to create a custom version of the executable program. There are no software restrictions with regard to the number of systems that can be installed simultaneously, the dimension of the phase space of each system, or the number of parameters defined for each system.

To illustrate how a researcher might utilize dstool, we present the following example of a four-dimensional vector field whose properties we are currently investigating. The vector field is defined by the equations

\[
\begin{align*}
\frac{dx_1}{dt} &= (l + ar^2 + bx_2^2 + cx_3^2 + dx_4^2)x_1 + ex_2x_3x_4 \\
\frac{dx_2}{dt} &= (l + ar^2 + bx_2^2 + cx_3^2 + dx_4^2)x_2 - ex_1x_3x_4 \\
\frac{dx_3}{dt} &= (l + ar^2 + bx_2^2 + cx_3^2 + dx_4^2)x_3 + ex_1x_2x_4 \\
\frac{dx_4}{dt} &= (l + ar^2 + bx_2^2 + cx_3^2 + dx_4^2)x_4 - ex_1x_2x_3
\end{align*}
\]

with

\[ r^2 = x_1^2 + x_2^2 + x_3^2 + x_4^2. \]

Here \((x_1, x_2, x_3, x_4) \in R^4\) and \(l, a, b, c, d, e\) are parameters. This system is the degree three normal form of a bifurcation with a particular discrete symmetry group and is typical of the types of mathematical examples dstool is designed to investigate. In studying bifurcations of symmetric dynamical systems, group theory and singularity theory can be used to describe some of the dynamical features that one encounters. Though the calculations are frequently lengthy and complex, they take only so far in finding and characterizing complicated dynamical behavior within these systems. In this example, we are primarily interested in \(l = 1\) and \(a = -1\) and small values of the remaining parameters. The system then has an invariant hypersurface that lies close to the unit sphere. The dynamics on this sphere are a scaled version of what happens in the system following a bifurcation in which \(l\) passes through 0 in a one-parameter family. We want to characterize the different possibilities that occur as the remaining parameters \(b, c, d, e\) vary. We choose an initial set of parameter values based on a linear analysis for the stability of equilibrium points. The analysis described below corresponds to a specific choice of parameter values for which all equilibrium points are unstable.

We initially use dstool to explore this example by simply computing trajectories. Figure 1a shows a typical single trajectory computed using a fourth-order quality control Runge-Kutta algorithm. We observe that the trajectory “circles about” heteroclinic orbits lying in invariant coordinate planes. Dstool can solve for the location of the equilibrium points numerically and compute the eigenvalues and eigen-vectors of the linearization of the vector field at these points. We discover that the equilibrium points nearest the trajectory are saddle points. Each saddle point has a two-dimensional stable manifold as well as a two-dimensional unstable manifold (whose associated eigenvalues are complex with small real parts), agreeing with our hand calculations. The trajectory is a sequence of segments, each of which follow the unstable manifold of one of these equilibria and then circle another heteroclinic orbit to the next spiral saddle. The saddles and heteroclinic orbits are images of each other under the symmetry group.

These initial observations motivate a more detailed study of the unstable manifold of the spiral saddle. Computer algebra techniques are used to compute a quadratic approximation to the unstable manifold and dstool is used to compute a set of initial conditions starting near the unstable manifold. We specify a set of initial conditions lying on a circle in the approximate unstable manifold surrounding the spiral saddle. The trajectories with these initial points give an image of the geometry of the unstable manifold, see Figures 1b and 1c. In this example, numerical study with dstool is contributing to the insights necessary for creating a geometrical model for the flow of this set of equivariant differential equations.

**Program Structure**

While the internal aspects of dstool can be ignored by users who want to use the package as provided, we have endeavored to provide an environment that can be tailored...
Computers and Mathematics

to guide very diverse kinds of computations. Understanding the basic organization of the program should enable a user to add enhancements to the code, without the need to become an expert C applications programmer. Conceptually, dstool consists of three parts: a set of computational algorithms organized into libraries, a graphical interface which provides a natural control over program operation, and a data object manager that mediates the flow of information between the libraries and interface. In this section, we briefly describe the major attributes of these three fundamental program components.

Dynamical systems theory focuses upon how trajectories of vector fields and discrete mappings partition their phase spaces. Computation provides a powerful tool for gaining insight into the geometric structures associated with dynamical systems. Numerical algorithms provide the foundation for these computations, but deciding upon the “best” algorithms to use for particular tasks is often difficult. For example, numerical integration of individual trajectories is a fundamental unit of computation in studying vector fields. There is an extensive literature concerning algorithms for numerical integration, and one would like to apply and compare different methods. The graphical appearance of trajectory data is no guarantee of its correctness—it is crucial that interactive packages like dstool be equipped with tools which can be used to scrutinize the data they produce. To address these issues, we designed generic points of attachment, or sockets, for the connection of integration routines. Incorporation of a new integration method into dstool requires merely the addition of procedures which define the algorithmic steps and respect the data conventions used by the socket. The installation of new integration methods is analogous to the addition of new dynamical systems—both benefit from the careful development of data structures and interfaces.

Once the routines required for a new integration method have been installed, their performance must be assessed. Our approach has been to follow the established convention of building driver programs, separate from both dstool and the graphical routines, which may be used to execute an entire computation subsection of the code, precisely as the code appears in dstool. For numerical integration, this main driver incorporates a number of established test cases [3,4] often used in the literature to critique the performance of new methods. Once the integrity of the newly installed integration method has been established, the stand-alone program may later be used to evaluate the validity of behavior observed in dstool, derive appropriate control parameters for specific applications, and compare accuracy of results using different algorithms. By establishing convenient tools for assessing the performance of blocks of dstool code, we seek to encourage the view that confidence regarding observed results is the product of careful analysis of both the dynamical system and the algorithms used to reveal them.

Besides the generation of trajectories, another common endeavor in studying dynamical systems is to determine bifurcation sets (parameter values at which qualitative changes in behavior occur) and the location of equilibria, periodic orbits, and their stable and unstable manifolds. In general, these are all formidable computational tasks. Performance of algorithms for finding equilibria and periodic orbits typically depends upon good starting values, and methods may behave very differently with the same initial data. Reliable

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Figures 1b, 1c: Two projections of a set of trajectories approximating the two-dimensional unstable manifold of an equilibrium point of the equivariant example.
algorithms for computing stable and unstable manifolds are not readily available and one would like an environment for their development.

The second major program component is the user interface. Dstool, like its predecessor kaos, has been developed and tested on Sun workstations. In contrast, however, it is designed to work in conjunction with the X11 window system and the XView toolkit, either with the MIT X11 server or Sun OpenWindows. This gives dstool two significant advantages relative to kaos. First, dstool can be executed remotely. This means that dstool may be executed on one, possibly very powerful, workstation while the user receives the images and controls the program from another, perhaps less capable, computer. In fact, the two workstations may be quite different; for example, Sun and NeXT workstations. Second, since X11 and XView are available in a number of different computing environments, the feasibility of porting dstool to a new machine is greatly enhanced. Indeed, we are currently testing a version of dstool for use on the IBM RS6000 workstation. Thus, we might reasonably expect the software lifecycle of dstool to be much longer than a similar program based on a proprietary environment such as SunView.

The interface itself is comprised of windows for the graphical visualization of data and panels that control the execution of computational routines. The panels have buttons that initiate actions and text items that display input values and the results of computation. The hierarchy of windows from the current distribution of dstool is shown in Figure 2. The principal windows used to interactively investigate a dynamical system are "view windows"—windows that are used to set and display data. A view window can be used to visualize the data from trajectories and other geometric structures in the product of the phase space and parameter space. Since the dimension of this product is typically much larger than two or three, a pair of functions is used to map points of the product into $\mathbb{R}^2$. These functions may be either coordinate functions or functions defined in a procedure for which a template is provided. The program currently allows one to represent visually a third dimension of information by using a color gradient, but development of an interactive 3-D viewer is well-advanced and should be completed soon.

Dstool is controlled mostly using buttons and text items located on panels. Each panel contains items that are functionally related and each panel may be independently created, removed, or iconized within a dstool session. Panel buttons and text items are used to perform such actions as controlling algorithms for integration, locating equilibrium points, viewing and changing initial conditions and parameter values, and printing (or saving) PostScript pictures. Certain actions can be initiated by mouse commands as well as keyboard input. We have established straightforward conventions for easily generating and adding new interaction windows to dstool. The program has a user panel mechanism allowing individuals to create windows doing highly customized computations while mustering whatever dstool resources are appropriate.

Underlying the graphical and computational activity in dstool is the management of the data required to control dstool and that produced by the algorithms. This task is the primary concern of the data object manager, the postmaster. Program information, together with the operations that may be performed upon it, are arranged in data objects. A data object may be as simple as a variable used to specify the plotting color, together with the operations required to obtain or change its current value. Objects may also be complex. The phase space manifold $T^k \times \mathbb{R}^{n-k}$, together with the operations required to lift a point to the covering space and translate it to a fundamental domain, is one such example. Duplication of data within the program has been minimized. The postmaster controls access to the only instance of a piece of data and interprets the meaning of required operations upon it. Thus, the definitions of data structures are placed within the postmaster, hiding them from the computation and plotting routines. During execution of dstool, data is entered, retrieved, or altered by making postmaster requests, ensuring that the data shared by various parts of the program remain up-to-date. Furthermore, when program development requires that a data structure must be enlarged or altered, the postmaster alone absorbs the changes.

This approach has important implications for collaborative efforts to expand the capabilities of dstool. Authors of new procedures for dstool are freed from the burden of locating the label of a global variable used to hold a particular piece of data or altering argument lists to pass data into their routines. The postmaster shelters the bulk of the code from features that depend upon the organization of data. Also, since the postmaster is interposed between the user-interface and the computation libraries, responsibility for display of data provided by a new procedure to the appropriate panel or window resides with the postmaster, not the applications programmer. We believe that such separation between data
management, generation, and display tasks should ease the implementation of new dstool features.

Work in Progress

Ddstool is evolving in several areas. In this section we describe three directions that give a sense of the evolving character of this software. The first area is visualization. We are completing the development of a three-dimensional geometry viewer, loosely based upon the program “viewworld” by Mark Phillips. This enhancement will allow convenient manipulation of three-dimensional data at speeds consistent with the interactive nature of dstool by using the XGL graphics library from Sun Microsystems. However, visualization problems associated with dynamical systems go well beyond displaying objects in \( R^3 \). This presents a major challenge for the future development of dstool, and we hope to experiment with the visualization of high-dimensional geometry.

A second area of current development entails broadening the class of dynamical systems that we can work with. In particular, we want to provide the facility for representing and investigating dynamical systems on manifolds. Dstool can currently handle dynamical systems with periodic variables (i.e., phase spaces of the form \( T^k \times R^{n-k} \)) without a noticeable sacrifice of performance through the judicious use of lifts into Euclidean space and projections onto tori. For more general manifolds, however, this is a more difficult problem since numerical algorithms only “know” about Euclidean space. The solution of this problem requires that dstool be provided with the facility to recognize the decomposition of a manifold into charts with explicit transition functions between them. Our expectation is that this additional layer of complexity will increase the computational demands for satisfactory performance considerably, but that the rapid increases in the speed of workstation processors and the ready availability of multiprocessor systems will meet these demands in a timely fashion.

A third area of current development involves the incorporation of additional numerical techniques into dstool. There is a large scope here both for integration of existing methods into dstool and for creating new algorithms. There are many algorithmic problems of interest, including computation of error estimates for trajectory calculations, multidimensional stable and unstable manifolds, higher codimension bifurcations in multiparameter families, and bifurcations in symmetries of vector fields. Currently, we are incorporating code for continuation of equilibria and periodic orbits based on established methods for numerical path following and generating solutions to two-point boundary value problems. As with numerical algorithms for root finding, there are no universal choices for the best algorithms for these purposes. It is desirable, then, to provide the user with a selection of the ones most useful in practice. Once installed, these algorithms can then serve as the building blocks for routines that track equilibrium points and periodic orbits as functions of parameters (with detection of bifurcations along the branches) as well as for computing bifurcation curves in two-parameter families. There are several packages (e.g., PITCON by Rheinboldt [5] and AUTO by Doedel [2]) that perform these calculations, and it is our desire to incorporate the algorithmic developments embodied in these existing packages as well as to experiment with alternative approaches. We plan to continue investigating algorithmic developments that will be tested on suites of dynamical systems drawn from our research interests.

Figure 3 (see next page) shows an example of our work with continuation methods. It displays bifurcation curves in the parameter space of a two-parameter family of vector fields: the Hodgkin-Huxley model of action potentials in a nerve axon. The equations are given by

\[
\begin{align*}
\frac{dV}{dt} &= -G(V,m,n,h) + I \\
\frac{dm}{dt} &= \Phi(T) \left[ (1-m)\alpha_m(V) - m\beta_m(V) \right] \\
\frac{dn}{dt} &= \Phi(T) \left[ (1-n)\alpha_n(V) - n\beta_n(V) \right] \\
\frac{dh}{dt} &= \Phi(T) \left[ (1-h)\alpha_h(V) - h\beta_h(V) \right]
\end{align*}
\]

with

\[
G(V,m,n,h) = \tilde{g}_N m^3 h(V - \tilde{V}_N) + \tilde{g}_K n^4 (V - \tilde{V}_K) + \tilde{g}_L (V - \tilde{V}_L)
\]

\[
\alpha_m(V) = \Psi \left( \frac{V + 25}{10} \right)
\]

\[
\beta_m(V) = 4e^{V/18}
\]

\[
\alpha_n(V) = 0.1 \Psi \left( \frac{V + 10}{10} \right)
\]

\[
\beta_n(V) = 0.125e^{V/80}
\]

\[
\alpha_h(V) = 0.07e^{V/20}
\]

\[
\beta_h(V) = \left( 1 + e^{V+30/10} \right)^{-1}
\]

\[
\Phi(T) = 3(T-6)/10
\]

\[
\Psi(x) = x/(e^x - 1)
\]

The parameters for this system are \( I, \tilde{g}_N, \tilde{V}_N, \tilde{g}_K, \tilde{V}_K, \tilde{g}_L, \tilde{V}_L \), and \( T \). The figure shows the computation of saddle-node and Hopf bifurcations as functions of the parameters \( I \) and \( \tilde{g}_K \), generated using a predictor-corrector algorithm. For this example, the computations can be performed directly with symbolic computation packages, and they have been checked with both Maple and Mathematica.

Open Software versus Black Boxes

Our work in building user interfaces for investigating dynamical systems began largely with a project of investigating diffeomorphisms of the two-dimensional torus [1]. We found that the investment that we made in developing interfaces for studying dynamical systems was repaid in our ability to work efficiently with the examples we were studying. The further additional effort that led to the creation of kaos and dstool was based on the assumption that these tools are important vehicles for conducting research in mathematics.

As stated earlier, our objective is for dstool to become a
provide a uniform framework for a body of related insights, the process of integrating related algorithms into coherent libraries and packages is an important "infrastructure" task for the mathematical community. Furthermore, it is important that this task be openly discussed and implemented. Packages that make our work more efficient and give us new capabilities have a clear benefit and can serve to advance the subject of mathematics (as well as its application to far-flung problems). But if we adopt the widespread attitude that such software development ought to be a commercial enterprise resulting in "products" for which the underlying source code is kept from users, then it is almost impossible for us to evaluate the correctness of the algorithms or to make incremental improvements in the software. We become dependent upon "black boxes" that may or may not do what their sellers claim, and we cannot participate directly in making them more effective for our use. Therefore, the mathematics community should find reasonable mechanisms to incorporate and support such computational work as part of the mathematical enterprise.

In the past, when the mathematics community has faced developments that affect its relations with other disciplines or endeavors, the response has been conservative, with insistence upon the primacy of the values of rigor and precision. The result has been that new disciplines like statistics, operations research, and parts of computer science have emerged as independent endeavors, rather than as branches of mathematics. The same thing may be happening to the areas described as "scientific computation" or "computational science." If this trend leads to a rejection of machine computation as a legitimate tool for doing mathematics, then we feel mathematics will suffer. On the other hand, embracing computation as part of the mathematical enterprise requires that we subject the process of computation to the same scrutiny that we give to proofs produced by mathematicians without the use of computers. We aim to carry forward the development of dstool within this spirit and encourage other mathematicians of like mind to join with us in this effort as collaborators, contributors, critics, and users of these computational tools.

Availability

The source code of dstool, designed for use with Sun workstations running OpenWindows or MIT X11 together with the XView toolkit, is available on the anonymous ftp server macomb.tn.cornell.edu (128.84.237.12). Preliminary versions of software documentation may also be obtained in this manner. Potential users who do not have access to the internet may obtain the program by sending a 1/4 inch cartridge tape or a pair of 1.44 MB 3 1/2 inch floppy disks to the Center for Applied Mathematics, Cornell University, Ithaca, NY 14853.

References


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Figure 3: Bifurcation diagram of the Hodgkin-Huxley equations in the parameter plane of the parameters representing external current and equilibrium potential for potassium ions. The heavy curve is formed by points of saddle-node bifurcations and the thinner curve is formed by points of Hopf bifurcation. The inset shows detail near the cusp along the saddle node curve. The endpoints of the Hopf bifurcation curve are points of Takens-Bogdanov bifurcation along the saddle-node curve.

In seeking collaborators for extending dstool, there are a number of pragmatic issues that arise. Building an environment out of programs that work together seamlessly requires that there be common or compatible data structures used by the different algorithms within the package. In the case of dstool, we confront the issue of how one effectively represents and efficiently computes the geometric objects associated with dynamical systems. To incorporate contributions from different authors requires that all agree upon these data structures. Outside of the realm of computer science, discussions of such architectural issues often seem lacking in substance. We expect that successful collaborations will involve detailed discussion of algorithms and supporting data structures.

Just as it is important for related mathematical theorems to undergo systematic amalgamation into theories that comprehensive package for computing everything that can be computed about dynamical systems. Since this project is open-ended and larger than we can hope to accomplish in a reasonable length of time, we would like to solicit collaborators. New algorithms need to be developed and existing methods need to be integrated into dstool. As our resources permit, we intend to undertake the evaluation and integration of new algorithms and to build new functionality into dstool. We encourage potential contributors to write or call us.
Reviews of Mathematical Software

Grapher
Reviewed by Jim Northrup*

Grapher is a program for graphing functions of one variable on a Macintosh computer. Though Grapher is designed to graph functions in the plane only, as opposed to plotting surfaces or trajectories, it does what it was designed to do very well. The user interface is friendly, with enough features so as to make the program versatile, but not so many as to make the interface cluttered. Its primary strengths are the great variety of planar curves that it can plot, and its small size.

At startup the user is presented with a blank slate, upon which functions will be graphed, and a collection of typical Macintosh pull-down menus. I found that the menus were clear enough to allow me to use Grapher without reading the manual, though I did find some helpful information in the manual after my initial exploration of the program. The program will plot eight different types of graphs. Competing programs such as Skrien Plot or TEMATH typically plot Cartesian functions, polar functions, and perhaps parametric functions. Grapher plots these as well as the graphs of solutions of differential equations, solutions of parametric differential equations, direction fields of differential equations, functions given as series, and polynomials interpolated through user-provided data points. It does not handle piecewise-defined functions. The numerical algorithms, such as those used to solve the differential equations, are described in the manual. If I were to add a ninth type of plotting to Grapher it would be the ability to graph splines drawn through points read from a data file.

When the user first requests a new graph, the program provides a dialog box into which the function should be typed. These dialog boxes are very easy to use, in part because the function parser is so well written. Most users of mathematical software are by now familiar with the use of "*" to denote multiplication and "^" to denote exponentiation; Grapher makes use of these conventions.

What is especially nice about this parser, however, is its context-sensitive use of grouping symbols. For example, parentheses can be used either to enclose the arguments of a function, as in "sin(x)", or to denote operator hierarchy, as in "5*(x+3)". Additionally, the symbols { } and [ ] can also be used to group expressions, making complicated expressions such as "\([3+x*[5+(x+2)*2]\)" much more readable. (This is a feature of the competitor Number Crunch as well, but not of Skrien Plot or TEMATH, for example.) It is understandable that so many other packages would reserve a different meaning for each of these three pairs of grouping symbols, but it is refreshing to see software that uses them in the same way as handwritten mathematics. Also, the dialog box into which function series are entered appeals to the intuition; a big sigma is drawn and the appropriate parameters are typed around the sigma, again approximating the manner in which they would be entered on a handwritten page (see figure).

Grapher provides a number of different graphing options for each type of plot; for example, coordinate axes can be scaled and marked in various ways by entering values in a dialog box. Logarithmic scaling, however, was absent. Also, Grapher does not allow you to drag a zoom box over a graph, as competitors such as Skrien Plot, Number Crunch, and TEMATH do; this is an unfortunate omission. The graphs themselves can be plotted using several pen types in Grapher, or even in color on a properly equipped Macintosh or color printer. The program can also be told to adjust the resolution or the aspect ratio of the graphs, the latter allowing circles to appear as circles on an ImageWriter page, rather than as ovals.

Additionally, there is a useful set of drawing tools in Grapher which can be used to incorporate extra features, such as labels, into your graphs. These include tools for drawing lines, big dots, and text. One could provide these extra labels and marks by cutting the graph out of Grapher and pasting it, as a bitmap, into a paint program such as Superpaint. By providing the labeling tools in Grapher...
itself, however, the graphs can be kept in quickdraw format, which makes for better printing. The text-entering tool does not have the “look and feel” of the text-entering tool used by most Macintosh drawing software, and there is no “eraser” tool for erasing mistakes. The only way to delete a mistake is to do so immediately with the “undo” edit option, so it pays to double check each feature of your picture as you add it, before moving on to the next.

For the most part, the 24 page Grapher manual is unnecessary, since the user interface is fairly obvious. The manual does explain most menu items clearly, and also describes the numerical algorithms used to solve the differential equations. The documentation is sketchy in a few places; for example, its explanation of the XOR line drawing mode is an illustration only, with no verbal description. Also, the manual does not include a list of valid intrinsic functions (sin(x), cos(x), log(x), etc.). Instead, it refers the user to a somewhat cluttered help screen in the program itself. The list of intrinsic functions is extensive though.

The Grapher disk includes three versions of the program: one for Macintoshes with floating point coprocessors, one for Macintoshes without coprocessors, and a freely distributable demonstration version. Grapher requires only 256K, so memory will not be an issue for most users. In fact, users of MultiFinder will probably find that Grapher’s low memory usage is one of its strongest features. There are plenty of “big” packages, such as Mathematica, which will also draw simple graphs of functions, but these programs will not leave you with much free memory for running other applications. Much smaller programs such as Grapher, Skrien Plot, or Number Crunch on the other hand, are fairly complete and can be loaded into memory along with your larger applications. Grapher’s main advantage over these other small packages is that it can graph more types of functions.

Registered owners of Grapher have access to a technical support phone number, apparently the author’s own phone number, though I expect users are unlikely to ever need it. I connected to an answering machine when I tried the phone number. Grapher was written by Steve Scarborough and is distributed by the PWS-Kent Publishing Company. (Number Crunch, by Jim Mahoney, is available from its author and is freely distributable. The shareware program Skrien Plot is also available from its author, Dale Skrien. TEMATH, by Robert Kowalczyk and Adam Hausknecht, is available from Brooks/Cole Publishing.)

ADVANCES IN SOVIET MATHEMATICS

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AMS Task Force on Employment
Report to the Mathematical Community
Donald E. McClure

- Economic conditions are severely affecting the current U.S. academic job market for mathematicians. The 40 doctorate-granting departments in the survey report 28 full-time doctoral faculty positions currently affected by temporary hiring freezes and anticipate elimination of 16 positions. Among all doctorate-granting mathematics departments, an estimated 106 positions are currently affected by freezes and an estimated 48 positions will be eliminated. In comparison, an estimated 536 doctoral mathematicians were hired to fill faculty positions in 1991–92 in the U.S.'s 170 doctorate-granting mathematics departments.

- There is a substantial influx of highly trained mathematicians from abroad. Citizens of Eastern European countries and the former Soviet Union accounted for 13% of all newly-hired faculty and 15% of the tenured and tenure-eligible new hires. 71% of the Eastern European/Soviet citizens received their doctorate in Eastern Europe or the Soviet Union.

- In addition, many foreign citizens trained in the U.S. join the nation’s academic job market. Citizens of Asian countries accounted for 22% of all newly-hired faculty and 16% of the tenured and tenure-eligible new hires. 91% of the Asian citizen new hires received their doctorate in the U.S.

- U.S. citizens accounted for 37% of all newly-hired faculty in the doctorate-granting mathematics departments. Among the tenured and tenure-eligible new hires, 46% were U.S. citizens, a proportion comparable to the representation of U.S. citizens among new doctorates awarded in the U.S.

- Estimates of the number of candidates available and of the number of positions under recruitment indicate that the current job market will be at least as difficult as last year’s. The 40 departments in the survey estimate that 385 current graduate students are likely to complete degree requirements in time for 1992–93 employment. In 1990–91, the same 40 departments awarded a total of 383 new doctorates.

- The majority of the positions filled in doctorate-granting mathematics departments are not tenure-eligible positions. Among all new hires, 62% filled positions that are not tenure-eligible and 52% filled non-tenure-eligible positions with contract durations of two years or less. From all doctorate-granting mathematics departments, an estimated 298 current doctoral faculty are likely to be seeking academic positions this year—a number equal to 56% of last year’s total hiring by the same departments.

Special Job Listing Service available on e-MATH

In an effort to widely broadcast late opening positions, the AMS Task Force on Employment urges all departments and other potential employers to post positions still available via a new, additional feature of the Society’s e-MATH service. Beginning mid-April and continuing through the summer, departments may submit, free of charge, listings of positions to be filled by fall 1992. Details of this additional e-MATH service were mailed to departments during March. The Task Force asks department chairs to alert any potential applicants to logon to e-MATH to check for newly-available positions.

To access e-MATH: telnet e-math.ams.com.
Login and password are: e-math
Introduction
The AMS Task Force on Employment¹ was appointed by President Artin during the summer of 1991, charged to review the current employment situation within the academic mathematics community and to make recommendations on ways to address the problems that may be found.

This article reports on one aspect of the data gathering and analysis done by the task force. A comprehensive report, including the task force’s recommendations, is currently in preparation. In the interest of making information that relates to the current year’s job market available to the community in a timely manner, however, this article is being published in advance of the full report.

The worsening employment market for Ph.D. mathematicians was widely felt in 1990–91, especially in the academic job market. Hiring departments reported swelling numbers of applications for open positions and candidates were confronted with a drastically reduced number of available positions.

The 1991 AMS-MAA Annual Survey provided firm evidence from the perspective of the job candidate of the more difficult market. In fall 1991, 12% of the 1990–91 new doctorates whose employment status was known were reported to be unemployed and still seeking employment (see Notices, November 1991, pp. 1087–1094). Since 1970–71, this rate of unemployment was exceeded only in fall 1975, when 14% of the 1974–75 new doctorates were unemployed. Commonly, the fall unemployment rate is 4 or 5%.

Three factors were recognized as contributing to the difficult market: an increased number of new Ph.D. s, reduced hiring due to economic conditions, and increased numbers of highly qualified recent U.S. immigrants seeking employment in academia.

The Annual Survey provides reasonably complete information about the characteristics of new doctorates as well as some measure of the impact on the job market of economic conditions. In 1990–91 the total number of new doctorates in mathematics, statistics, applied mathematics, and operations research awarded by U.S. institutions increased by 15% from the number in 1989–90. At the same time, the number of positions for which doctoral faculty were recruited was down by more than 15% in doctorate-granting mathematics departments and by more than 30% in master’s-granting mathematics departments from 1989–90 to 1990–91. (See 1991 Annual AMS-MAA Survey, 2nd Report, to appear in May Notices.)

Information about the circumstances of cutbacks in recruitment, e.g., whether they are due to temporary freezes or to permanent staffing reductions, and about numbers of recent immigrants being hired is less complete. The Academic Hiring Survey was designed to learn more about the impact of these factors on the academic job market.

In November 1991, questionnaires were sent to forty of the 170 doctorate-granting mathematics departments in the U.S. The surveyed departments were selected systematically from Groups I, II, and III of the grouping regularly used for the Annual Survey.² The departments surveyed included the twenty largest Group I departments and ten largest Group II departments, ranked according to the number of doctorates awarded between July 1, 1989 and June 30, 1990. The same thirty Group I and II departments participated in the spring 1991 survey on the employment experience of new Ph.D.s then seeking employment; they provided baseline information about recruitment at that time. In addition, ten Group III departments were selected to participate from the largest producers of new Ph.D.s among Group III departments over the ten-year period, July 1, 1981 through June 30, 1991. The participating departments are listed in Note 1 at the end of this report.

By early February, responses had been received from all forty departments describing (i) information about citizenship, education, and previous employment experience of all full-time doctoral faculty members hired for the 1991–92 academic year, (ii) tenure status and contract terms of the positions filled, (iii) numbers of current graduate students and faculty who may join this year’s academic job market, and (iv) departmental hiring plans and expectations for change in department size for the coming academic year.

Survey Results
The Academic Hiring Survey provides a snapshot of a limited, but important, segment of the mathematicians’ academic job market. Based on Annual Survey data from 1990 and 1991, the sampled departments employ a total of 2,118 full-time faculty members out of a total of 6,014 full-time doctoral faculty in all Group I, II, and III departments. Thus, the responding departments account for a significant proportion of total faculty of the doctorate-producing mathematics departments in the U.S. In terms of doctorate production, the forty sampled departments account for 50% of the 1990–91 Ph.D.s from mathematics departments in the U.S.

The Academic Hiring Survey does not examine the characteristics of new hires by departments whose highest degree is the bachelor’s or master’s, or by research institutes, two-year colleges, or other academic employers. Such segments of the academic job market account for a substantial proportion of the total academic job market for mathematicians. In 1990–91, 43% of the new doctorates from Group I–III departments who were employed in academic positions took a position in a Group I, II, or III department. Other forms of academic employment accounted for 57% of the U.S. academic job market for the same group of new Ph.D.s. It was not feasible to survey these segments of the academic market within the time and resource constraints faced by the task force.

The Group I, II, and III departments represent about 30% of the total job market—academic and nonacademic, domestic and foreign—for new doctorates from U.S. mathematics departments.

¹Task Force members are S.-Y. Cheng, Ronald M. Davis, Helen G. Grundman, D. J. Lewis (Chair), Bernard L. Madison, James W. Maxwell (ex officio), Donald E. McClure, Calvin C. Moore, and Carol S. Wood. The work of the Task Force is sponsored in part by National Science Foundation Grant No. DMS-9121741 to the American Mathematical Society.

²See November 1991 Notices, page 1086, for description of groups used in Annual AMS-MAA Surveys.
In analyzing the survey responses, we have projected the tallies from the survey per se to the full population of Group I, II, and III departments. Since the sample was selected systematically and not at random, these projections undoubtedly inherit selection biases. To mitigate the selection bias, the projections have been done separately for each of the three survey Groups, on the basis of total faculty size, predicated on the assumption that the separate Groups are homogeneous in terms of the selection criterion and the measured characteristics. The exact method of projection is explained in Note 2 at the end of the report. The reader should be aware that the sampling method introduces natural biases to the projections automatically and not at random, these projections undoubtedly make it impossible to apply statistical error bounds.

### Total Hiring, Tenure Status and Contract Terms

A total of 214 full-time doctoral faculty were hired for 1991–92 by the sampled departments. This projects to a total of 536 full-time doctoral faculty hired by all Group I–III departments. Table 1 gives a breakdown of the new hires, by Group and by tenure status of the positions filled. Among the sampled departments, two Group I departments and four Group III departments reported no hiring.

The distribution of tenure-eligible (TE) vs. non-tenure-eligible (NonTE) new hires varies significantly as a function of the Group. This is due more to differences in the numbers of NonTE hires between Groups than to differences in numbers of TE hires. The rate of TE hires per 1000 full-time tenured or tenure-eligible faculty members for the three Groups are: Group I, 32; Group II, 40; and Group III, 37. In contrast, the rate of NonTE hires per 1000 full-time faculty members are: Group I, 82; Group II, 68; and Group III, 23.

The durations of the initial employment contracts were reported for all NonTE hires. This information may give some indication of the numbers of persons currently employed who will reenter the job market in the next one to three years. While there is some variation across Groups in the durations, all of the distributions are skewed towards short-term contracts. Among the 148 NonTE hires in the sample, 79 (53%) report a contract duration of one year, 34 (23%) report a contract duration of two years, and 27 (18%) report a contract duration of three years.

### Year of Doctorate and Employment Experience of New Hires

Table 2 reports the numbers of new hires by Group and year of award of the doctorate. Projected to the full population of Group I–III departments, over 50% of the new hires have had their doctorate for two years or more.

The variation in the distribution of doctoral age between the Groups is associated with the variation in the distribution of NonTE new hires; Groups I and II report higher numbers of NonTE hires and correspondingly higher percentages of 1991 doctorate holders.

Doctoral age and previous employment experience are important factors for the tenured and tenure-eligible positions. In Group I, for example, among the 36 TE new hires, 23 (64%) earned their doctorate in 1988 or before. Among the 66 TE hires in the entire sample, only 10 (15%) hold 1991 doctorates, 8 (12%) hold 1990 doctorates, 12 (18%) hold 1989 doctorates, 13 (20%) hold 1986–88 doctorates, and 23 (35%) hold a doctorate from 1985 or before.

Across all Groups, the responding departments reported that new doctorates were “considered” for 52% of the TE positions. There is substantial variation in this percentage between the Groups, however: Group I, 36%; Group II, 84%; Group III, 45%.

Out of the 66 TE new hires, a total of 56 (85%) report having had prior full-time employment in the mathematical sciences since receiving their doctorate. There is little variation in this percentage between Groups: Group I, 89%; Group II, 79%; Group III, 82%.

### TABLE 1. Tenure Status of Full-time Doctoral Faculty Hired for 1991–92

<table>
<thead>
<tr>
<th>Tenure Status</th>
<th>Row Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenured/Non-TE</td>
<td>Row Total</td>
</tr>
<tr>
<td>Group I</td>
<td></td>
</tr>
<tr>
<td>106 (75%)</td>
<td>142</td>
</tr>
<tr>
<td>Group II</td>
<td></td>
</tr>
<tr>
<td>35 (65%)</td>
<td>54</td>
</tr>
<tr>
<td>Group III</td>
<td></td>
</tr>
<tr>
<td>7 (39%)</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>148</td>
<td>214</td>
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</table>

<table>
<thead>
<tr>
<th>Tenure Status</th>
<th>Row Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenured/Non-TE</td>
<td>Row Total</td>
</tr>
<tr>
<td>Group I</td>
<td></td>
</tr>
<tr>
<td>57 (25%)</td>
<td>225</td>
</tr>
<tr>
<td>Group II</td>
<td></td>
</tr>
<tr>
<td>63 (35%)</td>
<td>178</td>
</tr>
<tr>
<td>Group III</td>
<td></td>
</tr>
<tr>
<td>52 (39%)</td>
<td>133</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>201 (38%)</td>
<td>536</td>
</tr>
</tbody>
</table>

1 All percents are row percents.

### TABLE 2. Year of Ph.D. for Full-time Doctoral Faculty Hired for 1991–92

<table>
<thead>
<tr>
<th></th>
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<tr>
<td>Group I</td>
<td>28</td>
<td>19</td>
<td>18</td>
<td>19</td>
<td>58</td>
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<tr>
<td>Group II</td>
<td>11</td>
<td>6</td>
<td>10</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>Group III</td>
<td>7</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>46</td>
<td>27</td>
<td>30</td>
<td>31</td>
<td>80</td>
</tr>
</tbody>
</table>

<table>
<thead>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>44</td>
<td>30</td>
<td>28</td>
<td>30</td>
<td>92</td>
</tr>
<tr>
<td>Group II</td>
<td>36</td>
<td>20</td>
<td>33</td>
<td>26</td>
<td>63</td>
</tr>
<tr>
<td>Group III</td>
<td>52</td>
<td>15</td>
<td>15</td>
<td>30</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>132</td>
<td>65</td>
<td>76</td>
<td>86</td>
<td>177</td>
</tr>
</tbody>
</table>
Citizenship Status and Educational Background of New Hires

Table 3 and Figure 1 show the numbers of new hires by country or region of citizenship.

The proportion of non-U.S. citizen new hires echoes, on one hand, the high percentage of non-U.S. citizen Ph.D.s awarded by U.S. institutions and, on the other hand, substantial post-Ph.D. immigration. Table 4 and Figure 2 show the numbers of new hires by the country or region in which the doctorate was earned. Comparison of the two tables suggests that most of the Asian new hires earned their degrees in the U.S. whereas most of the new hires from Eastern Europe, the former Soviet Union, and Western Europe earned their degrees abroad. Indeed, 91% of the Asian-citizen new hires earned their doctorates in the U.S. and 71% of the new hires whose citizenship is in Eastern Europe or the Soviet Union earned their doctorates in Eastern Europe or the Soviet Union.

There are no known studies of hiring in earlier years with which we can compare the present survey's findings in order to understand temporal variation of the citizenship patterns.

The distribution of citizenship among the 66 TE new hires is not strikingly different from the distribution shown in Table 3 for all new hires. A higher percentage (49%) of the Group I TE hires than of all Group I new hires are U.S. citizens. When projected to the full population of Group I–III departments, 46% of the TE new hires are U.S. citizens, of the same order as the percentage in recent years of U.S. citizens among new doctorates from U.S. doctorate-granting mathematical sciences departments.

### TABLE 3. Citizenship Status of Full-time Doctoral Faculty Hired for 1991–92

<table>
<thead>
<tr>
<th></th>
<th>Citizenship</th>
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<th></th>
<th></th>
<th></th>
<th>Row Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>USA</td>
<td>Eastern European/ Soviet Union</td>
<td>Asian</td>
<td>Western European</td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>46</td>
<td>(33%)</td>
<td>17 (12%)</td>
<td>26 (18%)</td>
<td>26 (18%)</td>
<td>26 (18%)</td>
</tr>
<tr>
<td>Group II</td>
<td>12</td>
<td>(24%)</td>
<td>10 (20%)</td>
<td>16 (31%)</td>
<td>8 (16%)</td>
<td>5 (10%)</td>
</tr>
<tr>
<td>Group III</td>
<td>11</td>
<td>(61%)</td>
<td>1 (6%)</td>
<td>3 (17%)</td>
<td>2 (11%)</td>
<td>1 (6%)</td>
</tr>
<tr>
<td>Column Totals</td>
<td>69</td>
<td></td>
<td>28</td>
<td>45</td>
<td>36</td>
<td>32</td>
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</table>

<table>
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<th></th>
<th>Citizenship</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Row Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>USA</td>
<td>Eastern European/ Soviet Union</td>
<td>Asian</td>
<td>Western European</td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>73</td>
<td>(33%)</td>
<td>27 (12%)</td>
<td>41 (18%)</td>
<td>41 (18%)</td>
<td>41 (18%)</td>
</tr>
<tr>
<td>Group II</td>
<td>40</td>
<td>(24%)</td>
<td>33 (20%)</td>
<td>53 (31%)</td>
<td>26 (16%)</td>
<td>17 (10%)</td>
</tr>
<tr>
<td>Group III</td>
<td>82</td>
<td>(61%)</td>
<td>7 (6%)</td>
<td>22 (17%)</td>
<td>15 (11%)</td>
<td>7 (6%)</td>
</tr>
<tr>
<td>Column Totals</td>
<td>195</td>
<td>(37%)</td>
<td>67 (13%)</td>
<td>116 (22%)</td>
<td>82 (16%)</td>
<td>65 (12%)</td>
</tr>
</tbody>
</table>

1 See Note 3 at the end of this report for description of groupings used.
2 All percents are row percents.
3 Does not account for new hires whose citizenship status is unknown.
TABLE 4. Country/Region\(^1\) in which doctorate was earned, for full-time Faculty Hired for 1991–92

<table>
<thead>
<tr>
<th>Country/Region in which Doctorate Earned</th>
<th>Row Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>142</td>
</tr>
<tr>
<td>Eastern European/ Asian</td>
<td></td>
</tr>
<tr>
<td>Asia</td>
<td>9 (9%)</td>
</tr>
<tr>
<td>Western European</td>
<td>19 (13%)</td>
</tr>
<tr>
<td>Other</td>
<td>5 (4%)</td>
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</tbody>
</table>

FORTY SAMPLED DEPARTMENTS

<table>
<thead>
<tr>
<th>Group</th>
<th>USA</th>
<th>Eastern European/ Asian</th>
<th>Western European</th>
<th>Other</th>
<th>Row Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>102 (72%)</td>
<td>13 (9%)</td>
<td>3 (2%)</td>
<td>19 (13%)</td>
<td>5 (4%)</td>
</tr>
<tr>
<td>Group II</td>
<td>40 (74%)</td>
<td>7 (13%)</td>
<td>0</td>
<td>4 (7%)</td>
<td>3 (6%)</td>
</tr>
<tr>
<td>Group III</td>
<td>14 (78%)</td>
<td>1 (6%)</td>
<td>0</td>
<td>3 (17%)</td>
<td>0</td>
</tr>
<tr>
<td>Column Totals</td>
<td>156</td>
<td>21</td>
<td>3</td>
<td>26</td>
<td>8</td>
</tr>
</tbody>
</table>

ALL GROUP I, II, AND III DEPARTMENTS (PROJECTED)

<table>
<thead>
<tr>
<th>Country/Region in which Doctorate Earned</th>
<th>Row Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>225</td>
</tr>
<tr>
<td>Eastern European/ Soviet Union</td>
<td></td>
</tr>
<tr>
<td>Asia</td>
<td>5 (2%)</td>
</tr>
<tr>
<td>Western European</td>
<td>30 (13%)</td>
</tr>
<tr>
<td>Other</td>
<td>8 (4%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group</th>
<th>USA</th>
<th>Eastern European/ Soviet Union</th>
<th>Western European</th>
<th>Other</th>
<th>Row Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>161 (72%)</td>
<td>21 (9%)</td>
<td>5 (2%)</td>
<td>30 (13%)</td>
<td>8 (4%)</td>
</tr>
<tr>
<td>Group II</td>
<td>132 (74%)</td>
<td>23 (13%)</td>
<td>0</td>
<td>13 (7%)</td>
<td>10 (6%)</td>
</tr>
<tr>
<td>Group III</td>
<td>104 (78%)</td>
<td>7 (6%)</td>
<td>0</td>
<td>22 (17%)</td>
<td>0</td>
</tr>
<tr>
<td>Column Totals</td>
<td>397 (74%)</td>
<td>51 (10%)</td>
<td>5 (1%)</td>
<td>65 (12%)</td>
<td>18 (3%)</td>
</tr>
</tbody>
</table>

\(^1\)See Note 3 at the end of this report for description of groupings used.

\(^2\)All percents are row percents.

**1991–92 Recruitment Plans and Expected Changes in Faculty Size**

The departments participating in the survey provided information about their recruitment plans for new faculty for 1992–93. The results need to be read with some caution because the information was provided early (November 1991–January 1992) and the responding departments were thus asked to predict their future in a rather unsettled time. Since the time of the survey, several state university systems have announced hiring reductions or freezes. We do not know whether these actions were anticipated at the time of the survey.

Responses indicate less hiring this year than last. Compared to the 142 new hires for 1991–92, the 20 Group I departments reported recruitment plans for 112 positions, of which 40 are tenured or tenure-eligible and 84 are considered open to new doctorates. The 10 Group II departments report plans to recruit for 38 positions (vs. 54 filled in 1991–92), of which 20 are tenured or tenure-eligible and 36 are considered open to new doctorates. The 10 Group III departments report plans to recruit for 15 positions (vs. 18 filled in 1991–92), of which 14 are tenured or tenure-eligible and 14 are considered open to new doctorates.

The departments also reported anticipated growth or reduction in full-time doctoral faculty size for 1992–93. Nine of the 20 Group I departments anticipate no change. Four Group I departments anticipate growth by a total of 10 positions, though
one of these departments reported that existing open positions will be affected by a hiring freeze. Five Group I departments anticipate that a total of 16 positions will be held in abeyance by hiring freezes and four Group I departments anticipate the permanent loss of a total of 10 positions.

Five out of 10 Group II departments anticipate no change in faculty size. Of the remaining 5 departments, three expect growth by a total of 9 positions, one expects 2 positions to be frozen, and one expects elimination of 3 positions.

Four out of 10 Group III departments anticipate no change in faculty size. Of the remaining 6 departments, two expect growth by a total of 4 positions, three expect 10 positions to be frozen, and two expect elimination of a net total of 2 positions.

The recruitment plans and the expectations for changes in faculty size show no promise for improvement of this year’s academic job market over the market of 1990–91. These indicators are consistent with other early indicators of hiring activity, such as the increasing ratio of applicants to available positions at the annual Mathematical Sciences Employment Register (almost five applicants per position at the January 1992 Register in Baltimore) and the declining number of positions advertised in Employment Information in the Mathematical Sciences (the January 1992 issue contained 23 percent fewer positions than a year ago).

**Job Candidates on the Current Academic Market**

The departments participating in the survey provided information about current faculty and graduate students who may join the current year’s academic job market.

Ph.D. production is difficult to estimate prospectively, since many voluntary and involuntary factors affect decisions to award an individual degree. Departments were asked, though, to estimate the number of their current doctoral students who are likely to complete degree requirements in time for employment in 1992–93. The overall response indicates that the number of new doctorates on the job market is likely to be comparable to the 1990–91 number which, in turn, was 15% greater than the number in 1989–90. The 20 Group I departments estimate 285 current doctoral students will complete requirements in time for 1992–93 employment, compared to 291 new doctorates awarded by the same departments in 1990–91. The 10 Group II departments estimate 62 students completing in time for 1992–93 employment, compared to 61 new doctorates awarded in 1990–91. The 10 Group III departments estimate 38 students completing in time for 1992–93 employment, compared to 31 new doctorates awarded in 1990–91.

The sampled departments reported numbers of current faculty likely to join this year’s academic job market because their current appointment will terminate by the end of this academic year. The numbers are consistent with the large number of NonTE positions known to have short-term contracts. The 20 Group I departments expect 90 current faculty to join the 1991–92 academic job market, of whom 84 now hold NonTE positions. The 10 Group II departments expect 27 current faculty to be seeking academic positions, of whom 23 now hold NonTE positions. The 10 Group III departments expect 9 current faculty to be seeking academic positions, of whom 8 now hold NonTE positions. When projected to all Group I–III departments, a total of 298 current faculty are expected to join the 1991–92 academic job market in the U.S.

**Notes**

1. **Sampled Departments.** Questionnaires were mailed to 40 of the 170 doctorate-granting departments of mathematics in the U.S. See November 1991 Notices, page 1086, for description of groups used in Annual AMS-MAA Surveys. Participating departments were:
   - **Group I (20 of 39 Group I departments)—** Cornell University, Harvard University, Massachusetts Institute of Technology, New York University—Courant Institute, Ohio State University, Princeton University, Purdue University, Rutgers University, SUNY-Stony Brook, University of California-Berkeley, University of California-San Diego, University of Chicago, University of Illinois-Chicago, University of Illinois-Urbana/Champaign, University of Maryland, University of Michigan, University of Minnesota, University of Texas-Austin, University of Wisconsin, and Yale University;  
   - **Group II (10 of 43 Group II departments)—** Iowa State University, Michigan State University, North Carolina State University, University of Arizona, University of California-Davis, University of Colorado, University of Connecticut, University of Notre Dame, University of Pittsburgh, and Virginia Polytechnic Institute & State University;  
   - **Group III (10 of 88 Group III departments)—** American University, Boston University, Clarkson University, Clemson University, Colorado State University, Kent State University, University of Northern Colorado, University of South Carolina, University of Texas-Arlington, University of Houston.

2. **Projection of Survey Response to All Group I–III Departments.** The projections of survey results to the full population of Group I, II, and III departments were done on the basis of faculty size. Each projection was done separately by Group, based on the assumption that the departments within a Group are alike in terms of the relationship between the selection criterion (Ph.D. production) and the measured characteristics. We can expect some selection biases. For example, a department (within a Group) with a large Ph.D. program may place relatively greater emphasis on its overall research program and may, in turn, be expected to hire a greater proportion of postdoctoral or other non-tenure–eligible faculty. The survey tallies of all new hires, regardless of tenure status, were projected on the basis of numbers of all full-time doctoral faculty including positions that are not tenure–eligible. Based on the 1990 and 1991 Annual Surveys, the total faculty size of the 39 Group I departments is 2050; the total faculty size of the twenty sampled Group I departments is 1296. Projected tallies of all new hires for Group I were obtained from the Group I survey response by dividing by the sample fraction 1296/2050 = 0.632. The corresponding faculty size figures for the other Groups are: Group II, 43 total departments, 1710 full-time faculty, 10 sampled departments with 518 faculty, sampled fraction 0.303; Group III, 88 total departments, 2254 full-time faculty, 10 sampled departments with 304 faculty, sampled fraction 0.135. The survey tallies of tenured or tenure–eligible new hires were projected on the basis of numbers of full-time doctoral tenured or tenure–eligible faculty. The respective sample fractions of tenured or tenure–eligible faculty are: Group I, 1123/1774 = 0.633; Group II, 475/1614 = 0.294; Group III, 294/2154 = 0.136. Projections are rounded to the nearest integer.

3. **Citizenship/Region.** Countries were grouped in broad categories, as follows: “Eastern European/Soviet Union” includes the former USSR, Czechoslovakia, Hungary, Poland, Romania, and Yugoslavia. “Asia” includes The People’s Republic of China, Korea, Taiwan, Japan, Hong Kong, and India. “Western European” includes Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, The Netherlands, Spain, Sweden, Switzerland, and the United Kingdom. “Other” includes Argentina, Australia, Brazil, Canada, Iran, Israel, Mexico, New Zealand, and South Africa.
This month’s column is written by Lisa A. Thompson, who is the Assistant for Governmental Affairs of the Joint Policy Board for Mathematics (JPBM).

Mathematical Sciences in the FY 1993 Budget

Overview

- Federal support for the mathematical sciences in FY 1993 will total approximately $173 million, which is roughly 3 percent more than the FY 1992 total; adjusting for inflation, FY 1993 funding is not expected to rise above the FY 1992 level.
- The National Science Foundation (NSF) budget request for the mathematical sciences is 8 percent higher in FY 1993 than in FY 1992; as the increment is targeted for cross-disciplinary and computational mathematics and special projects, proposed funding for disciplinary mathematics remains at the FY 1992 level. (Also, see the NSF Budget Request for FY 1993 in this issue of the Notices, pp. 286–297.)
- The Department of Defense (DOD) support for the mathematical sciences is projected to decline slightly; in real terms, it will drop to below the FY 1991 level.
- Proposed FY 1993 funding for the mathematical sciences at the Department of Energy (DOE) is constant at the FY 1992 level; adjusting for inflation, non-NSF support for the mathematical sciences will likely drop to below the FY 1990 level.
- The Presidential Research Initiatives and other interdisciplinary research activities are becoming increasingly important in determining the nature of federally supported mathematical research.

Trends in Federal Support for the Mathematical Sciences

For the last five years or so, federal support for the mathematical sciences has been growing at an annual rate of just two or three percent above inflation. Budget crunches in both the domestic and defense sectors and shifts in federal R&D priorities—which increasingly emphasize large science projects and targeted research programs—have conspired to bring to a close the expansion of federal mathematical sciences programs during the early and mid-1980s.

The most notable feature of recent federal funding for the mathematical sciences is the increasing degree to which it is influenced by the Presidential Research Initiatives and other multidisciplinary activities. These initiatives provide the field with new opportunities and resources in the context of important national science and technology goals. However, slower growth in overall funding for the mathematical sciences combined with expansion of cross-disciplinary activities raises questions about the adequacy of support for research in core mathematics.

It should be noted that the increasingly quantitative nature of research in general hinders the complete accounting of federal support for mathematical scientists. For instance, beginning in FY 1992, a new NSF-wide activity will make awards to the High Performance Computing and Communications (HPCC) initiative’s Grand Challenges Applications Groups, multidisciplinary teams seeking to apply high performance computing techniques and resources to fundamental problems in science and engineering with broad economic and scientific impact. The involvement of the mathematical sciences in such an activity would not necessarily be reflected in the spending figures presented here.

Federal Support for the Mathematical Sciences in FY 1993

In FY 1993, combined spending by the seven mathematical sciences programs is projected to grow by a little more than three percent above the FY 1992 level. As this is the expected rate of inflation, it appears that federal support for the mathematical sciences will experience no real growth in FY 1993.

This result arises from the combined effects of proposed spending increases by the NSF and the Office of Naval Research (ONR), and relatively flat spending or projected decreases by the other programs at the Department of Defense, including a sharp drop in funding from the Defense Advanced Research Projects Agency (DARPA).

The table shown at the end of this article gives budget figures for the seven federal mathematical sciences programs, including estimates of FY 1992 spending and of proposed...
spending for FY 1993. The FY 1993 proposals are subject to the congressional budget process and to future revision by the responsible agencies. All figures shown in the chart and cited below are in terms of current dollars.

Each funding agency provides support for a variety of activities including individual and group awards, institutes, equipment, and education and human resources development. Thus, the figures given are not for spending on mathematical research per se, but are funds spent or estimated to be spent by the federal mathematical sciences programs on the various elements of the mathematical sciences enterprise.

National Science Foundation (NSF)
The NSF Division of Mathematical Sciences (DMS) fosters the creation and development of mathematical ideas and techniques, supports their interaction with theory and practice in other scientific and engineering disciplines, and encourages their diffusion into the infrastructure for education and human resource development and the technology base.

DMS provides almost half of all federal support for the mathematical sciences, covering the broadest range of mathematical fields with support for individual investigators and small groups, research institutes, shared computing equipment, postdoctoral fellowships, research conferences, and undergraduate programs.

The Division budget, which will grow in FY 1992 by 7.4 percent to $78.58 million, has been reorganized into three categories: disciplinary research in mathematics, cross-disciplinary and computational research in mathematics, and special projects. DMS has requested a budget of $84.95 million for FY 1993, a proposed increase of $6.37 million or 8.1 percent over FY 1992 spending. Funds for disciplinary research in FY 1993 would remain at the FY 1992 level, $48.23 million; support for cross-disciplinary and computational research would expand from $15.55 million to $20.48 million; and funds for special projects would increase by $1.44 million to $16.24 million.

This budget proposal reflects the priorities of the overall Foundation and federal R&D effort. More than three-quarters of the proposed DMS budget increase would be used to enhance the participation of the mathematical sciences in the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET) and NSF research initiatives—High Performance Computing and Communications, Advanced Materials and Processing, Biotechnology, Advanced Manufacturing, and Environmental Science. Researchers currently supported in disciplinary programs will be able to take advantage of the new opportunities in the cross-disciplinary and computational research category. The remainder of the increment would be used to expand support for postdoctoral fellowships and for undergraduate curriculum development.

Air Force Office of Scientific Research (AFOSR)
Funding for mathematical sciences research in support of the Air Force mission is provided by the Mathematical and Information Sciences Directorate of AFOSR. Projected spending for the mathematical sciences in FY 1992 and FY 1993 is expected to remain at the FY 1991 level of $17 million.

Army Research Office (ARO)
The Army Research Office plans a slight budget increase for the mathematical sciences program, from $13.5 million in FY 1992 to $14.0 million in FY 1993. Among other areas of interest, the program is focusing on mathematics of materials science, high performance computing, and mathematical and computational science in intelligent manufacturing. In FY 1993, the program will continue to fund the Mathematical Sciences Institute, the Center on Nonlinear Analysis and Mathematics of Materials Science, and the Army High Performance Computing Research Center. It will begin supporting the Center on Foundations of Intelligent Systems with FY 1992 University Research Initiative (URI) funds, but does not intend to establish any new centers in FY 1993.

Defense Advanced Research Projects Agency (DARPA)
The Applied and Computational Mathematics program at DARPA is undertaken to support the agency's advanced technology development mission. DARPA funds mathematical sciences research in four areas: modeling and simulation; algorithmic development; digital signal processing; and intelligent control. It should be noted that in this environment some of the research supported transcends the traditional boundary dividing the disciplines of mathematics, on the one hand, and computer science and engineering, on the other.

In addition to core research activities, the program sponsors activities that contribute to the missions of several DOD-wide initiatives, which typically receive special appropriations from Congress. The University Research Initiative provides funds for multidisciplinary centers, and other sources provide support for graduate students and research at small businesses.

The DARPA program has grown rapidly over the past few years, and in fact, is the only DOD mathematical sciences program to experience any real growth in FY 1992. But the overall decline of the defense budget will take its toll next year. The proposed FY 1993 budget is $16.05 million, down from $18.67 million in FY 1992. Within the FY 1993 total, $11 million is allocated for core research, down from the current level of $12.32 million. URI funding would remain constant at $2.5 million.

National Security Agency (NSA)
The NSA Mathematical Sciences Program supports research in algebra, number theory, discrete mathematics, probability, statistics, and cryptology and awards grants in four categories: the Young Investigators Grant, the Standard Grant, the Senior Investigators Grant, and the Conferences and Special Situations Grant.

The NSA was the first DOD mathematical sciences program to experience a declining budget: spending peaked at $3.4 million in FY 1990 and will drop to at most $3 million in FY 1992. FY 1993 spending is estimated to
continue at that level, although further cuts cannot be ruled out.

**Office of Naval Research (ONR)**

The Mathematical Sciences Division of the Office of Naval Research funds research in support of the naval mission, with designated programs in the areas of applied analysis, discrete mathematics, numerical analysis, operations research, probability and statistics, and signal analysis. It maintains a core program and also funds Accelerated Research Initiatives (ARIs) as needed.

In FY 1992, the division plans to spend about $9.4 million on the core programs and about $4.7 million on ARIs. The FY 1993 budget includes $10 million in core program funding and $5.5 million for ARIs. The total of $15.71 million includes a small amount of funds from a DOD-wide initiative to support young investigators.

**Department of Energy (DOE)**

The Applied Mathematical Sciences program in the DOE Office of Energy Research has two missions: to ensure the broad range of research in the mathematical and computer sciences necessary to underpin all the other sciences; and to manage an international network to provide state-of-the-art supercomputing facilities for DOE-supported researchers. Its work is proceeding in the context of the multiagency HPCC initiative, which encompasses R&D needed to produce the next generation of high performance computing hardware and software.

While the overall Applied Mathematical Sciences Program is experiencing strong growth because of its association with the HPCC initiative, spending increases are directed to software development activities. The program continues support for basic mathematical sciences, including research and related activities in analytical and numerical methods and information analysis techniques at universities and national laboratories. The budget for those activities will remain unchanged from FY 1992 to FY 1993 at $13.5 million.

**Other Federal Agencies**

Several agencies—for instance, the National Aeronautics and Space Administration, the National Institutes of Health, and the National Institute of Standards and Technology—support mathematical sciences research, largely as an intramural activity. These and other agencies, such as the Environmental Protection Agency and the Department of Transportation, supply a limited number of grants to academic mathematical scientists. The table shows a rough estimate of $1 million for extramural support from federal agencies without dedicated mathematical sciences programs.

### Federal Support for the Mathematical Sciences

<table>
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<tr>
<th></th>
<th>FY90</th>
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<th>FY93</th>
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<td>160.05</td>
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News and Announcements

Grace Murray Hopper 1906–1992
Rear Admiral Grace Murray Hopper, a mathematician and computer pioneer, died on January 1, 1992 at the age of 85.

Admiral Hopper made several crucial contributions to the development of modern computing systems, including helping to invent the Cobol programming language, which is still in widespread use in the business world. Her work led to the first practical compiler for modern computers. She is also known for coining the term “bug,” after a moth was removed from a computer she was working on at Harvard in 1945.

Admiral Hopper was born December 9, 1906 in New York City. After receiving her Ph.D. in mathematics from Yale University in 1934, she taught mathematics at her alma mater, Vassar College. In 1943, she joined the Navy and was assigned to the Bureau of Ordnance Computation Project at Harvard University. There she worked as a programmer on a calculating device called the Mark I, a precursor of electronic computers. She left the Navy in 1946 but remained at Harvard as a faculty member in the computation laboratory.

In 1949, she worked as a mathematician at the Eckert-Mauchly Corporation, a company formed by two University of Pennsylvania professors, John Eckert and John Mauchly, who had in 1946 developed ENIAC, one of the world’s first electronic computers. The company was then building the Univac I, the first commercial electronic computer. Remington Rand Corporation bought Eckert-Mauchly in 1951, and Admiral Hopper remained with that company until 1967. She also continued to work on computers and programming for the Navy as a reservist. Just one year after her retirement from the reserves in 1966, she was recalled to active duty to oversee a program to standardize the Navy’s computer programs and languages. In 1986, she retired as the Navy’s oldest active duty officer. At the time of her death, Admiral Hopper was employed as a senior consultant to Digital Equipment Corporation.

In September 1991, Admiral Hopper was awarded the National Medal of Technology, the nation’s highest honor in engineering and technology, for her contributions to computer programming languages. She was the first woman to receive the medal as an individual. In 1969, the Data Processing Management Association selected her as its first computer sciences “Man of the Year.” She was elected fellow of the Institute of Electrical and Electronic Engineers in 1962.

Charles Fefferman

Charles Fefferman of Princeton University has been selected as the 1992 awardee of the Stefan Bergman Trust. The trust, established in 1988, recognizes mathematical accomplishments in the areas of research in which Stefan Bergman worked. The award consists of $20,000 per year for two years.

Prize Citation
The committee awarding the prize to Professor Fefferman consisted of Frederick J. Gehring, J. J. Kohn (chair), and Halsey Royden. The committee’s citation for the prize says, “Charles Fefferman has made enormously important contributions to the study of the Bergman kernel and has initiated much of the activity in the topic. The following papers by Charles Fefferman contain his most striking results on this:


Charles Fefferman
original ideas and techniques which are of great importance . . .

"Other noteworthy contributions of Fefferman to the study of the Bergman kernel include his recent work (with various co-authors) on Holder regularity on weakly pseudoconvex domains and his remarkable expository paper (jointly with Michael Beals and Robert Grossman), "Strictly pseudoconvex domains in \( C^n \)," Bull. AMS, 8 (1983) 125-322."

In response to receiving the award, Professor Fefferman said, "I'm grateful to the selection committee for awarding me the Bergman Prize. Bergman’s ideas have been a major influence in my work. They continue to provide deep, important problems for analysis."

Biographical Sketch
Charles Fefferman was born April 18, 1949 in Washington, DC. He received his B.S. in mathematics and physics from the University of Maryland in 1966 and his Ph.D. in mathematics from Princeton University in 1969. He was a lecturer at Princeton (1969-1970) before moving to the University of Chicago, where he advanced to the rank of professor in 1971. In 1973, he returned to Princeton, where he was appointed to his current position as Herbert Jones University Professor in 1984. He has held visiting positions at a number of institutions, including University of Maryland, California Institute of Technology, Courant Institute of Mathematical Sciences, University of Paris, Mittag-Leffler Institute, and the Weizmann Institute.

Professor Fefferman is on the editorial board of Communications in Partial Differential Equations, Advances in Mathematics, Annals of Mathematics, Revista Mat. Iberoamericana, and Compositio Mathematica. In 1971, he was named the first recipient of the Alan T. Waterman Award of the National Science Foundation. In 1978, he received the Fields Medal. His other awards and honors include the Salem Prize (1971); election to the American Academy of Arts and Sciences (1972), to the National Academy of Sciences (1979), and to the American Philosophical Society (1989); and honorary doctorates from the University of Maryland (1979), Knox College (1981), Bar-Ilan University (1985), and the University of Madrid (Autónoma) (1990).

About the Prize
The Bergman Prize honors the memory of Stefan Bergman, best known for his research in several complex variables and the Bergman projection and the Bergman kernel function which bear his name. A native of Poland, he taught at Stanford University for many years and died in 1977 at the age of seventy-eight. He was an AMS member for thirty-five years. When his wife died, the terms of her will stipulated that funds should go toward a special prize in her husband’s honor.

The AMS was asked by Wells Fargo Bank of California, the managers of the Bergman Trust, to assemble a committee to select recipients of the prize. In addition, the Society assisted Wells Fargo in interpreting the terms of the will to assure sufficient breadth in the mathematical areas in which the prize may be given. Awards will be made every two years in the following areas: 1) The theory of the kernel function and its applications in real and complex analysis; 2) Function-theoretic methods in the theory of partial differential equations of elliptic type with attention to Bergman’s operator method.

Carleson and Thompson Receive Wolf Prize
Lennart Carleson and John G. Thompson have been selected as the recipients of the 1992 Wolf Foundation Prize in Mathematics. The two will share the $100,000 prize, which will be presented by the President of Israel on May 17, 1992 in Jerusalem. The prize is presented annually by the Israel-based Wolf Foundation for outstanding achievements in medicine, chemistry, physics, agriculture, the arts, and mathematics.

Lennart Carleson has made fundamental contributions to Fourier analysis, complex analysis, quasiconformal mappings, and dynamical systems that clearly establish his position as one of the greatest analysts of the twentieth century. His 1952 Acta pa-

Carleson and Benedicks introduced in 1984 a new method to study chaotic behavior of the map \( 1 - ax^2 \), and, in
1988, they extended this method in a tour de force to prove that the Hénon map \((x, y) \rightarrow (1 + y - ax, bx)\) exhibits "strange attractors" for a nonempty (even positive measure) set of parameter values. This historic paper has opened an entire area of research in dynamical systems.

Lennart Carleson was born in 1928 in Stockholm, Sweden. He received his B.A. in 1947 and his Ph.D. in 1950, both from the University of Uppsala. During 1950–1951, he engaged in postgraduate studies at Harvard University, before returning to Uppsala as an assistant professor. He served as professor at the University of Stockholm (1954–1955), and has been professor of mathematics at Uppsala since 1955. Since 1986, he has held a joint position at the University of California at Los Angeles. He was a Distinguished Visiting Professor at the Institute for Advanced Study in Princeton during 1988–1989.

He served as editor of Acta Mathematica (1956–1979), director of the Mittag-Leffler Institute (1968–1984), and President of the International Mathematical Union (1978–1982). In 1984, he received the Steele Prize of the AMS. A member of the Swedish Academy of Sciences, Carleson is also a foreign member of the American Academy of Arts and Sciences, as well as of the Soviet, Danish, Norwegian, Finnish, and Hungarian Academies of Science.

John G. Thompson was cited for his profound contributions to all aspects of finite group theory and connections with other branches of mathematics. His work has changed the face of finite group theory. His doctoral thesis solved a longstanding conjecture reaching back to the work of Frobenius at the turn of the century: if a finite group has a fixed-point-free automorphism of finite order, then the group is nilpotent. The solution was obtained by the introduction of novel and highly original ideas. He next turned his attention to the classification of the finite simple groups. The first astonishing achievement was his joint work with Walter Feit in which they prove that a finite nonabelian simple group must have even order. Thompson went on to classify the finite simple groups in which every soluble subgroup has a soluble normalizer. This work is a key element in the collective effort that led to the classification of finite simple groups.

In the late 1970s, Thompson took up McKay’s remarkable observation that there is a connection between the Fischer-Griess group and the modular j-function in order to formulate a series of conjectures relating modular functions and finite sporadic simple groups. These have now been verified and have led to deep and important questions which will occupy mathematicians for some time to come.

Also during this period, Thompson significantly contributed to coding theory and to the theory of finite projective planes. The recent solution of the classical problem of the nonexistence of a plane of order ten owes much to his efforts. During the past few years, he has investigated the problem of constructing Galois groups over number fields, especially \(Q\). The starting point here is Hilbert’s irreducibility theorem. Thompson’s work may well be the most important advance since Hilbert’s time.

The penetrating power of Thompson’s genius is astonishing; his contributions to group theory and related subjects are of enduring significance.

John G. Thompson was born in Ottawa, Kansas in 1932. He received his B.A. from Yale University in 1955 and his Ph.D. from the University of Chicago in 1959. He was an assistant professor at Harvard University (1961–1962) and a professor at the University of Chicago (1962–1968) before becoming a Fellow of Churchill College, Cambridge, a position he still holds. Since 1970, he has also held the position of Rouse Ball Professor of Pure Mathematics at Cambridge University.

Thompson’s awards include the AMS Cole Prize in 1966, the Fields Medal in 1970, and the Senior Berwick Prize of the London Mathematical Society in 1982. He has received honorary doctorates from Yale University (1980), the University of Chicago (1985), and Oxford University (1987). He was elected to the National Academy of Sciences in 1971 and to the Royal Society of London in 1979.

**Olga Beaver Receives AWM Hay Award**

The Association for Women in Mathematics (AWM) has selected Olga Beaver, director of the Summer Science Program at Williams College, as the second recipient of the annual Louise Hay Award for Contributions to Mathematics Education.

Professor Beaver received her B.A. in 1968 and M.S. in 1969, both from the University of Missouri, and her Ph.D. in 1979 from the University of Massachusetts at Amherst. Since then she has been at Williams College, where she is an associate professor and currently is also a Gaudino Scholar. In her role as director and driving force of the Williams College Summer Science Program, Professor Beaver has been able to bring about an "...extraordinary change in spirit," wrote Frank Morgan, chair of the Department of Mathematics at Williams. "Now there are successful role models; students help each other."

The Louise Hay Award is intended to highlight the importance of mathematics education. At the time of her death in 1989, Louise Hay headed the Department of Mathematics, Statistics, and Computer Science at the University of Illinois at Chicago. She was widely known for her work in mathematical logic and for her devotion to students and to nurturing their mathematical tal-
...ents. On the selection committee for this year's Hay Award were Sylvia Bozeman of Spelman College, Rhonda Hughes of Bryn Mawr College, and Mary Ellen Rudin (chair) of the University of Wisconsin at Madison.

Elections to the National Academy of Engineering
Two mathematical scientists have been elected to the National Academy of Engineering. C. William Gear, Vice President of NEC Research Institute was elected "for seminal work in methods and software for solving classes of differential equations and differential-algebraic equations of significance in applications." Richard A. Tapia, Noah Harding Professor of Mathematical Sciences at Rice University, was elected "for contributions in linear and nonlinear programming, and for creative leadership in minority education in computer science."

AMS Representatives Attend OSTP Meeting
On January 22, 1992, AMS President Michael Artin, AMS President-Elect Ronald L. Graham, and AMS Executive Director William H. Jaco attended a meeting of presidents and executive officers of scientific professional societies. The meeting was held at the Office of Science and Technology Policy (OSTP) in Washington, DC. Allan Bromley, Assistant to President Bush for Science and Technology, has during this tenure called several meetings of this type with representatives from various sectors of the science and technology communities. The purpose is to communicate what OSTP is doing and how it operates, as well as to open avenues of discussion through which these communities can bring their concerns to OSTP.

OSTP, established by Congress in 1976, is intended in part to facilitate communication between the executive and congressional branches of government on matters of science and technology policy. When Bromley took this position, he was made a member of President Bush's Cabinet—a first for Presidential science advisers. In addition, OSTP is for the first time in its history fully staffed. Bromley, a physicist, also serves as chair of the Federal Coordinating Council on Science, Engineering, and Technology, the body that oversees such large-scale cross-disciplinary programs as the High Performance Computing and Communications initiative.

The two-hour meeting was organized around four presentations on issues raised by the invitees. The first was by Ronald L. Graham of AT&T Bell Laboratories, President-Elect of the AMS, who spoke on the supply and demand for mathematics and science doctorates in the short- and long-terms. He discussed the employment picture for new doctorates in chemistry, physics, computer science, and mathematics and examined of the pressures in academia that are contributing to the current tight job market.

Other presentations were made by Sidney C. Wolff, President of the American Astronomical Association, who spoke on earmarking of funds for scientific research and facilities, and by Ernest L. Eliel, President of the American Chemical Society, who spoke on the role of the mathematics and scientific communities in dealing with K-12 education. G. Brent Dalrymple, President of the American Geophysical Union, distributed an opinion piece he had written about support for big and small science ("The Importance of 'Small' Science," Renewable Resources Journal, Spring 1991, pages 12-15).

The mathematical sciences community has had contact with OSTP before—for example, the update of the "David Report" was presented to Bromley by Ed David, who chaired the committee producing the report, and by Phillip Griffiths, who was then chair of the Board on Mathematical Sciences. Since the meeting in January, Artin, Jaco, and Richard Herman, Chair of the Joint Policy Board for Mathematics, have met with OSTP staff to discuss the position of mathematics in federal support for research. Other such meetings are anticipated in the future. Forging stronger, more official ties between OSTP and the mathematical community should prove useful in bringing the concerns of the community before federal policymakers.

NSF Mathematics Advisory Committee Meeting
The Advisory Committee for the Mathematical Sciences of the National Science Foundation (NSF) provides advice to the Foundation about support for mathematics research and education. The Committee also serves as a liaison between the mathematical sciences community and the NSF, bringing the concerns of the community before the NSF and carrying back responses and other news from the Foundation. The next meeting of the Committee will be held May 4-6, 1992 at NSF headquarters in Washington, DC.

There has been considerable concern expressed over how the Division of Mathematical Sciences (DMS) fared in the fiscal year 1993 budget request for NSF (see the article "The NSF Fiscal Year 1993 Budget Request," and the Forum piece by DMS director Judith Sunley, both in this issue of the Notices). This controversial topic is likely to make for an interesting meeting. The meetings generally consist of discussions of the entire Committee, more focused work in subgroups of the Committee, presentations by NSF staff, and a discussion with the NSF director.

The Committee meetings are open to the public. Those wishing to attend should contact the DMS at 202-357-9669.

New Director at ICTP
Beginning in October 1992, M.S. Narasimhan, Professor of Eminence at the Tata Institute of Fundamental Research in Bombay, India, will be the new director of mathematics at the International Centre for Theoretical Physics (ICTP) in Trieste, Italy. James Eells, the current director of mathematics at ICTP, has announced his retirement both from ICTP and from the University of Warwick.

Call for Nominations for Ostrowski Prize
The A. M. Ostrowski Prize is awarded every two years to a scientist or group of scientists who, during the previ-
ous five years, have made important advances in pure mathematics or in the theoretical foundations of numerical mathematics. The amount of the prize is 50,000 Swiss francs. The first two prizewinners were Louis de Branges in 1990 and J. Bourgain in 1992.

Nominations are now being solicited for the 1994 prize. Please send suggestions for candidates to: Mathematical Institute of the University of Basel, Ostrowski Prize, Rheinsprung 21, CH-4051 Basel, Switzerland. Nominations should be sent by June 1993.

News from the
Fields Institute for Research in
Mathematical Sciences

Official Opening
The Fields Institute for Research in Mathematical Sciences will hold its Official Opening on Thursday, June 11, 1992 at Waterloo, Ontario, Canada. Further details with respect to opening ceremonies and schedule of speakers will be available in the next issue of the Notices.

Research Program 1992–1993
The research program at the Fields Institute from August 1992 to July 1993 will be in Dynamical Systems and Bifurcation Theory. The areas of concentration will be Finite Dimensional Systems: ODE’s and Chaos (August 1992–December 1992), Infinite Dimensional Systems: PDE’s and Pattern Formation (January 1993–March 1993), and Applications and Computations (April 1993–June 1993). The Program Committee consists of J. Chadam (McMaster, 416-525-9140, ext. 3426, chadam@fields.waterloo.edu), L. Glass (McGill, 514-398-4338, md56@musica.mcgill.ca) and W. Langford (Guelph, 519-824-4747, ext. 6556, langford@fields.waterloo.edu).

Short- and long-term visitors who have expressed an interest in being in residence during the program include: D. Armbruster (Arizona State), L. Bates (Calgary), H. Broer (Groningen), S.-N. Chow (Georgia Tech), R. Cushman (Utrecht), G. Doolen (Los Alamos), G. Iooss (Nice), M. Field (Sydney), P. Fife (Utah), H. Freedman (Alberta), W. Gilbert (Waterloo), M. Golubitsky (Houston), B. Hasslacher (Los Alamos), K. Huseyin (Waterloo), R. Kapral (Toronto), H. Keller (Caltech), B. Keyfitz (Houston), K. Kirchgassner (Stuttgart), E. Knobloch (Berkeley), M. Krupa (Groningen), A. Lawniczak (Guelph), J. Mallet-Paret (Brown), J. Marsden (Fields), B. Matkowsky (Northwestern), R. Miura (British Columbia), J. Murray (Washington), W. Nagata (British Columbia), S. Namachchivaya (Illinois), S. Newhouse (North Carolina), P. Ortoleva (Indiana), G. Oster (Berkeley), W. Peltier (Toronto), T. Ratiu (Santa Cruz), D. Rod (Calgary), D. Rothman (MIT), J. Sanders (Amsterdam), D. Sattinger (Minnesota), J. Scheurle (Hamburg), I. Stewart (Warwick), F. Takens (Groningen), J. Tyson (VPI), A. Vanderbauwhede (Gent), S. van Gils (Eindhoven), E.R. Vrscay (Waterloo), B. Wetton (British Columbia), S. Wiggins (Caltech), and J. Wu (York). Other participants are to be announced, including the Fields Institute Fellows.

Workshops are being planned in: Conservative Systems and Quantum Chaos (October 1992); Normal Forms, Homoclinic Bifurcations, and Chaos (November 8–15, 1992); Pattern Formation and Symmetry Breaking (February 21–27, 1993); Pattern Formation in Geologic, Atmospheric, and Oceanic Sciences (March 23–28, 1993); Ecological Systems (May 1993); and Pattern Formation and Cellular Automata (June 8–12, 1993).

For more information about the program, workshops, or other activities of the Institute contact the Program Committee at the above addresses or the Program Office at the above addresses.

News from the
Mathematical Sciences Institute
Cornell University
The Mathematical Sciences Institute, with administrative headquarters at Cornell University, coordinates the activities for three of the Army Research Office’s Centers of Excellence in the Mathematical Sciences. Anil Nerode of Cornell is the Institute Director. The Center for the Mathematics of Nonlinear Systems, directed by James Glimm, is located at SUNY Stony Brook and may be reached at gлимм@ams.sunysb.edu. The Center for Symbolic Methods in Algorithmic Mathematics (ACSyAM), directed by Moss Sweedler, and the Center for Stochastic Analysis, directed by Richard Durrett, are both located at Cornell University and may be reached at msi@msiadmin.cit.cornell.edu. Information on upcoming events, postdoctoral fellowships, and visitor programs may also be obtained by contacting: MSI, 409 College Ave., Ithaca, NY 14850, 607-255-8911.

The following programs are currently scheduled:

May 1, 1992, contact E. Beltrami at SUNY Stony Brook for information on the Fourth Annual Conference on Biomathematics; email: ebeltrami@ams.sunysb.edu.

H. Blair or Syracuse University will organize a workshop on Documents, Computation, and Preference to meet in Washington. These workshops are cosponsored by the Center for Symbolic Methods in Algorithmic Mathematics. The Center will emphasize Real Closed Systems during the 1992–1993 academic year.

In addition, MSI will help support the symposium on Logical Foundations of Computer Sciences to meet in Tver, Russia from July 20–24, 1992, and will send participants to the Tenth U.S. Army Mathematics Conference to meet at West Point from June 16–19, 1992.

News from the Mathematical Sciences Research Institute Berkeley, California

A special event has been scheduled to take place June 15–17, 1992 to celebrate the completion of the first decade since the founding of the Mathematical Sciences Research Institute (MSRI) in 1982, and to honor Irving Kaplansky upon his retirement after eight years as Director. There will be a number of expository talks on areas represented by one or more programs over the past ten years. Speakers scheduled so far include Raoul Bott, Ronald Graham, Vaughan Jones, Barry Mazur, Dusa McDuff, John Milnor, Isadore Singer, and William Thurston. The mathematical community is warmly invited to attend. There are no registration fees or application forms. More detailed information can be obtained by writing MSRI at 1000 Centennial Drive, Berkeley, CA 94720, or by sending email to info@msri.org with a message consisting of “get event 15june92”.

MAA Issues Report on Education Conference

The Mathematical Association of America (MAA) has released “Communicating Among Communities,” a report of a conference on Research in Collegiate Mathematical Education. The conference, held November 8–10, 1991 in Washington, DC, brought together twenty-eight participants representing the mathematics and mathematics education communities to discuss the growing interest in research in the teaching and learning of mathematics at the undergraduate level.

The organizing committee for the conference consisted of Donald J. Albers, MAA associate director of publications and programs; Ed Dubinsky of Purdue University; James R. C. Leitzel of the Ohio State University; Samuel M. Rankin III, AMS associate executive director; and Lynn Arthur Steen of St. Olaf College.

The conference looked at four aspects of research in collegiate mathematics education: communicating to faculty the growing body of research in undergraduate mathematics education; improving student learning by stimulating change in collegiate teaching based on research findings; encouraging high standards of quality research in this area; and supporting the increasing number of faculty undertaking such research.

The report notes that discussion of these issues revealed diverse views among the conference participants. “Some felt that basic research in undergraduate mathematics education is an essential and continuing part of the process of change,” the report states. “Still others were skeptical that such research would have any effect at all, and cited the limited amount of persuasive evidence produced in a field which is perceived by many mathematicians to be jargon-laden. Another group argued that such basic research is critically important but independent of attempts to improve undergraduate education. There was also a group who believed that there are some mathematicians in the teaching force who would not be motivated to change their habits regardless of how compelling the research results may be.”

Despite these disagreements, a number of recommendations grew out of discussion. Among them are publication of annual volumes containing research papers in mathematics education, conferences on research in undergraduate mathematics education, and ideas for bringing the MAA and the AMS into closer collaboration with such organizations as the National Council of Teachers of Mathematics and the American Mathematical Association of Two-Year Colleges.

The full report was published in the February 1992 issue of Focus, the member newsletter of the MAA.
Bethlehem, Pennsylvania
Lehigh University
April 11–12, 1992

Program

The eight-hundred-and-seventy-fourth meeting of the American Mathematical Society (AMS) will be held at Lehigh University in Bethlehem, Pennsylvania on Saturday and Sunday, April 11 and 12, 1992. All special sessions and sessions for contributed papers will be held in the Christmas-Saucon Hall and in the Seeley G. Mudd Building. The invited addresses will be in Neville Auditorium I.

Invited Addresses

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

Jean-Luc Brylinski, Pennsylvania State University, University Park, Geometry of characteristic classes, 1:30 p.m., Sunday, April 12.

Ingrid Daubechies, AT&T Bell Labs, On some functions with weird differentiability properties, 1:30 p.m., Saturday, April 11.

Edward Y. Miller, Polytechnic University, Spectral flow, small eigenvalues and symplectic geometry applied to 3-manifolds, 11:00 a.m., Sunday, April 12.

Douglas Ravenel, University of Rochester, The nilpotence and periodicity in homotopy theory, 11:00 a.m., Saturday, April 11.

Special Sessions

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

Finite geometry, E. F. Assmus Jr., Lehigh University; and Jennifer D. Key, Clemson University.

Sequence spaces, Graham Bennett, Indiana University; Jeffrey S. Connor, Ohio University, Athens; and Andrew K. Snyder, Lehigh University.

Characteristic classes, algebraic K-theory, and field theory, Jean-Luc Brylinski and Dennis A. McLaughlin, Princeton University.

Homotopy theory, Donald M. Davis, Lehigh University, and Douglas Ravenel.

Geometric analysis, David L. Johnson and Penny Smith, Lehigh University.

New invariants of links and 3-manifolds, Xiao-Song Lin, Columbia University.

Set theory, Lee J. Stanley, Lehigh University.

Stochastic processes, Joseph E. Yukich, Lehigh University.

Abstracts for consideration for these sessions should have been submitted by the January 2, 1992 deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited Speakers and Special Sessions section of Notices.

Contributed Papers

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

Conference on Finite Geometry

The above mentioned special session on Finite geometry constitutes the first two days of a four-day conference on Finite geometry to be funded by NSA and perhaps by NSF. Persons interested in the Monday and Tuesday activities of the conference should contact the Project Director, E. F. Assmus, Jr., Department of Mathematics, Building 14, Lehigh University, Bethlehem, PA 18015 or via e-mail at efa0@ns.cc.lehigh.edu.

Registration

The meeting registration desk will be located in the lobby of Neville Hall. The registration fees are $30 for members of the AMS, $45 for nonmembers, and $10 for students or unemployed mathematicians.

Social Event

A reception and banquet will be held at 6:30 p.m. on Saturday, April 11, 1992 in honor of Professor Albert (Tommy) Wilansky on his retirement from Lehigh University after forty-four years of service. The event will be held in the Asi Packer Room of the University Center. Arrangements to attend must be made directly with Andrew K. Snyder, Department of Mathematics, Building 14, Lehigh University, Bethlehem, PA 18015 (indicate ATTN: Banquet). Enclose a check for $25 made out to Department of Mathematics. Reservations and payment must be received by Friday, March 27, 1992. Seating is limited.
Meetings

Accommodations

Rooms have been blocked for participants at the Hotel Bethlehem, Econo Lodge, and the McIntosh Inn. Participants should make their own arrangements with the hotel of their choice and mention the AMS meeting at Lehigh University to obtain the rates listed below. All rates are subject to a six percent sales tax. The AMS is not responsible for rate changes or the quality of the accommodations offered by these hotels/motels.

**Hotel Bethlehem (Twenty-minute walk from Neville Hall)**  
437 Main Street, Bethlehem, PA 18018  
Telephone: 215-867-3711  
The deadline for reservations is March 26.  
Single $60  
Double $72

**Econo Lodge (Ten minutes by car from Neville Hall)**  
Catasauqua Road, Bethlehem, PA 18018  
Telephone: 215-867-8681  
The deadline for reservations is March 26.  
Single $36.95  
Double $42.95

**McIntosh Inn (Ten minutes by car from Neville Hall)**  
Rt. 22 & Airport Road, Allentown, PA 18103  
Telephone: 800-444-2775  
The deadline for reservations is April 1.  
Single $34.95  
Double $40.95

Food Service

There are numerous restaurants and fast food establishments within a short walk of Neville Hall, and several Lehigh University cafeterias will be open on a cash basis. A list of these restaurants will be available at the registration desk.

Parking

Parking is permitted and free of charge during daytime and evening hours on Saturday and Sunday in several Lehigh lots adjacent to the registration area. Three large lots are located just north of Neville Hall and several smaller lots are nearby.

Travel and Local Information

The Allentown-Bethlehem-Easton International Airport is served by major airlines including American, Continental, Delta, Northwest, United, and USAir. There is nonstop jet service from Atlanta, Chicago, Detroit, and Pittsburgh and commuter flights from Baltimore, Boston, New York, Philadelphia, Providence, and Washington, D.C. Taxi service can be arranged from the airport to the meeting site (approximately a ten-minute ride).

Bus service to Bethlehem includes Trans Bridge Lines from the New York area, Greyhound-Trailways from Pittsburgh and Harrisburg, and Carl R. Bieber Tourways from Philadelphia.

ARRIVING BY AUTOMOBILE: Driving from the New York City area: Take route 22 west and exit at the last Bethlehem exit, Route 378. Route 378 heads only south; continue for 3.6 miles and cross the bridge over the Lehigh River being careful to stay in the left lane. At the far end of the bridge, turn left at the traffic light for Third Street; continue one block to the traffic light at Brodhead Avenue and turn right; Continue three blocks to the stop sign at Packer Avenue, and turn left. Neville Hall is approximately two blocks on your left.

Driving from western points: Take Route 22 east, exiting at Route 378, which is the first of three Bethlehem exits. Continue south as described above.

Arriving from Philadelphia: Take the Northeast Extension of the Pennsylvania Turnpike north to Exit 33 (Lehigh Valley), then head east on Route 22 and follow the directions from western points.

Weather and Local Attractions

The average high temperature in Bethlehem in April is 61°F and the average low is 39°F. The average rainfall for the month is 3.9 inches.

Points of interest in the area reflect the history of Bethlehem since its founding by Moravians in 1741 and most are within walking distance of the meeting site and Hotel Bethlehem. An 18th century industrial area consists of restored and partially reconstructed mills. Nearby museums and sites include Gemeinhaus (Moravian Museum), Central Moravian Church and God’s Acre, The Apothecary Museum, 1758 Sun Inn, and the Kemerer Museum of Decorative Arts.

Institutes of higher education in the Allentown-Bethlehem-Easton area include Cedar Crest, Lafayette, Moravian, and Muhlenberg Colleges and Lehigh University.

W. Wistar Comfort  
Associate Secretary  
Middletown, Connecticut
Meetings

LEHIGH UNIVERSITY
(LOWER CAMPUS)

Admissions
Visitor Information

Webster St.

W. Packer Ave.

Vine St.

Library Drive

6a

6

6a

6

14a

14a

29

29

Neville

Seeley G. Mudd

Christmas-Saucon

University Center
Presenters of Papers

Numbers following the names indicate the speakers' positions on the program.

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AMS Special Session Speaker

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Program of the Sessions

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

Abstracts of papers presented in the sessions at this meeting will be found in the April 1992 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.

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### Saturday, April 11

#### Special Session on Homotopy Theory, I

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<td>8:30 a.m.</td>
<td>Modules over $E_{\infty}$ ring spectra.</td>
<td>Anthony D. Elmendorf, Purdue University, Calumet Campus (874-55-34)</td>
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<td>9:00 a.m.</td>
<td>Bialgebra deformation theory and rational $H$-spaces.</td>
<td>Ronald N. Umble, Millersville University of Pennsylvania (874-53-107)</td>
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<td>9:30 a.m.</td>
<td>Phantom phenomena and maps obeying certain rational conditions.</td>
<td>C. A. McGibbon, Wayne State University, and Joseph Roltberg*, Hunter College, City University of New York (874-55-39)</td>
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<tr>
<td>10:00 a.m.</td>
<td>Zabrodsky's work on maps between classifying spaces.</td>
<td>John Harper, University of Rochester (874-55-114) (Sponsored by Douglas C. Ravenel)</td>
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<td>10:30 a.m.</td>
<td>Homotopy nilpotent compact Lie groups have no torsion in homology.</td>
<td>Vidhyanath Rao, Ohio State University, Newark (874-55-128)</td>
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#### Special Session on Finite Geometry, I

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<td>9:00 a.m.</td>
<td>On designs and formally self-dual codes. Preliminary report.</td>
<td>George Kennedy and Vera Pless*, University of Illinois, Chicago (874-05-26)</td>
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<td>9:30 a.m.</td>
<td>Divisible lexicographic codes. Preliminary report.</td>
<td>Harold N. Ward, University of Virginia (874-94-22)</td>
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<td>10:00 a.m.</td>
<td>Generalized Reed-Muller codes and finite geometries.</td>
<td>K. J. Rose, Lehigh University (874-05-24)</td>
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<td>10:30 a.m.</td>
<td>The full automorphism groups of the generalized Reed-Muller codes.</td>
<td>P. Charpin, INRIA, France (874-05-12) (Sponsored by Edward F. Assmus)</td>
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#### Special Session on Sequence Spaces, I

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<td>Informal Discussion</td>
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<td>9:30 a.m.</td>
<td>Unconditional bases in $\ell_p$ when $0 &lt; p &lt; 1$.</td>
<td>N. J. Kalton, University of Missouri, Columbia (874-46-51)</td>
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<td>10:00 a.m.</td>
<td>Generalized sectional convergence and barrelledness.</td>
<td>William H. Ruckel, Clemson University (874-46-88)</td>
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<td>10:30 a.m.</td>
<td>Statistical limit points.</td>
<td>John Fridy, Kent State University (874-40-35)</td>
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#### Special Session on Geometric Analysis, I

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<td>9:00 a.m.</td>
<td>An interpretation of Kronecker indices as diffeomorphism invariants of an exterior differential system.</td>
<td>Robert B. Gardner, University of North Carolina, Chapel Hill and Fields Institute for Mathematical Research, Canada (874-53-99)</td>
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<td>9:30 a.m.</td>
<td>Surfaces minimizing area plus length of singular curves.</td>
<td>Frank Morgan, Williams College (874-53-78)</td>
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<tr>
<td>10:00 a.m.</td>
<td>Area-minimizing surfaces with large singular sets.</td>
<td>Preliminary report.</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Inextendible conformal realizations of Lorentz surfaces in Minkowski 3-space.</td>
<td>Tilla Weinstein, Rutgers University, New Brunswick (874-53-79)</td>
</tr>
</tbody>
</table>

#### Special Session on Set Theory, I

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 a.m.</td>
<td>Remote filters in ccc Boolean algebras.</td>
<td>Alan Dow, York University (874-02-86)</td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>Informal Discussion</td>
<td></td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>$\Delta_1^1$ sets of reals: Measure and category.</td>
<td>Joan Bagaria* and W. Hugh Woodin, University of California, Berkeley (874-03-103)</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Speaker(s)</th>
<th>Institution(s)</th>
<th>Page Numbers</th>
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<tbody>
<tr>
<td>10:30 a.m.</td>
<td>Liftings for Lebesgue measure.</td>
<td>Maxim R. Burke, University of Prince Edward Island</td>
<td>874-04-10</td>
<td>10:00</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>Special Session on Stochastic Processes, I</td>
<td>Richard C. Bradley, Indiana University, Bloomington</td>
<td>874-60-83</td>
<td>9:00</td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>Probabilistic analysis of exceptional points for critical Weierstrass nondifferentiable functions.</td>
<td>Loren D. Pitt*, University of Virginia, and J. M. Anderson</td>
<td>874-60-21</td>
<td>9:30</td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>Applications of stochastic planar matching.</td>
<td>Peter W. Shor, AT&amp;T Bell Laboratories, Murray Hill, New Jersey</td>
<td>874-60-02 (Sponsored by Robert Calderbank)</td>
<td>10:00</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>A general form of Gambler's ruin.</td>
<td>Terry R. McConnell* and Philip S. Griffin, Syracuse University</td>
<td>874-60-63</td>
<td>10:30</td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>Stiefel-Whitney classes, singularities of projections and Whitney duality.</td>
<td>Ockie E. Johnson, Saint Olaf College</td>
<td>874-57-33</td>
<td>9:30</td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>The rationality of geometric signatures of open 4-manifolds.</td>
<td>Xiaochun Rong, Columbia University</td>
<td>874-53-48</td>
<td>10:00</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>K theory for p-adic groups.</td>
<td>Paul F. Baum, Pennsylvania State University, University Park</td>
<td>874-22-53</td>
<td>10:30</td>
</tr>
<tr>
<td>9:30 a.m.</td>
<td>Real representations of knot groups and Hecke algebras.</td>
<td>D. D. Long*, University of California, Santa Barbara, and A. W. Reid, Mathematical Sciences Research Institute, Berkeley</td>
<td>874-57-37</td>
<td>9:30</td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>Temperley-Lieb algebra and the Turaev-Viro invariant.</td>
<td>Louis H. Kauffman, University of Illinois, Chicago</td>
<td>874-57-109</td>
<td>10:00</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Witten-Roshtekihin-Turaev invariants and the semiclassical approximation.</td>
<td>Lisa Claire Jeffrey, Institute for Advanced Study</td>
<td>874-57-49</td>
<td>10:30</td>
</tr>
<tr>
<td>11:00 a.m.</td>
<td>Invited Address</td>
<td>Douglas C. Ravenel, University of Rochester</td>
<td>874-55-113</td>
<td>11:00</td>
</tr>
<tr>
<td>1:30 p.m.</td>
<td>Invited Address</td>
<td>Ingrid Daubechies, AT&amp;T Bell Laboratories, Murray Hill, New Jersey</td>
<td>874-46-40</td>
<td>1:30</td>
</tr>
<tr>
<td>2:45 p.m.</td>
<td>Special Session on Finite Geometry, II</td>
<td>R. Mathon, University of Toronto</td>
<td>874-20-44 (Sponsored by Jennifer D. Key)</td>
<td>2:45</td>
</tr>
<tr>
<td>3:15 p.m.</td>
<td>Counting subregular spreads.</td>
<td>Robert A. Liebler, Colorado State University</td>
<td>874-51-45</td>
<td>3:15</td>
</tr>
<tr>
<td>3:45 p.m.</td>
<td>On the full collineation group of the Figueroa planes.</td>
<td>Lynn Margaret Batten, University of Manitoba</td>
<td>874-51-56</td>
<td>3:45</td>
</tr>
<tr>
<td>4:15 p.m.</td>
<td>Computational techniques for projective planes.</td>
<td>M. Cordero-Vourtsanis, Texas Tech University</td>
<td>874-51-119</td>
<td>4:15</td>
</tr>
<tr>
<td>4:45 p.m.</td>
<td>Singer groups, an approach from a group of multipliers of even order.</td>
<td>Chat Y. Ho, University of Florida</td>
<td>874-51-42</td>
<td>4:45</td>
</tr>
<tr>
<td>2:45 p.m.</td>
<td>Special Session on Sequence Spaces, II</td>
<td>J. Connor, Ohio University, Athens</td>
<td>874-46-126</td>
<td>2:45</td>
</tr>
<tr>
<td>3:15 p.m.</td>
<td>Informal Discussion</td>
<td>Graham Bennett, Indiana University, Bloomington</td>
<td>874-46-129</td>
<td>3:15</td>
</tr>
<tr>
<td>3:45 p.m.</td>
<td>Integrability and L1-convergence of trigonometric series II.</td>
<td>Martin Buntinas*, Loyola University of Chicago, and N. Tanović-Miller, University of Sarajevo, Yugoslavia</td>
<td>874-40-122</td>
<td>3:45</td>
</tr>
<tr>
<td>4:15 p.m.</td>
<td>Sequence spaces and the classical inequalities.</td>
<td>Grahame Bennett, Indiana University, Bloomington</td>
<td>874-46-129</td>
<td>4:15</td>
</tr>
<tr>
<td>4:45 p.m.</td>
<td>L-convergence.</td>
<td>W. Beekmann, Fern University, Germany, and S-C. Chang*, Brock University</td>
<td>874-40-71</td>
<td>4:45</td>
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</tbody>
</table>
### Program of the Sessions

#### Saturday, April 11 (cont'd)

**Special Session on Characteristic Classes, Algebraic K-Theory, and Field Theory, II**

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>2:45 p.m.</td>
<td>Room 302, Christmas-Saucon Hall Semi-infinite de Rham cohomology. Preliminary report.</td>
</tr>
<tr>
<td>2:45 p.m.</td>
<td>Alexander A. Voronov, Princeton University (874-58-74) (Sponsored by Dennis A. McLaughlin)</td>
</tr>
<tr>
<td>3:15 p.m.</td>
<td>Special</td>
</tr>
<tr>
<td>3:45 p.m.</td>
<td>The Chern-Simons character of a lattice gauge field.</td>
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<tr>
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<td>Anthony V. Phillips, State University of New York, Stony Brook, and David A. Stone,</td>
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<td>Brooklyn College, City University of New York (874-53-110)</td>
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**Special Session on Homotopy Theory, II**

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>2:45 p.m.</td>
<td>Room 343, Seeley G. Mudd Building Nilpotence in the Steenrod algebra.</td>
</tr>
<tr>
<td>2:45 p.m.</td>
<td>Kenneth G. Monks, University of Scranton (874-55-06)</td>
</tr>
<tr>
<td>3:15 p.m.</td>
<td>Primitive elements in Brown-Peterson cohomology.</td>
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<tr>
<td>3:45 p.m.</td>
<td>David C. Johnson, University of Kentucky, J. M. Boardman*, and W. Stephen Wilson, Johns</td>
</tr>
<tr>
<td></td>
<td>Hopkins University, Baltimore (874-55-80)</td>
</tr>
<tr>
<td>3:45 p.m.</td>
<td>The Brown-Peterson homology and nilpotence of the infinite special orthogonal group.</td>
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<tr>
<td></td>
<td>Dung-yung Yan, Johns Hopkins University, Baltimore (874-55-116)</td>
</tr>
<tr>
<td>4:15 p.m.</td>
<td>Periodic homotopy theory.</td>
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<tr>
<td>4:45 p.m.</td>
<td>Periodic telescopes and localizations.</td>
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<tr>
<td></td>
<td>Mark Mahowald*, Northwestern University, Doug Ravenel, University of Rochester, and Paul</td>
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<td></td>
<td>Shick*, John Carroll University (874-55-81)</td>
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**Special Session on Geometric Analysis, II**

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>2:45 p.m.</td>
<td>Room 353, Seeley G. Mudd Building Connections with prescribed curvature—$C^\infty$ results.</td>
</tr>
<tr>
<td>2:45 p.m.</td>
<td>Dennis DeTurck* and Nets Katz, University of Pennsylvania (874-49-18)</td>
</tr>
<tr>
<td>3:15 p.m.</td>
<td>Preliminary report.</td>
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<tr>
<td>3:45 p.m.</td>
<td>Joseph H.G. Fu, University of Georgia (874-53-84)</td>
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<tr>
<td>3:45 p.m.</td>
<td>Minimizing the squared-mean-curvature integral with the surface evolver.</td>
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<td></td>
<td>Rob Kusner, University of Massachusetts, Amherst (874-49-36)</td>
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</tbody>
</table>

**Special Session on New Invariants of Links and 3-Manifolds, II**

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>2:45 p.m.</td>
<td>Room 253, Seeley G. Mudd Building Quantum group constructions at the classical level.</td>
</tr>
<tr>
<td>2:45 p.m.</td>
<td>Alan Weinstein, University of California, Berkeley, and Ping Xu*, University of Pennsylvania (874-58-68) (Sponsored by Alan D. Weinstein)</td>
</tr>
<tr>
<td>3:15 p.m.</td>
<td>Quantum representations of modular groups via ideal triangulations. Preliminary report.</td>
</tr>
<tr>
<td>3:45 p.m.</td>
<td>Invariants of torus knots derived from quantum groups.</td>
</tr>
<tr>
<td>4:15 p.m.</td>
<td>Invariant theory and a Casson-style count of $SL(2, C)$-representations of fundamental groups of rational homology spheres. Preliminary report.</td>
</tr>
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<td></td>
<td>Cynthia L. Curtis, Princeton University (874-57-130)</td>
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</tbody>
</table>

**Special Session on Set Theory, II**

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>2:45 p.m.</td>
<td>Auditorium III, Neville Hall The Tukey ordering of partially ordered sets.</td>
</tr>
<tr>
<td>2:45 p.m.</td>
<td>Stevo Todorcevic, Mathematicki Institut, Yugoslavia (874-03-120) (Sponsored by Lee J. Stanley)</td>
</tr>
<tr>
<td>3:15 p.m.</td>
<td>Informal Discussion.</td>
</tr>
<tr>
<td>3:45 p.m.</td>
<td>Almost disjoint families and iterations of $\nu$. Preliminary report.</td>
</tr>
<tr>
<td>4:15 p.m.</td>
<td>Homogeneity for open partitions. Preliminary report.</td>
</tr>
<tr>
<td>4:45 p.m.</td>
<td>Stationary subsets of $[\omega J]^\omega$.</td>
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<td></td>
<td>Kecheng Liu, Ohio State University, Columbus (874-04-69)</td>
</tr>
</tbody>
</table>

**Special Session on Stochastic Processes, II**

<table>
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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>2:45 p.m.</td>
<td>Room 201, Christmas-Saucon Hall Decoupling, expansions and tail behavior of Chaos processes.</td>
</tr>
<tr>
<td>2:45 p.m.</td>
<td>Miguel A. Arcones, Mathematical Sciences Research Institute, Berkeley, and Evarist Giné*, University of Connecticut, Storrs (874-56-93)</td>
</tr>
</tbody>
</table>
Program of the Sessions

Sunday, April 12

Special Session on Finite Geometry, III

8:30 a.m.–10:50 a.m. Auditorium II, Neville Hall

8:30 a.m. Some characterizations of quasi-symmetric designs with a spread.
Mohan S. Shrikhande*, Central Michigan University, and S. S. Sane, University of Bombay, India
(874-05-66)

9:00 a.m. Locally classical generalized quadrangles.
D. Ghinelli, University of Rome La Sapienza, Italy (874-51-57) (Sponsored by Jennifer D. Key)

9:30 a.m. Unitals in symmetric designs.
Tran Van Trung*, University of Essen, Germany, and R. Mathon, University of Toronto (874-05-67)

10:00 a.m. Nets and their codes.
Steven T. Dougherty, Lehigh University (874-05-23) (Sponsored by Edward F. Assmus)

10:30 a.m. A design and a code invariant under the simple group C3
Willem H. Haemers, Tilburg University, The Netherlands, Christopher Parker, University of Wisconsin, Madison, Vera Pless, University of Illinois, Urbana-Champaign, and Vladimir D. Tonchev*, Michigan Technological University (874-05-25)

Special Session on Homotopy Theory, III

8:30 a.m.–10:50 a.m. Room 343, Seeley G. Mudd Building

8:30 a.m. Approximations to iterated loop spaces.
Jeffrey L. Caruso, Carlisle, Massachusetts (874-55-98)

9:00 a.m. The fibre of the iterated Freudenthal suspension.
Shiu-chun Wong, University of Toronto, Canada (874-55-115)

9:30 a.m. Level N elliptic cohomology. Preliminary report.
Mark Hovey*, Yale University, and J. Barr Von Oehsen, William Paterson College (874-55-82)

10:00 a.m. Brown-Gitter spectra and cobordism with singularities.
Boris I. Botvinnik, York University (874-55-117) (Sponsored by Douglas C. Ravenel)

10:30 a.m. On the dual spectrum of the classifying space of a torus.
Chun-Nip Lee, Northwestern University (874-55-05)

Special Session on Geometric Analysis, III

8:30 a.m.–10:50 a.m. Room 353, Seeley G. Mudd Building

8:30 a.m. Non-minimal critical points of the Higgs functional with arbitrary coupling constant. Preliminary report.
L. M. Sibner*, Polytechnic Institute of New York, and Janet Talvacchia, Swarthmore College (874-35-08)

9:00 a.m. Causal boundary of a product spacetime. Preliminary report.
Steven G. Harris, Saint Louis University (874-53-135)
Program of the Sessions

**Sunday, April 12 (cont'd)**

**9:30 a.m.**  
*Gap theorems for indefinite manifolds.*  
*(86) Lars Andersson,* Royal Institute of Technology, Sweden, and *Ralph Howard,* University of South Carolina, Columbia (874-83-139)

**10:00 a.m.**  
*On the regularity of spherically symmetric wave maps.*  
*(87) Demetrios Christodoulou,* New York University-Courant Institute, and *A. Shadi Tahvildar-Zadeh,* Institute for Advanced Study (874-58-150)

**10:30 a.m.**  
*3-dimensional contact manifolds with the characteristic vector field has an eigenvector of the Lapacian operator.*  
*(88) Haiwen Chen,* State University of New York, Stony Brook (874-53-75)

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**Special Session on New Invariants of Links and 3-Manifolds, III**

**8:30 a.m.–10:50 a.m.**  
Room 253, Seeley G. Mudd Building

**8:30 a.m.**  
*Another way to calculate the Conway polynomial.*  
*(89) Fred Hickling,* Santa Clara University (874-57-62)

**9:00 a.m.**  
*Different 3-manifolds with the same invariants of Witten and Reshetikhin-Turaev.*  
*(90) Joanna Kania-Bartoszynska,* Boise State University (874-57-101)

**9:30 a.m.**  
*Normal surface equations for branched covers.*  
*(91) Preliminary report.*  
*(92) John Hempel,* Rice University (874-57-131)

**10:00 a.m.**  
*Torsion in skein modules of links in 3-manifolds.*  
*(93) Józef H. Przytycki,* University of California, Riverside (874-57-123)

**10:30 a.m.**  
*Torsion class and universal constraint of Donaldson invariants for odd manifolds.*  
*(94) Selman Akbulut,* Michigan State University, Tom Mrowka, California Institute of Technology, and Yongbin Ruan, Michigan State University (874-57-132)

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**Special Session on Set Theory, III**

**8:30 a.m.–10:50 a.m.**  
Auditorium III, Neville Hall

**8:30 a.m.**  
*Infinitary hydra.*  
*(95) Dan Velleman,* Amherst College (874-03-56)

**9:00 a.m.**  
*Informal Discussion*

**9:30 a.m.**  
*Semimorasses and nonreflection at singular cardinals.*  
*(96) Preliminary report.*  
*(97) Piotr Koszmider,* University of Toronto (874-03-15)

**10:00 a.m.**  
*Partition ordinals: The big picture.*  
*(98) Jean A. Larson,* University of Florida (874-04-58)

**10:30 a.m.**  
*Informal Discussion*

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**Special Session on Stochastic Processes, III**

**8:30 a.m.–10:50 a.m.**  
Room 201, Christmas-Saucon Hall

**8:30 a.m.**  
*Rice formula: The expected number of low and high level crossings for stationary stable processes.*  
*(99) Robert J. Adler,* Technion-Israel Institute of Technology, Israel, and *Gennady Samorodnitsky,* Cornell University (874-60-19)

**9:00 a.m.**  
*Some nonlinear operators on two distribution functions.*  
*(100) R. M. Dudley,* Massachusetts Institute of Technology (874-60-94)

**9:30 a.m.**  
*Densities with Gaussian tails.*  
*(101) A. A. Balkema,* University of Amsterdam, Holland, Claudia Klüppelberg, Eidgen Technological Hochschule, Germany, and Sidney Resnick* (Sponsored by John B. Conway)

**10:00 a.m.**  
*Geography of level sets of the Brownian sheet.*  
*(102) Robert C. Dalang,* Tufts University, and *John B. Walsh,* University of British Columbia (874-60-09)

**10:30 a.m.**  
*Generalized stable moving averages.*  
*(103) Preliminary report.*  
*(104) Jan Rosinski,* University of Tennessee, Knoxville (874-60-38) (Sponsored by John B. Conway)

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**Special Session on Sequence Spaces, III**

**9:00 a.m.–10:50 a.m.**  
Room 303, Christmas-Saucon Hall

**9:00 a.m.**  
*Weak sequential completeness of alpha-duals.*  
*(105) Christopher E. Stuart,* New Mexico State University, Las Cruces (874-40-31)

**9:30 a.m.**  
*The weak gliding humps property.*  
*(106) Johann Boos,* Fern University, Germany, and *Dan Fleming,* Saint Lawrence University (874-46-11)

**10:00 a.m.**  
*Commutants for some classes of Hausdorff matrices.*  
*(107) B. E. Rhoades,* Indiana University, Bloomington (874-40-77)

**10:30 a.m.**  
*A basis for c_0 which fails the Wilansky property.*  
*(108) Preliminary report.*  
*(109) A. K. Snyder,* Lehigh University (874-46-90)

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**Session on Applied and Applicable Mathematics**

**9:10 a.m.–10:50 a.m.**  
Room 203, Christmas-Saucon Hall

**9:10 a.m.**  
*Nearly optimal strategies for singularly perturbed wide-band driven delay systems.*  
*(110) K. M. Ramachandran,* University of South Florida (874-60-03)

**9:25 a.m.**  
*On the growth of the Galton-Watson predator-prey process.*  
*(111) John Coffey,* Purdue University, Calumet Campus (874-60-01)

**9:40 a.m.**  
*Formulas for the value of asian options.*  
*(112) Miguel A. Arío,* University Carlos III de Madrid, Spain (874-90-50)
<table>
<thead>
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<td><strong>Special Session on Characteristic Classes, Algebraic K-Theory, and Field Theory, III</strong></td>
<td>Room 302, Christmas-Saucon Hall</td>
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<td>10:00 a.m.</td>
<td>Informal Discussion</td>
<td></td>
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<tr>
<td>10:30 a.m.</td>
<td>Topological physics and geometric topology.</td>
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</tr>
<tr>
<td>11:00 a.m.-11:50 a.m.</td>
<td>Invited Address, Auditorium I, Neville Hall</td>
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### Sunday, April 12 (cont'd)

#### Special Session on Geometric Analysis, IV

<table>
<thead>
<tr>
<th>Time</th>
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<th>Speaker(s)</th>
<th>Location</th>
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<tbody>
<tr>
<td>2:45 p.m.</td>
<td>Hypersurfaces of hyperbolic space that have nonnegative Ricci curvature. Preliminary report.</td>
<td>Robert J. Currier, Smith College (874-53-65)</td>
<td>Room 353, Seeley G. Mudd Building</td>
</tr>
<tr>
<td>3:15 p.m.</td>
<td>Generalizing the collar lemma.</td>
<td>Ara Basmajian, University of Oklahoma (874-53-04)</td>
<td></td>
</tr>
<tr>
<td>3:45 p.m.</td>
<td>On the Einstein equation.</td>
<td>Chuan-Chih Hsiung, Lehigh University (874-53-60)</td>
<td></td>
</tr>
<tr>
<td>4:15 p.m.</td>
<td>On the possibilities for a convex domain to contain another in ( \mathbb{R}^3 ). Preliminary report.</td>
<td>Jiazu Zhou, Temple University (874-53-125)</td>
<td></td>
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</table>

#### Special Session on New Invariants of Links and 3-Manifolds, IV

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<tr>
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<tbody>
<tr>
<td>2:45 p.m.</td>
<td>A Seifert algorithm for knotted oriented surfaces.</td>
<td>J. Scott Carter*, University of South Alabama, and Masahiko Saito, University of Texas, Austin (874-57-17)</td>
<td>Room 253, Seeley G. Mudd Building</td>
</tr>
<tr>
<td>3:15 p.m.</td>
<td>Reidemeister moves for surface isotopies and their interpretation as moves to movies.</td>
<td>J. Scott Carter, University of South Alabama, and Masahiko Saito*, University of Texas, Austin (874-57-46)</td>
<td></td>
</tr>
<tr>
<td>3:45 p.m.</td>
<td>Triality in braid theory. Preliminary report.</td>
<td>Michael Khovanov, Yale University (874-57-137) (Sponsored by Ronnie Lee)</td>
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#### Special Session on Set Theory, IV

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<tbody>
<tr>
<td>2:45 p.m.</td>
<td>Special topologies on ( L^p ). Preliminary report.</td>
<td>William G. Fleissner, University of Kansas (874-54-91)</td>
<td>Auditorium III, Neville Hall</td>
</tr>
<tr>
<td>3:15 p.m.</td>
<td>Informal Discussion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:45 p.m.</td>
<td>Instances of dependent choice and the measurability of ( \kappa_{\omega_1} ).</td>
<td>Arthur W. Apter*, Bernard M. Baruch College, City University of New York, and Menachem Magidor, Hebrew University, Israel (874-04-36)</td>
<td></td>
</tr>
</tbody>
</table>

#### Special Session on Stochastic Processes, IV

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker(s)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:45 p.m.</td>
<td>Some problems in classical probability. Preliminary report.</td>
<td>Abram Kagan and Larry Shepp*, AT&amp;T Bell Laboratories, Murray Hill, New Jersey (874-60-73)</td>
<td>Room 201, Christmas-Saucon Hall</td>
</tr>
<tr>
<td>3:15 p.m.</td>
<td>Self-normalized trimmed sums: Nonormal limits.</td>
<td>Daniel C. Weiner, Boston University (874-60-41)</td>
<td></td>
</tr>
<tr>
<td>3:45 p.m.</td>
<td>Exact convergence rates for the bounded law of the iterated logarithm in Hilbert space.</td>
<td>Uwe Einmahl, Indiana University, Bloomington (874-60-100) (Sponsored by Victor W. Goodman)</td>
<td></td>
</tr>
</tbody>
</table>
Invited Addresses and Special Sessions

April 1992 Meeting in Bethlehem, Pennsylvania
Eastern Section
Associate Secretary: W. Wistar Comfort
Deadline for organizers: Expired
Deadline for consideration: Expired
Please see the announcement elsewhere in this issue.

June 1992 Meeting in Cambridge, England
(Joint Meeting with the London Mathematical Society)
Associate Secretary: Robert M. Fossum
Deadline for organizers: Expired
Deadline for consideration: February 7, 1992
Please see the announcement in the January issue.

October 1992 Meeting in Dayton, Ohio
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: Expired
Deadline for consideration: July 13, 1992
Colin C. Adams and Ara S. Basmajian, Hyperbolic manifolds
Carolyn A. Dean, Timothy J. Hodges, and J. Toby Stafford,
Quantum groups and regular algebras
Joanne M. Dombrowski and Richard Mercer, Operator theory and operator algebras
Anthony B. Evans and Terry A. McKee, Combinatorics and graph theory
Daniel E. Frohardt, Finite groups and finite geometries
Lop Fat Ho, Srdjan D. Stojanovic and Thomas Svoobody,
Control theory and partial differential equations
Muhammad N. Islam and Lawrence Turyn, Differential and integral equations
Louis H. Kauffman, Knots and topological quantum field theory
Hendrik J. Kuiper and Tapas Mazumdar, Ricatti equations and transport theory
Anatoly S. Libgober and Stephen Sperber, Topology of affine hypersurfaces and related number theory
Joe D. Mashburn, Set-theoretic topology
C. David Minda, Function theory

November 1992 Meeting in Los Angeles, California
Western Section Associate Secretary: Lance W. Small
Deadline for organizers: Expired
Deadline for consideration: July 13, 1992

Organizers and Topics of Special Sessions

Invited Addresses 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.

Bethlehem, PA, April 1992
Please see the announcement of this meeting elsewhere in this issue.

Cambridge, England, June 1992
(Joint meeting with the London Mathematical Society)
Please see the announcement of this meeting in the January issue.

Dayton, OH, October 1992
Martin Golubitsky
Jonathan I. Hall
Louis H. Kauffman
J. T. Stafford

San Antonio, TX, January 1993
Luis A. Caffarelli
(Colloquium Lectures)

Washington, DC, April 1993
Fan R. K. Chung
Leopold Flatto
Joel Spruck
A. Zamolodchikov

Invited addresses at Sectional Meetings are selected by the Section Program Committee, usually twelve to eighteen months in advance of a meeting. Members wishing to nominate candidates for invited addresses should send the relevant information to the Associate Secretary for the Section who will forward it to the Section Program Committee.

Organizers and Topics of Special Sessions

The list below contains all the information about Special Sessions at meetings of the Society available at the time this issue of Notices went to the printer. The section below entitled Information for Organizers describes the timetable for announcing the existence of Special Sessions.
January 1993 Meeting in San Antonio, Texas
Associate Secretary: W. Wist Far Comfort
Deadline for organizers: April 13, 1992
Deadline for consideration: September 17, 1992

March 1993 Meeting in Knoxville, Tennessee
Southeastern Section
Associate Secretary:
Joseph A. Cima (until 1/31/93)
Robert J. Daverman (after 1/31/93)
Deadline for organizers: June 26, 1992
Deadline for consideration: December 15, 1992
Don B. Hinton and Kenneth Shaw, Sturm-Liouville operators, applications, and extensions
Balram S. Rajput and Jan Rosinski, Stochastic processes

April 1993 Meeting in Salt Lake City, Utah
Western Section
Associate Secretary: Lance W. Small
Deadline for organizers: July 9, 1992
Deadline for consideration: January 6, 1993

April 1993 Meeting in Washington, DC
Eastern Section
Associate Secretary:
W. Wist Far Comfort (until 1/31/93)
Lesley M. Sibner (after 1/31/93)
Deadline for organizers: July 17, 1992
Deadline for consideration: January 6, 1993

May 1993 Meeting in DeKalb, Illinois
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: August 21, 1992
Deadline for consideration: February 3, 1993
Peter Weateman, Discrete groups

August 1993 Meeting in Vancouver,
British Columbia, Canada
Associate Secretary: Lance W. Small
Deadline for organizers: November 11, 1992
Deadline for consideration: April 27, 1993

October 1993 Meeting in College Station, Texas
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: January 22, 1993
Deadline for consideration: July 14, 1993

January 1994 Meeting in Cincinnati, Ohio
Associate Secretary:
Joseph A. Cima (until 1/31/93)
Robert J. Daverman (after 1/31/93)
Deadline for organizers: April 5, 1993
Deadline for consideration: September 23, 1993

March 1994 Meeting in Lexington, Kentucky
Southeastern Section
Associate Secretary:
Joseph A. Cima (until 1/31/93)
Robert J. Daverman (after 1/31/93)
Deadline for organizers: June 18, 1992
Deadline for consideration: To be announced

March 1994 Meeting in Manhattan, Kansas
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: June 25, 1993
Deadline for consideration: To be announced

January 1995 Meeting in Denver, Colorado
Associate Secretary: Andy R. Magid
Deadline for organizers: April 20, 1994
Deadline for consideration: To be announced

March 1995 Meeting in Chicago, Illinois
Central Section
Associate Secretary: Andy R. Magid
Deadline for organizers: June 24, 1994
Deadline for consideration: To be announced

January 1996 Meeting in Orlando, Florida
Associate Secretary: Lance W. Small
Deadline for organizers: April 12, 1995
Deadline for consideration: To be announced

Information for Organizers
Special Sessions at Annual and Summer Meetings are held under the supervision of the Program Committee for National Meetings (PCNM). They are administered by the Associate Secretary in charge of that meeting with staff assistance from the Meetings Department in the Society office in Providence.

According to the “Rules for Special Sessions” of the Society, Special Sessions are selected by the PCNM from a list of proposed Special Sessions in essentially the same manner as individuals are selected to give Invited Addresses. The number of Special Sessions at a Summer or Annual Meeting is limited. The algorithm that determines the number of Special Sessions allowed at a given meeting, while simple, is not repeated here, but can be found in “Rules for Special Sessions” on page 614 in the April 1988 issue of Notices.

Each person selected to give an Invited Address is invited to generate a Special Session, either by personally organizing one or by having a Special Session organized by others. Proposals to organize a Special Session are sometimes requested either by the PCNM or by the Associate Secretary. Other proposals to organize a Special Session may be submitted to the Associate Secretary in charge of that meeting (who is an ex-officio member of the committee and whose address may be found below). These proposals must be in the hands of the PCNM at least nine months prior to the meeting at which the Special Session is to be held in order that the committee may consider all the proposals for Special Sessions simultaneously. Proposals that are sent to the Providence office of the Society, to Notices, or directed to anyone other than the Associate Secretary will have to be forwarded and may not be received in time to be considered for acceptance.

It should be noted that Special Sessions must be announced in Notices in such a timely fashion that any member of the Society who so wishes may submit an abstract for consideration for presentation in the Special Session before
the deadline for such consideration. This deadline is usually three weeks before the deadline for abstracts for the meeting in question.

Special Sessions are very effective at Sectional Meetings and can usually be accommodated. The processing of proposals for Special Sessions for Sectional Meetings is handled in essentially the same manner as for Annual and Summer Meetings by the Section Program Committee. Again, no Special Session at a Sectional Meeting may be approved so late that its announcement appears past the deadline after which members can no longer send abstracts for consideration for presentation in that Special Session.

The Society reserves the right of first refusal for the publication of proceedings of any Special Session. These proceedings appear in the book series Contemporary Mathematics.

More precise details concerning proposals for and organizing of Special Sessions may be found in the “Rules for Special Sessions” or may be obtained from any Associate Secretary.

Proposals for Special Sessions to the Associate Secretaries

The programs of Sectional Meetings are arranged by the Associate Secretary for the section in question:

Western Section
Lance W. Small, Associate Secretary
Department of Mathematics
University of California, San Diego
La Jolla, CA 92093
Electronic mail: g.small@math.ams.com
(Telephone 619–534–3590)

Central Section
Andy R. Magid, Associate Secretary
Department of Mathematics
University of Oklahoma
601 Elm PHSC 423
Norman, OK 73019
Electronic mail: g.magid@math.ams.com
(Telephone 405–325–6711)

Eastern Section
W. Wistar Comfort, Associate Secretary (until January 31, 1993)
Department of Mathematics
Wesleyan University
Middletown, CT 06457
Electronic mail: g.comfort@math.ams.com
(Telephone 203–347–9411)
Lesley M. Sibner, Associate Secretary (beginning February 1, 1993)
Department of Mathematics
Polytech University of New York
Brooklyn, NY 11201–2990
(Telephone 718–260–3505)

Southeastern Section
Joseph A. Cima, Associate Secretary (until January 31, 1993)
Department of Mathematics
University of North Carolina, Chapel Hill
Chapel Hill, NC 27599–3002
Electronic mail: g.cima@math.ams.com
(Telephone 919–962–1050)
Robert J. Daverman, Associate Secretary (beginning February 1, 1993)
Department of Mathematics
University of Tennessee
Knoxville, TN 37996–1300
(Telephone 615–974–6877)

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

Information for Speakers

A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special Session has been scheduled. Contributors should know that there is a limitation in size of a single Special Session, so that it is sometimes true that all places are filled by invitation. Papers not accepted for a Special Session are considered as ten-minute contributed papers.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Meetings Department, American Mathematical Society, P. O. Box 6887, Providence, RI 02940) by the special deadline for Special Sessions, which is usually three weeks earlier than the deadline for contributed papers for the same meeting. The Council has decreed that no paper, whether invited or contributed, may be listed in the program of a meeting of the Society unless an abstract of the paper has been received in Providence prior to the deadline.

Electronic submission of abstracts is available to those who use the \TeX\ typesetting system. Requests to obtain the package of files may be sent electronically via the Internet to abs-request@math.ams.com. Requesting the package electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Electronic Abstracts, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940, USA. When requesting the abstracts package, users should be sure to specify whether they want the plain \TeX, \AmS-\TeX, or the \LaTeX\ package.

Number of Papers Presented

Joint Authorship

Although an individual may present only one ten-minute contributed paper at a meeting, any combination of joint authorship may be accepted, provided no individual speaks more than once. An author can speak by invitation in more than one Special Session at the same meeting.

An individual may contribute only one abstract by title in any one issue of Abstracts, but joint authors are treated as a separate category. Thus, in addition to abstracts from two individual authors, one joint abstract by them may also be accepted for an issue.

Site Selection for Sectional Meetings

Sectional Meeting sites are recommended by the Associate Secretary for the Section and approved by the Committee
of Associate Secretaries and Secretary. Recommendations are usually made eighteen to twenty-four months in advance. Host departments supply local information, ten to twelve rooms with overhead projectors for contributed paper sessions and Special Sessions, an auditorium with twin overhead projectors for invited addresses, and registration clerks. The Society partially reimburses for the rental of facilities and equipment, and for staffing the registration desk. Most host departments volunteer; to do so, or for more information, contact the Associate Secretary for the Section.

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Memoria of the American Mathematical Society

Number 463

Sum of Even Powers of Real Linear Forms
Bruce Reznick

This work initiates a systematic analysis of the representation of real forms and the resulting implications in real algebraic geometry, number theory, combinatorics, functional analysis, and numerical analysis. The proofs utilize elementary techniques from linear algebra, convexity, number theory, and real algebraic geometry, and many explicit examples and relevant historical remarks are presented.

1991 Mathematics Subject Classifications: 11; 05, 12, 14, 26, 44, 46, 52, 65
Indiv. mem. $19, List $29, Inst. mem. $24
Your ordering code is MEMO/463NA

Number 464

Kernel Functions, Analytic Torsion, and Moduli Spaces
John Fay

This work investigates analytic torsion on the moduli space of degree zero stable bundles on a compact Riemann surface. Zeta-function regularization and perturbation-curvature formulas for torsion are developed using a modified resolvent-Szego kernel. Fay discusses the bosonization formulas of mathematical physics, Riemann vanishing theorems for torsion, and analytic properties for the nonabelian theta function and Szego kernel. In addition, Fay provides background material on bundle-moduli spaces, Quillen metrics, and theta functions.

1991 Mathematics Subject Classifications: 32, 14, 30
Indiv. mem. $18, List $27, Inst. mem. $23
Your ordering code is MEMO/464NA

All prices subject to change. Free shipment by surface: for air delivery, please add $6.50 per title. Prepayment required.
Order from: American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, or call toll free 800-321-4AMS in the continental U.S. and Canada to charge with VISA or MasterCard.
Canada residents, please include 7% GST.
The twenty-second AMS-SIAM Summer Seminar in Applied Mathematics will be held July 26–August 1, 1992 at Colorado State University, Fort Collins, Colorado. The seminar will be sponsored by the American Mathematical Society, the Society for Industrial and Applied Mathematics, and the Department of Mathematics at Colorado State University. It is anticipated that it will be supported by grants from federal agencies. The proceedings of the seminar will be published by the American Mathematical Society in the Lectures in Applied Mathematics series.

The aim of the conference is to provide a wide-ranging survey of the exploitation of symmetry in applied and numerical analysis. The seminar will have both an entry level summer school component intended for young researchers and a frontier level research aspect. A number of the anticipated participants will be experts from foreign countries.

A purpose of the seminar is to stimulate interaction between aspects of Applied Mathematics (e.g., PDEs, integral equations, bifurcation), Numerical Mathematics (e.g., numerical linear algebra, boundary and finite element methods), Pure Mathematics (e.g., representation theory of groups), and Classical Physics (e.g., Taylor and Bénard problems).

The tentative list of invited speakers includes William F. Ames, Georgia Institute of Technology; Dieter Armbruster, Arizona State University; George W. Bluman, University of British Columbia; Alain Bossavit, Electricité de France; Fritz H. Busse, University of Bayreuth, Germany; Pascal Chossat, University of Nice, France; Peter A. Clarkson, University of Exeter; John David Crawford, University of Pittsburgh; Gerhard Dangelmayr, University of Tübingen, Germany; Michael Dellnitz, University of Houston; Timothy J. Healey, Cornell University; Henry Hermes, University of Colorado; Darryl D. Holm, Los Alamos National Laboratories; Gérard Iooss, University of Nice, France; Edgar Knobloch, University of California, Berkeley; P. S. Krishnaprasad, University of Maryland, College Park; Jan Mandel, University of Colorado, Denver; Ian Melbourne, University of Houston; Hans-Detlef Mittelmann, Arizona State University; K. Murota, University of Tokyo; Heinz-Otto Peitgen, University of Bremen, Germany; Tudor Ratiu, University of California, Santa Cruz; Werner C. Rheinboldt, University of Pittsburgh; Duane Sather, University of Colorado; David Sattinger, University of Minnesota; Jurgen Scheurle, University of Hamburg, Germany; André Vanderbauwhede, University of Ghent, Belgium; Bodo Werner, University of Hamburg, Germany.

The Organizing Committee consists of Martin Golubitsky, University of Houston; Klaus W. Kirchgässner, University of Stuttgart, Germany; Peter J. Olver, University of Minnesota; and the local organizers Eugene L. Allgower (Co-chairman), Kurt Georg (Co-chairman), and Rick Miranda (Co-chairman), Colorado State University.

Those interested in attending the Seminar should send the following information to Summer Seminar Conference Coordinator, American Mathematical Society, P.O. Box 6887, Providence, R.I. 02940, email: DLS@MATH.AMS.COM, before May 6, 1992. Please type or print the following:

1. Full name;
2. Mailing address;
3. Telephone number and area code for office and home;
4. Email address if available;
5. Anticipated arrival and departure dates;
6. Your scientific background relevant to the topic of the seminar;
7. Financial assistance requested (please estimate cost of travel), indicate if support is not required, and if interested in attending even if support is not offered.

Participants who wish to apply for a grant-in-aid should so indicate: funds available for the seminar are very limited and individuals who can obtain support from other sources should do so. Graduate students who have completed at least one year of graduate school are encouraged to participate.
Mathematical Sciences
Meetings and Conferences

This section contains announcements of meetings and conferences of interest to some segment of the mathematical public, including ad hoc, local, or regional meetings, and meetings or symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. Information on meetings of the Society, and on meetings sponsored by the Society, will be found inside the front cover.

An announcement will be published in Notices if it contains a call for papers, and specifies the place, date, subject (when applicable), and the speakers; a second full announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in each issue until it has been held and a reference will be given in parentheses to the month, year, and page of the issue in which the complete information appeared. Asterisks (*) mark those announcements containing new or revised information.

In general, announcements of meetings and conferences held in North America carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of Notices, care of the American Mathematical Society in Providence.

Deadlines for entries in this section are listed on the inside front cover of each issue. In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of Notices prior to the meeting in question. To achieve this, listings should be received in Providence six months prior to the scheduled date of the meeting.

Effective with the 1990 volume of Notices, the complete list of Mathematical Sciences Meetings and Conferences will be published only in the September issue. In all other issues, only meetings and conferences for the twelve-month period following the month of that issue will appear. As new information is received for meetings and conferences that will occur later than the twelve-month period, it will be announced at the end of the listing in the next possible issue. That information will not be repeated until the date of the meeting or conference falls within the twelve-month period.


1992

April 1992

May 1992
10–12. Workshop on Cellular Automata, Mathematical Sciences Institute, Ithaca, NY.
Meetings and Conferences

**Organizer:** D. Griffeth, University of Wisconsin, Madison.
**Information:** R. Durrett email: rtd@cornella.cit.cornell.edu.


**Program:** The main topic of this meeting will be the recent advances in the theory of harmonic maps which use the methods of integrable systems, and the growing interplay between the two subjects. The object is to bring together workers in the two areas.
**Information:** Organizers: A. Fordy (tel: +44-532-335115/335116; email: amt@leeds.ac.uk) and J.C. Wood (tel: +44-532-335106, pmt@leeds.ac.uk). School of Mathematics, University of Leeds, Leeds, LS2 9JT, England, Fax: +44-532-429925.


**Invited Talks:** L. Yates (Convergence on Chebyshev series) and J. Haag (Biogradable matrices).
**Information:** R. Montgomery, Dept. of Math., Southern Oregon State College, Ashland, OR 97520; 503-552-6580.

18–23. Second European Conference on Computer Vision, Santa Margherita Ligure, Italy. (Jul./Aug. 1991, p. 645)

**Sponsor:** TUBITAK (The Scientific and Technical Research Council of Turkey).
**Invited Speakers:** A. Casson, R. Fintushel, R. Gompf, N. Hitchen, R. Kirby, P. Kronheimer, J. Morgan, T. Parker, R. Stern.
**Information:** Turgut Onder, Dept. of Math., Middle East Technical U., Ankara, Turkey; email: matgrt@metu.bitnet@cupym.cuny.edu or Selman Akbulut: akbulut@math.msu.edu.
25–June 5. School on Dynamical Systems, International Centre for Theoretical Physics, Trieste, Italy. (Jan. 1992, p. 49)
27–31. IMACS International Conference on Finite Elements and Boundary Elements in Geosciences, Florida State University, Tallahassee, FL. (Jan. 1992, p. 49)
27–31. NSF-CBMS Conference on Weak Turbulence and Nonlinear Waves with Applications in Oceanography and Geophysics, Case Western Reserve University, Cleveland, OH. (Jan. 1992, p. 49)
**Organizers:** J. Remmel (UCSD) and P. Clote (Boston College).
**Information:** J. Remmel at jremmel@ucsd.edu.

**June 1992**


*1–3. Logical Analysis and Computer Science in Honor of the 60th Birthday of MSI Director A. Nerode, Mathematical Sciences Institute, Ithaca, NY.

**Organizer:** R. Shore, Cornell.
**Information:** J. Chiment email: jjc@cornella.cit.cornell.edu.

1–5. IMA Workshop on Linear Algebra for Control Theory, University of Minnesota, Minneapolis, MN. (Oct. 1990, p. 1141)
1–5. Calcul Formel et Équations Différentielles, Marseille, France. (Jan. 1992, p. 49)
1–5. NSF-CBMS Regional Research Conferences in the Mathematical Sciences: Number Theory and Dynamical Systems, California State University, Fresno, Cali-
Meetings and Conferences

4-6. AT LAST: An NSF-ILAS Project to Augment the Teaching of Linear Algebra through the use of Software Tools, West Valley College, Saratoga, CA. (Feb. 1992, p. 142)


8-12. Séminaire Sud-Rhodanien de Géométrie, Marseille, France. (Jan. 1992, p. 49)

8-12. NSF Undergraduate Faculty Enhancement Workshop: Algorithmic Number Theory, California State University, Fresno, CA. (Jan. 1992, p. 50)

8-12. Gordon Research Conferences “Frontiers of Science”, Tilton, NH.

PROGRAM: The object and exclusive purpose of these conferences is to foster and promote education and science by organizing and operating meetings of research scientists with common interest in the fields of chemistry or related sciences for the purpose of discussions and the free exchange of ideas. Attendance at each conference is limited to approximately 100 attendees. Deadline for receipt of applications is April 27, 1992.


Information: A.M. Crickshank, Gordon Research Conferences, Gordon Research Center, U. of Rhode Island, Kingston, RI 02881-0801; 401-783-4011 or 401-783-3372; Fax: 401-783-7644; email: bcp101@uriacc.bitnet.


9-19. Workshop on Dynamical Systems, International Centre for Theoretical Physics, Trieste, Italy. (Jan. 1992, p. 50)


Program: The meeting is part of the GADGET project and is also supported by DFG. Recent developments will be presented in areas such as Riemannian geometry, Kaehler geometry, symplectic geometry, index theory, and minimal surfaces.


Information: Contact the Organizers: U. Abresch, W.T. Meyer, Mathematisches Institut der Universität, 4400 Münster, Einsteinstr. 62, Germany; tel: (0) 251-83-3732 or -3748; email: abresch@math.uni-muenster.de or meyer@math.uni-muenster.de; or D. Gromoll, Dept. of Math., SUNY, Stony Brook, NY 11794-3651; 516-632-8286 or -8250; email: detlef@math.sunysb.edu.


11-13. AT LAST: An NSF-ILAS Project to Augment the Teaching of Linear Algebra through the use of Software Tools, Auburn University, Auburn, AL. (Feb. 1992, p. 142)


Program: The Calculus Consortium based at Harvard U. will host a summer workshop in conjunction with NSF and John Wiley and Sons. The scope is broad; there will be no focus on one particular project, approach or technology. Two year college, four year college, university, and secondary faculty are welcome.

Chairmen: T. Tucker (MAA) and J.S. Bradley (AMS).


Conference Topics: Changing the climate, client disciplines, nontraditional classroom methods, student projects, secondary schools, and technology.

Information: H.O. Satholz, Harvard U., Math. Dept., Science Center; Room 325, One Oxford St., Cambridge, MA 02138; email: calculus@math.harvard.edu.


13-16. Conference in Geometric Group Theory, Ohio State University, Columbus, OH. (Nov. 1991, p. 1168)


14-20. Fifth International Symposium on Statistical Decision Theory and Related Topics, Purdue University, West Lafayette, IN. (Sep. 1990, p. 938)


15-19. Tire a Préciser, Marseille, France. (Jan. 1992, p. 50)


Meetings and Conferences


18–20. AT LAST: An NSF-ILAS Project to Augment the Teaching of Linear Algebra through the use of Software Tools, University of Wisconsin, Madison, WI. (Feb. 1992, p. 143)


21–July 10. Summer Geometry Institute, Park City, Utah. (Nov. 1991, p. 1169)


22–25. Seventh Annual Conference on Structure in Complexity Theory, Boston University, Boston, MA. (Nov. 1991, p. 1169)

22–26. Fifth International Meeting on Statistical Climatology (5MSC), Toronto, Canada. (Nov. 1991, p. 1169)


22–July 17. Patch Dynamics II, Mathematical Sciences Institute, Ithaca, NY.

INFORMATION: Cosponsored by the Center for Stochastic Analysis and the Center for Applied Mathematics. Contact: gucken@mssun7.msi.cornell.edu.


25–27. AT LAST: An NSF-ILAS Project to Augment the Teaching of Linear Algebra through the use of Software Tools, University of Wyoming, Laramie, WY. (Feb. 1992, p. 143)


INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6887, Providence, Rhode Island 02940.


July 1992


5–August 1. NSF Regional Geometry Institute: Computational Algebraic Geometry, Amherst College, Amherst, MA. (Oct. 1991, p. 1010)


PROGRAM: The program will feature fifty invited lectures (ten plenary lectures and forty conferences organized in parallel sessions) and sixteen two hour round tables in parallel sessions. Invited lectures aim at presenting to a wide audience of mathematicians various new aspects of pure and applied mathematics. Round tables are intended as a forum for discussions of the present and future role of mathematics in society, education, and its interaction with other sciences as well as with industry. Policy makers, mediados, members of the European institutions, and the general public will take part.

6–10. Mathematical Conferences in Perth, University of Western Australia. (Sep. 1991, p. 838)


6–10. Strange Attractors and Knots, Dynamical Systems Institute, Boston University, Boston, MA. (Feb. 1992, p. 144)

6–11. RICA '92: RISC-LINZ Summer School in Computer Algebra 1992, Johannes Kepler University, Linz, Austria. (Feb. 1992, p. 144)

*6–13. Regional Institute in Geometry and Computational Algebraic Geometry, Amherst College, MA.

ORGANIZERS: M. Stillman and B. Sturmfels of Cornell Univ.
INFORMATION: D. Cox email: dac@cs.amherst.edu.


6–August 14. Summer Program in Mathematical Physiology, Mathematical Sciences Research Institute, Berkeley, CA. (Sep. 1991, p. 838)

*7–August 7. Workshop on Stochastic Partial Differential Equations, Mathematical Sciences Institute, Ithaca, NY.

ORGANIZER: C. Mueller (U. Rochester).
INFORMATION: C. Mueller email: cmlr@uhura.cc.rochester.edu.

*8–25. Twenty-second Summer Ecole d'ete
de Calcul des Probabilités, Saint-Flour (Canada).

INVITED SPEAKERS AND TOPICS: D. Bakry, L’hypercontractivité et son utilisation en théorie des semigroupes; R.D. Grill, Topics from survival analysis; S.A. Molchanov, Stationary random media: homogenization, localization, and intermittency. INFORMATION: P. Bernard, Univ. Blaise Pascal, Math. Appliquees, F63177 Aubiere Cedex; tel: 73.40.70.50; telefax: 73.40.70.64; email: stflour@ucfma.uucp.

10–12. Annual Meeting for the Australasian Association for Logic, Australian National University, Canberra, Australia. (Mar. 1992, p. 246)


12–16. Dynamics of Annuus Maps, Dynamical Systems Institute, Boston University, Boston, MA. (Feb. 1992, p. 144)


13–17. Tutre a Préciser, Marseille, France. (Jan. 1992, p. 51)

13–17. RISC-LINZ Summer Course on Quantifier Elimination, Johannes Kepler Universität, Linz, Austria. (Feb. 1992, p. 144)


19–23. Complexity and Computability over the Reals, Dynamical Systems Institute, Boston University, Boston, MA. (Feb. 1992, p. 144)


20–24. Tutre a Préciser, Marseille, France. (Jan. 1992, p. 51)


22–25. AT LAST: An NSF-ILAS Project to Augment the Teaching of Linear Algebra through the use of Software Tools, University of Maryland, College Park, MD. (Feb. 1992, p. 145)


26–30. Dynamics, Competition, and Neutral Networks, Dynamical Systems Institute, Boston University, Boston, MA. (Feb. 1992, p. 145)


26–August 1. Variationsrechnung, Oberwolfach, Germany. (Feb. 1991, p. 147)

26–August 1. AMS-SIAM Summer Seminar on Exploiting Symmetry in Applied and Numerical Analysis, Colorado State University, Fort Collins, CO.

INFORMATION: D.L. Saltzer, AMS, P.O. Box 6887, Providence, RI 02940.


August 1992

August 1992. The International Conference Lobachevsky and Modern Geometry devoted to the 200th Anniversary of Lobachevsky’s birthday, Kazan, USSR. (Feb. 1991, p. 147)


*5–9. Topology, University of Georgia, Athens, GA.

PROGRAM: The conference will cover low-dimensional and geometric topology, with lectures by about 15 invited speakers. Travel support is available, especially for graduate students. INFORMATION: C. McCrory, Math. Dept., U. of Georgia, Athens, GA 30602; email: clint@joe.math.uga.edu; 404-542-2576.
Meetings and Conferences


PURPOSE: There are four primary objectives: 1) to study and further explore applications of various kinds of generalized numerical ranges and numerical radii in different branches of science; 2) to discuss existing mathematical tools and techniques and try to generate new methods to handle problems on numerical ranges and numerical radii; 3) to discuss possible research projects or computer projects on numerical ranges and numerical radii appropriate for the undergraduate or graduate level; 4) to exchange research problems, ideas, and experience on the subject.

PROGRAM: Discussion will be focused on the ranges and applications of numerical ranges and numerical radii to other topics.


INFORMATION: M. Clapp and C. Prieto: Inst. de Matematicas, UNAM, Mexico 20 D.F., Fax: (525) 5489499; Bitnet: imate@unamvml or J. Ize: IIMAS, UNAM, A.P. 20-726, Mexico 20 D.F.; Fax: (525) 550-00-47; Bitnet: ize@unamvml.dgsc.unam.mx.

*30–September 5. International Congress on Nonlinear Analysis; Variational and Topological Methods, Xalapa, Veracruz, Mexico.

PROGRAM: The purpose of the meeting is to provide a forum for the presentation and discussion of recent advances in variational and topological methods in nonlinear analysis.


INFORMATION: M. Clapp and C. Prieto: Inst. de Matematicas, UNAM, Mexico 20 D.F., Fax: (525) 5489499; Bitnet: imate@unamvml or J. Ize: IIMAS, UNAM, A.P. 20-726, Mexico 20 D.F.; Fax: (525) 550-00-47; Bitnet: ize@unamvml.dgsc.unam.mx.

September 1992


*September 1992. Workshop on Topics in Probability and Lie Groups—Boundary Theory, Centre de Recherches Mathematiques, Universite de Montreal, Montreal Quebec, Canada.

Organizer: J. Taylor, McGill U.
Invited Speakers: E.B. Dynkin (Cornell U.) will be the principal speaker (Aisenstadt Chair).

MINICOURSES: W. Cantor (Oregon), An introduction to buildings; P. Diaconis (Harvard), Random walks on Lie groups of finite type; S. Evans (Berkeley), Local field Brownian motion; Y. Guivarc'h (Rennes), Random walks on matrix groups over a local field; F. LeDrappier (Paris VI), Exponential growth rates for random walks.

Information: S. Chenevert, CRM, Univ. de Montreal, C.P. 6128-A, Montreal, Quebec H3C 3J7; 514-343-2197; Fax: 514-343-2254; chenevert@ere.umontreal.ca.

*2-4. Ninth IFAC Workshop on Control Applications of Optimization, Munich, Germany.

Program: The objective of the workshop is to bring together experts in control and optimization from research and industry to exchange ideas, experiences, and future developments in control applications of optimization.

Conference Topics: Nonlinear programming: interior point methods, large structured problems, nonsmooth problems, vector-valued criteria; Optimal control: boundary value problems, state and control constraints; Optimization-based control system design; Applied to models and systems from the field of: control engineering, aerospace engineering, process control, path planning and control of robots, transportation systems engineering.

Information: D. Kraft, Fachhochschule Munich, Dachauerstrasse 98 b, D-8000 Munich 2, Federal Republic of Germany; tel: 0049 89 1265 1108 or 0049 8153 2493; Fax: 0049 89 1265 1392; email: kraft@maschinenbau.fh-muenchen.dpb.de.

*4-9. Homotopy Theory, Lake of Garda, Italy. (Please note change of date and location from Jul./Aug. 1991, p. 645)


Information: R. Piccinini, U. of Milan, Via Saldini 50, 20133 Milan, Italy; tel: 39/2/2660 2271; email: renzo@imuucca.csi.unimi.it.


7-11. Réseaux, Marseille, France. (Jan. 1992, p. 53)


16-18. Second SIAM Conference on Control in the 90s, Minneapolis, MN. (Feb. 1991, p. 148)


31-October 4. Third International Conference on Function Spaces, Institute of Mathematics, Adam Mickiewicz University, Poznan, Poland. (Feb. 1992, p. 147)

October 1992

*October 1992. Workshop on Superprocesses and Interacting Systems, Centre de Recherches Mathématiques, Université de Montréal, Montréal, Quebec, Canada.


Organizer: D.A. Dawson (Carleton U.).

Workshop Topics: Superprocesses, Fleming-Viot processes, spde, and interacting particle systems.

Invited Speakers: E.B. Dynkin (Cornell U.) will be the principal speaker (Aisenstadt Chair). Also, D.A. Dawson, Carleton; R.T. Durrett, Cornell; T.G. Kurtz, Wisconsin; E.A. Perkins, UBC; J.B. Walsh, UBC.

Information: S. Chenevert, CRM, Univ. de Montréal, C.P. 6128-A, Montréal, Quebec H3C 3J7; 514-343-2197; Fax: 514-343-2254; chenevert@ere.umontreal.ca.


*15-17. Jumelage 92, Mathematical Sciences Institute, Ithaca, NY.

Organizer: A. Nerode.

Information: J. Chiment email: jjc@cornell.cit.cornell.edu.


Meetings and Conferences

November 1992


November 1992. Workshop on Stochastic Control, Centre de Recherches Mathématiques, Université de Montréal, Montréal, Quebec, Canada.

CHAIRMEN: P. Caines (McGill U.), D. Dawson (Carleton U.), J. Taylor (McGill U.)

ORGANIZER: P. Caines, McGill U.

WORKSHOP TOPICS: First week: Nonlinear filtering theory and stochastic PDEs; Second week: Stochastic and geometric control theory; Third week: Hypoellipticity, invariant measures, and stochastic control; Fourth week: Adaptation and stabilization of stochastic systems and control of financial systems.

INVITED SPEAKERS: E.B. Dynkin (Cornell U.) will be the principal speaker (Aisenstadt Chair). First week: R.J. Elliott (Alberta), E. Pardoux (Provence); Second week: T. Duncan (Kansas), W. Fleming (Brown); Third week: W. Kliemann (Iowa State), S. Meyn (Illinois), R. Tweedie (Colorado State); Fourth week: M. Davis (Imperial College), R.Z. Has’minski.

INFORMATION: S. Chenevert, CRM, Univ. de Montréal, C.P. 6128-A, Montréal, Quebec H3C 3J7; 514-343-2197; Fax: 514-343-2254; chenevert@ere.umontreal.ca.


2-6. Workshop on Symbolic Dynamics, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1992, p. 54)


INVITED SPEAKERS: A. Friedman (U. Minnesota), C. Kenig (U. Chicago), M. Murray (VPI&SU), J. Yorke (U. Maryland).

INFORMATION: P.D. Hislop, Math. Dept., U. Kentucky, Lexington, KY 40506-0027; 606-257-5637; mwseac@ms.uky.edu or hislop@ms.uky.edu.


* 16-20. The Fifth Annual High Per
Meetings and Conferences

performance Computing and Communication Conference–Supercomputing 92, Minneapolis, MN.

PROGRAM: Supercomputing 92 will focus on the past, present, and future role of supercomputing in society, with special emphasis on its potential as an aid to discovery. The conference will consist of a technical program (contributed and invited papers, panels, roundtables, workshops, and research exhibits), an industry exhibition (featuring hardware and software products from all sectors of the computing industry), and tutorials.

INFORMATION: Susan Cross, SC92 Conference Office, SCID/NCAR, P.O. Box 3000, Boulder, CO 80307; 303-497-1133; email: sc92info@ncar.ucar.edu.


PROGRAM: The program will focus on hamiltonian bifurcations, homoclinic chaos, quasiperiodic flows, dynamic bifurcations with symmetry and pattern formation, applications to the earth and biological sciences will also be stressed from the PDE, symmetry/group theoretic and lattice gas cellular automata viewpoints. There will be intensive course modules covering these topics.

PROGRAM DIRECTORS: J. Chadam (McMaster U.), L. Glass (McGill U.), W. Langford (Guelph), J. Marsden (Fields), and W.F. Shadwick (Fields).

INVITED SPEAKERS: D. Armbruster (Arizona State), L. Bates (Calgary), H. Broer (Groningen), S.-N. Chow (Georgia Tech), R. Cushman (Utrecht), G. Doollen (Los Alamos), G. Iooss (Nice), M. Field (Sydney), P. Fife (Utah), H. Freedman (Alberta), W. Gilbert (Waterloo), M. Golubitsky (Houston), B. Hasslacher (Los Alamos), K. Huseyin (Waterloo), R. Kapral (Toronto), H. Keller (Caltech), B. Keyfitz (Houston), K. Kirchhassner (Stuttgart), E. Knobloch (Berkeley), M. Krupa (Groningen), A. Lawnczak (Guelph), J. Mallet-Paret (Brown), J. Marsden (Fields), B. Matkowsky (Northwestern), R. Miura (British Columbia), J. Murray (Washington), W. Nagata (British Columbia), S. Namachchivaya (Illinois), S. Newhouse (North Carolina), P. Ortoleva (Indiana), G. Oster (Berkeley), W. Peltier (Toronto), T. Ratiu (Santa Cruz), D. Rod (California), D. Rothman (MIT), J. Sanders (Amsterdam), D. Sattinger (Minnesota), J. Scheurle (Hamburg), I. Stewart (Warwick), F. Takens (Groningen), J. Tyson (VPI), A. Vanderbauwhede (Gent), S. van Gils (Eindhoven), E.R. Vrscay (Waterloo), B. Wetton (British Columbia), S. Wiggins (Caltech), and J. Wu (York). Other participants are to be announced, including the Fields Institute Fellows.

INFORMATION: J. Chadam (McMaster, 416-525-9140, ext. 3426, chadam@fields.waterloo.edu), L. Glass (McGill, 514-398-4338, md56@music.mcgill.ca), W. Langford (Guelph, 519-824-4747, ext 6556, langford@fields.waterloo.edu); or E. Reidt, The Fields Institute for Research in Mathematical Sciences, 185 Columbia St. West, Waterloo, Ontario, Canada N2L 3Z5; 519-725-0096; Fax: 519-725-0704; email: workshop@fields.waterloo.edu.


23–27. Séminaire Sud-Rhodanien de Géométrie, Marseille, France. (Jan. 1992, p. 54)


December 1992


PROGRAM: In celebration of its 25th Anniversary, INRIA is organizing a conference for the scientific community that will feature leading scientists from throughout the world presenting lectures in research fields covered by INRIA.

CONFERENCE TOPICS: Parallel processing, data bases, networks, and distributed systems; symbolic computation, programming, and software engineering; artificial intelligence, cognitive systems, and machine communication; robotics—image and vision; signal processing, control, numerical software, and computer-aided engineering.

INFORMATION: C. Genest, F. Tapiossier, INRIA–Rocquencourt; tel: (33) (1) 39 63 56 00; email: symposia@cluny.inria.fr.


January 1993


4–9. Advances in Computational Mathematics, India International Center, New Delhi, India. (Feb. 1992, p. 149)


13–16. Joint Mathematics Meetings, San Antonio, TX. (including the annual meetings of the AMS, AWM, MAA, and NAM)

INFORMATION: H. Daly, AMS, P.O. Box 6887, Providence, RI 02940.


Meetings and Conferences


February 1993

1–3. IMA Minisymposium on Biological Control of Movement, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, MN. (Nov. 1991, p. 1172)


Program: The program will focus on Hamiltonian bifurcations, homoclinic chaos, quasiperiodic flows, dynamic bifurcations with symmetry and pattern formation, applications to the earth and biological sciences will also be stressed from the PDE, symmetry/group theoretic and lattice gas cellular automata viewpoints. There will be intensive course modules covering these topics.

Program Directors: J. Chadam (McMaster U.), L. Glass (McGill U.), W. Langford (Guelph), J. Marsden (Fields), and W.F. Shadwick (Fields).

Invited Speakers: D. Armbruster (Arizona State), L. Bates (Calgary), H. Broer (Groningen), S.-N. Chow (Georgia Tech), R. Cushman (Utrecht), G. Doole (Los Alamitos), G. Iooss (Nice), M. Field (Sydney), P. Fife (Utah), H. Freedman (Alberta), W. Gilbert (Waterloo), M. Golubitsky (Houston), B. Hasslacher (Los Alamitos), K. Haseyin (Waterloo), R. Kapral (Toronto), H. Keller (Caltech), B. Keyfitz (Houston), K. Kirchgasser (Stuttgart), E. Knobloch (Berkeley), M. Krupa (Groningen), A. Lawiczak (Guelph), J. Mallet-Paret (Brown), J. Marsden (Fields), B. Matkowsky (Northwestern), R. Miura (British Columbia), J. Murray (Washington), W. Nagata (British Columbia), S. Namachchivaya (Illinois), S. Newhouse (North Carolina), P. Ortoleva (Indiana), G. Oster (Berkeley), W. Peltier (Toronto), T. Ratiu (Santa Cruz), D. Rod (Calgary), D. Rothman (MIT), J. Sanders (Amsterdam), D. Sattin (Minnesota), J. Scheurle (Hamburg), I. Stewart (Warwick), F. Takens (Groningen), J. Tyson (VPI), A. Vanderbauwhede (Gent), S. van Gils (Eindhoven), E.R. Vrscay (Waterloo), B. Wetton (British Columbia), S. Wiggins (Caltech), and J. Wu (York).

Information: J. Chadam (McMaster, 416-525-9140, ext. 3426, chadam@fields.waterloo.edu), L. Glass (McGill, 514-398-4338, md56@music.mcgill.ca), W. Langford (Guelph, 519-824-4747, ext 6556, langford@fields.waterloo.edu); or E. Reidt, The Fields Institute for Research in Mathematical Sciences, 185 Columbia St. West, Waterloo, Ontario, Canada N2L 525; 519-725-0096; Fax: 519-725-0704; email: workshop@fields.waterloo.edu.


March 1993


Program: The program will focus on Hamiltonian bifurcations, homoclinic chaos, quasiperiodic flows, dynamic bifurcations with symmetry and pattern formation, applications to the earth and biological sciences will also be stressed from the PDE, symmetry/group theoretic and lattice gas cellular automata viewpoints. There will be intensive course modules covering these topics.

Program Directors: J. Chadam (McMaster), L. Glass (McGill), W. Langford (Guelph), J. Marsden (Fields), and W.F. Shadwick (Fields).

Invited Speakers: D. Armbruster (Arizona State), L. Bates (Calgary), H. Broer (Groningen), S.-N. Chow (Georgia Tech), R. Cushman (Utrecht), G. Doole (Los Alamitos), G. Iooss (Nice), M. Field (Sydney), P. Fife (Utah), H. Freedman (Alberta), W. Gilbert (Waterloo), M. Golubitsky (Houston), B. Hasslacher (Los Alamitos), K. Haseyin (Waterloo), R. Kapral (Toronto), H. Keller (Caltech), B. Keyfitz (Houston), K. Kirchgasser (Stuttgart), E. Knobloch (Berkeley), M. Krupa (Groningen), A. Lawiczak (Guelph), J. Mallet-Paret (Brown), J. Marsden (Fields), B. Matkowsky (Northwestern), R. Miura (British Columbia), J. Murray (Washington), W. Nagata (British Columbia), S. Namachchivaya (Illinois), S. Newhouse (North Carolina), P. Ortoleva (Indiana), G. Oster (Berkeley), W. Peltier (Toronto), T. Ratiu (Santa Cruz), D. Rod (Calgary), D. Rothman (MIT), J. Sanders (Amsterdam), D. Sattin (Minnesota), J. Scheurle (Hamburg), I. Stewart (Warwick), F. Takens (Groningen), J. Tyson (VPI), A. Vanderbauwhede (Gent), S. van Gils (Eindhoven), E.R. Vrscay (Waterloo), B. Wetton (British Columbia), S. Wiggins (Caltech), and J. Wu (York). Other participants to be announced, including the Fields Institute Fellows.

Information: J. Chadam (McMaster, 416-525-9140, ext. 3426, chadam@fields.waterloo.edu), L. Glass (McGill, 514-398-4338, md56@music.mcgill.ca), W. Langford (Guelph, 519-824-4747, ext 6556, langford@fields.waterloo.edu); or E. Reidt, The Fields Institute for Research in Mathematical Sciences, 185 Columbia St. West, Waterloo, Ontario, Canada N2L 525; 519-725-0096; Fax: 519-725-0704; email: workshop@fields.waterloo.edu.

24–25. Central Section, DePaul University, Chicago, IL.

Information: W. Drady, AMS, P.O. Box 6857, Providence, RI 02940.

28–April 3. Combinatorial Convexity and Algebraic Geometry, Oberwolfach, Federal
Meetings and Conferences

April 1993


9–10. Western Section, University of Utah, Salt Lake City, Utah.

Information: W. Drady, AMS, P.O. Box 6887, Providence, RI 02940.


May 1993


Program: The program will focus on Hamiltonian bifurcations, homoclinic chaos, quasiperiodic flows, dynamic bifurcations with symmetry and pattern formation, applications to the earth and biological sciences will also be stressed from the PDE, symmetry/group theoretic and lattice gas cellular automata viewpoints. There will be intensive course modules covering these topics.

Program Directors: J. Chadam (McMaster U.), L. Glass (McGill U.), W. Langford (Guelph), J. Marsden (Fields), and W.F. Shadwick (Fields).

Invited Speakers: D. Armbruster (Arizona State), L. Bates (Calgary), H. Broer (Groningen), S.-N. Chow (Georgia Tech), R. Cushman (Utrecht), G. Doolen (Los Alamos), G. Iooss (Nice), M. Field (Sydney), P. Fife (Utah), H. Freedman (Alberta), W. Gilbert (Waterloo), M. Golubitsky (Houston), B. Hasslacher (Los Alamos), K. Huseyin (Waterloo), R. Kapral (Toronto), H. Keller (Caltech), B. Keyfitz (Houston), K. Kirchgasser (Stuttgart), E. Knobloch (Berkeley), M. Krupa (Groningen), A. Lawniczak (Guelph), J. Mallet-Paret (Brown), J. Marsden (Fields), B. Matkowsky (Northwestern), R. Miura (British Columbia), J. Murray (Washington), W. Nagata (British Columbia), S. Namachchivaya (Illinois), S. Newhouse (North Carolina), P. Ortoleva (Indiana), G. Osier (Berkeley), W. Peltier (Toronto), T. Ratiu (Santa Cruz), D. Rod (California), D. Rothman (MIT), J. Sanders (Amsterdam), D. Sattinger (Minnesota), J. Scheurle (Hamburg), I. Stewart (Warwick), F. Takens (Groningen), J. Tyson (VPI), A. Vanderbauwhede (Gent), S. van Gils (Enschede), E.R. Vrscay (Waterloo), B. Wotton (British Columbia), S. Wiggins (Caltech), and J. Wu (York). Other participants are to be announced, including the Fields Institute Fellows.

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June 1993


Program: The program will focus on Hamiltonian bifurcations, homoclinic chaos, quasiperiodic flows, dynamic bifurcations with symmetry and pattern formation, applications to the earth and biological sciences will also be stressed from the PDE, symmetry/group theoretic and lattice gas cellular automata viewpoints. There will be intensive course modules covering these topics.

Program Directors: J. Chadam (McMaster U.), L. Glass (McGill U.), W. Langford (Guelph), J. Marsden (Fields), and W.F. Shadwick (Fields).

Invited Speakers: D. Armbruster (Arizona State), L. Bates (Calgary), H. Broer (Groningen), S.-N. Chow (Georgia Tech), R. Cushman (Utrecht), G. Doolen (Los Alamos), G. Iooss (Nice), M. Field (Sydney), P. Fife (Utah), H. Freedman (Alberta), W. Gilbert (Waterloo), M. Golubitsky (Houston), B. Hasslacher (Los Alamos), K. Huseyin (Waterloo), R. Kapral (Toronto), H. Keller (Caltech), B. Keyfitz (Houston), K. Kirchgasser (Stuttgart), E. Knobloch (Berkeley), M. Krupa (Groningen), A. Lawniczak (Guelph), J. Mallet-Paret (Brown), J. Marsden (Fields), B. Matkowsky (Northwestern), R. Miura (British Columbia), J. Murray (Washington), W. Nagata (British Columbia), S. Namachchivaya (Illinois), S. Newhouse (North Carolina), P. Ortoleva (Indiana), G. Osier (Berkeley), W. Peltier (Toronto), T. Ratiu (Santa Cruz), D. Rod (California), D. Rothman (MIT), J. Sanders (Amsterdam), D. Sattinger (Minnesota), J. Scheurle (Hamburg), I. Stewart (Warwick), F. Takens (Groningen), J. Tyson (VPI), A. Vanderbauwhede (Gent), S. van Gils (Enschede), E.R. Vrscay (Waterloo), B. Wotton (British Columbia), S. Wiggins (Caltech), and J. Wu (York). Other participants are to be announced, including the Fields Institute Fellows.

Information: J. Chadam (McMaster, 416-525-9140, ext. 3426, chadam@fields.waterloo.edu), L. Glass (McGill, 514-398-4338, md56@musica.mcgill.ca), W. Langford (Guelph, 519-824-4747, ext 6556, langford@fields.waterloo.edu); or E. Reidt, The Fields Institute for Research in Mathematical Sciences, 185 Columbia St. West, Waterloo, Ontario, Canada N2L 5Z5; 519-725-0096; Fax: 519-725-0704; email: workshop@fields.waterloo.edu.

August 1993


Program: Lectures, scientific sections; symposia; exhibitions; poster presentations; business and general meetings; tours, excursions, get-together meetings.

Information: XIX International Congress of History of Science, Facultad de Ciencias (Matematicas), Ciudad Universitaria, 50009 Zaragoza (Spain), Fax: 76-565852; Telex 58198 EDUC1-E; email: ichs@cc.unizar.es.

August 1994

GEOMETRY AND NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS
Vladimir Oliker and Andrejs Treibergs, Editors
(Contemporary Mathematics, Volume 127)

This volume contains the proceedings of an AMS Special Session on Geometry, Physics, and Nonlinear PDEs, held in March 1990 at the AMS meeting in Fayetteville. In recent years, there has been an enormous surge of activity in these areas, and there was an overwhelming response to invitations to the session. The conference brought together specialists in Monge-Ampere equations, prescribed curvature problems, mean curvature, harmonic maps, evolution with curvature-dependent speed, isospectral manifolds, and general relativity. Twenty-five half-hour addresses were presented at the session, and the majority of the papers in this volume are expositions of those addresses. The book provides an excellent overview of the frontiers of research in these areas.

Contents

John K. Beem and Phillip E. Parker, Null directions and curvature; Philippe Delanoe, Generalized stereographic projections with prescribed scalar curvature; Paul E. Ehrlich and Gerard G. Emch, The conjugacy index and simple astigmatic focusing; Michael E. Gage, On the size of the blow-up set for a quasilinear parabolic equation; S. I. Goldberg and D. Perrone, Contact 3-manifolds with positive scalar curvature; Bernhard Kawohl, Remarks on the operator div (Vu/|Vu|); Jeffrey M. Lee, Finite inverse spectral geometry; Robert C. McOwen, Conformal metrics with singularities and finite negative total curvature on Riemann surfaces; Peter Li, Andrejs Treibergs, and S. T. Yau, How to hear the volume of convex domains; Nina Uraltseva, Gradient estimates for solutions of nonlinear parabolic oblique boundary problem; S. Walter Wei, Liouville theorems and regularity of minimizing harmonic maps into super-strongly unstable manifolds.

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Recent Appointments

Committee members’ terms of office on standing committees expire on January 31 following the year given in parentheses following their names, unless otherwise specified.


An ad hoc Committee on Nominating Procedures has been appointed by President Michael Artin. Members of the committee are Chandler Davis, Robert M. Fossum (ex officio), Frank L. Gilfeather, Jerry L. Kazdan, Ray A. Kunze, James W. Maxwell (ex officio), and Ruth J. Williams. Professor Davis will serve as chair.

The following individuals have been elected by the Council upon recommendation of the Editorial Boards Committee:

Murray H. Protter (1994) to the Bulletin Editorial Committee; continuing members of the committee are Richard S. Palais (1992) and Frank S. Quinn (1993), chair;

Luis A. Caffarelli (1994) to the Colloquium Editorial Committee; G. D. Mostow (1993) has been appointed chair; the continuing member of the committee is H. Jerome Keisler (1992);

James H. Curry (1994) and Brian Markus (1994) to the Committee to Monitor Problems in Communication; continuing members of the committee are William Abikoff (1993), Jon Barwise (1992), Judy Green (1992), chair, William H. Jaco (ex officio), and Diane Meuser (1993);

Richard W. Beals (1994), Clark Robinson (1994), and Peter M. Winkler (1994) to the Contemporary Mathematics Editorial Committee; Professor Beals has also been appointed chair; continuing members of the committee are Craig Huneke (1992), and Linda Preiss Rothschild (1992);

H. Blaine Lawson, Jr. (1994) and Andrew M. Odlyzko (1994) to the Journal of the AMS; continuing members of the committee are Robert D. MacPherson (1993), Richard B. Melrose (1993), and Wilfried Schmid (1993), chair;

Robert E. Greene (1992), David W. McLaughlin (1994), and Marc A. Rieffel (1994) to the Mathematical Surveys and Monographs Editorial Committee; Professor Rieffel has also been appointed chair; the continuing member of the committee is Bhama Srinivasan (1993);

Andrew M. Odlyzko (1994) to the Mathematics of Computation Editorial Committee; continuing members of the committee are Walter Gautschi (1992), chair, Frank W. J. Olver (1993), and Lars B. Wahlbin (1992);


Upon recommendation of the Editorial Boards Committee, President Michael Artin has reappointed Harold M. Edwards (1994) and has appointed Guido Weiss (1994) to the History of Mathematics Editorial Committee. Professor Edwards has also been appointed chair. The continuing member of the committee is Charles W. Curtis (1993).

Jill P. Mesirov (1994) was reappointed to the Visiting Committee on Computer Operations and Facilities by then chair of the Board of Trustees, Frederick W. Gehring. Continuing members of the committee are Maria M. Klawe (ex officio), Richard Mandelbaum (1992), and Peter J. Wein...
Rodrigo Banuelos (1993) and Julia Knight (1993) have been appointed to the Central Section Program Committee by President Michael Artin. John M. Franks (1992) has been appointed chair. Continuing members of the committee are Andy Roy Magid (ex officio) and Jing-Mei Wu (1992).

President Michael Artin has appointed Roy Adler (1993) to the Eastern Section Program Committee. Lesley M. Sibner (1992) has been appointed chair. Continuing members of the committee are W. Wistert Comfort (ex officio), John C. Moore (1992) and Gregg J. Zuckerman (1993).

Jean Larson (1993) and Donald St. P. Richards (1993) have been appointed to the Southeastern Section Program Committee by President Michael Artin. Carl Pomerance (1992) has been appointed chair. Continuing members of the committee are Joseph A. Cima (ex officio) and Sue E. Goodman (1992).

President Michael Artin has appointed F. Michael Christ (1993) and Robert R. Phelps (1993) to the Western Section Program Committee. Ronald J. Stern (1992) has been appointed chair. Continuing members of the committee are Janos Kollar (1992) and Lance W. Small (ex officio).

Michael Atiyah, Cathleen S. Morawetz, Michael O. Rabin, and Thomas Spencer have been appointed to the Committee to Select the Gibbs Lecturer for 1993 and 1994 by President Michael Artin. Professor Spencer has also been appointed chair.


President Michael Artin has appointed Mary B. Martin (1994) and De Witt Summers (1994) to the Pi Mu Epsilon Liaison Committee. Eileen Poiani (1992) has been appointed chair. Continuing members of the committee are David W. Ballew (1993), Lynne M. Butler (1993), and Bruce Reznick (1993).

Donald J. Lewis (1994) and Albert Marden (1994) have been appointed by President Michael Artin to the Committee on Professional Ethics. Continuing members of the committee are Leonard D. Berkovitz (1993), Everett Pitcher (1992), chair, and Judith Roitman (1993).


An ad hoc Employment Task Force Committee has been appointed by President Michael Artin. Members of the committee are S.-Y. Cheng, Ronald M. Davis, Helen G. Grundman, D. J. Lewis, chair, Bernard L. Madison, James W. Maxwell (ex officio), Donald E. McClure, Calvin C. Moore, and Carol S. Wood.

Kenneth M. Hoffman (1996) has been appointed by President Michael Artin to the Committee to Select the Winner of the Award for Public Service. William Browder (1995) has been appointed chair. Continuing members of the committee are Robert M. Fossum (1992), John C. Polking (1994), and David P. Roselle (1993).

Joan S. Birman (1993) and Richard S. Palais (1993) have been appointed to the Committee on National Awards and Public Representation by President
Michael Artin. Continuing members of the committee are Michael Artin (ex officio), chair, Robert M. Rossum (ex officio), and Ronald L. Graham (ex officio).

Dusa McDuff (1993) and Alan D. Weinstein (1993) have been appointed by President Michael Artin to the Committee to Select the Winner of the Satter Prize for 1993. Professor McDuff has also been appointed chair. The continuing member of the committee is Joan S. Birman (1992).

An ad hoc Committee on AMS Prizes and Awards has been appointed by President Michael Artin. Members of the committee are Joan S. Birman, Frederick W. Gehring, Ronald L. Graham, Joseph J. Kohn, Gian Carlo Rota, and Joseph L. Taylor.

President Michael Artin has appointed Efrem P. Armendariz (ex officio), Alfred W. Hales (1993), Raymond Johnson (ex officio), Philip C. Kutzko (1993), Louise Raphael (1993), V. Frederick Rickey (ex officio), Mary Beth Ruskai (1993), Chih-Han Sah (ex officio), and Melvin Thornton (ex officio) to the Liaison Committee with AAS.

Donald L. Burkholder (1995) and Melvin Hochster (1995) have been appointed to the Committee on Summer Institutes and Special Symposia by President Michael Artin. Continuing members of the committee are Lawrence Craig Evans (1994), Nicholas Katz (1993), Francois Treves (1993), and Edward Witten (1994). Terms expire on February 28.


Luchezar Avramov (AMS, 1994) and Igor Dolgachev (AMS, 1994) have been appointed to the joint AMS-ASL-IMS-SIAM Committee on Translations from Russian and Other Slavic Languages by President Michael Artin. Upon recommendation of the Editorial Boards Committee, President Michael Artin reappointed Peter S. Landweber (AMS, 1992) and as chair. Continuing members of the AMS subcommittee are V. I. Arnol’d, consultant, S. G. Gindikin, consultant, Askold Georgievic Khovanski, consultant, Arunas Liulevicius (1993), N. K. Nikol’ski, consultant, and Washek Pfeiffer (1993). The ASL subcommittee members are Vladimir Lifschitz (1993), Elliott Mendelson (1992), chair, Grigori Mints (1993), Benjamin F. Wells (1992), and Boris I. Zilber (1994). The IMS subcommittee members are M. I. Freidlin, chair, B. Pittel, A. Rukhin, and W. J. Studden.

President Michael Artin appointed Spencer Bloch (AMS), Dusa McDuff (AMS), and Nancy K. Stanton (AMS) to the AMS-CMS Joint Program Committee. Continuing members of the committee are David W. Boyd (CMS), Carl Herz (CMS), chair, Victor P. Snaith (CMS).

 Presidents Deborah T. Haimo (MAA) and Michael Artin (AMS) have reappointed John D. Fulton (MAA, 1994) and James F. Hurley (AMS, 1994) to the joint AMS-MAA Data Committee. Continuing members of the committee are Edward A. Connors (AMS, 1993), Lincoln K. Durst, consultant, Charlotte Lin (AMS, 1992), Don O. Loftsgaarden (MAA, 1993), David J. Lutzer (MAA, 1993), James W. Maxwell (ex officio), Donald E. McClure (AMS, 1993), chair, and Donald C. Rung (AMS, 1992).

Deborah Hughes Hallett (AMS, 1993), Timothy L. Lance (AMS, 1994), and Daniel J. Madden (AMS, 1994) have been appointed to the joint AMS-MAA Committee on Teaching Assistants and Part Time Instructors (TA/PTI) by President Michael Artin. Continuing members of the committee are Thomas F. Banchoff (AMS, 1992), John P. Huneke (MAA, 1992), chair, Shelba J. Morman (MAA, 1992), and Stephen B. Rodi (MAA, 1994).

Shair Ahmad, Don Bailey, Carol Redfield, David A. Sanchez, Gene Sims, and Betty Travis have been appointed by Presidents Deborah T. Haimo (MAA) and Michael Artin (AMS) to the joint AMS-MAA Arrangements Committee for the San Antonio Meeting. Shair Ahmad has been appointed chair. W. Wistar Comfort, William H. Jaco, Kenneth A. Ross, and Marcia P. Sward will serve ex officio.

Richard Askey (MAA), Hermann Flaschka (AMS), Roger Horn (MAA), and Richard A. Tapia (AMS) have been appointed to the AMS-MAA Joint Program Committee for the San Antonio Meeting by Presidents Deborah T. Haimo (MAA) and Michael Artin (AMS). Professor Horn will serve as chair.

Frank R. Demeyer (AMS, 1994) has been appointed by President Michael Artin to the AMS-MAA-SIAM Joint Committee on Employment Opportunities. Continuing members of the committee are Stanley Benkoski (AMS, 1993), Peter E. Castro (SIAM, 1992), Ronald M. Davis (MAA, 1993), James W. Maxwell (ex officio), S. Brent Morris (MAA, 1994), chair, and Leon H. Seidelman (SIAM, 1994).

President Robert E. O’Malley, Jr. (SIAM) and Michael Artin (AMS) have appointed Marsha J. Berger (1994) and Paul C. Fife (1994) to the joint AMS-SIAM Committee on Applied Mathematics. James M. Hyman (1993) has been appointed chair. Continuing members of the committee are Andrew J. Majda (1992), Michael Shub (1993), and Joel Spencer (1992).

President Michael Artin appointed Efrem P. Armendariz (Section Q, 1995), Raymond Johnson (Section A, 1995), V. Frederick Rickey (Section L, 1995), Chih-Han Sah (Section B, 1995), and Melvin Thornton (Section T, 1995) as representatives to the American Association for the Advancement of Science. Terms expire on February 21.
Officers of the Society
1991 and 1992
Except for the Members-at-Large of the Council, the month and year of the first term and the end of the present term are given. For Members-at-Large of the Council, the last year of the present term is listed.

COUNCIL
President
Michael Artin 2/91–1193
Ex-President
William Browder 2/91–1192
President-Elect
Ronald L. Graham 2/92–1193
Vice Presidents
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Chandler Davis 2/91–1/94
Linda Keen 2/92–1/94
Dennis P. Sullivan 1/90–1/92
Secretary
Robert M. Fossum 1/89–1/93
Associate Secretaries
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W. Wistar Comfort 1/83–1/93
Andy Roy Magid 1/88–1/94
Lance W. Small 1/88–1/94

MEMBERS-AT-LARGE
All terms are for 3 years and expire on January 31 following the year given.
1991
Jonathan L. Alperin
Fan R. K. Chung
Lawrence J. Corwin
Michael C. Reed
Hugo Rossi

1992
Sheldon Axler
Joan S. Birman
Charles Herbert Clemens
Carl Pomerance
Shing-Tung Yau

1993
David A. Cox
John M. Franks
Frank Gilfeather
Steven H. Weintraub
Ruth J. Williams

1994
Ruth M. Charney
Carl C. Cowen, Jr.
Rebecca A. Herb
Elliott H. Lieb
Gunther A. Uhlmann

MEMBER OF EXECUTIVE COMMITTEE
Members of the Council, as provided for in Article 7, Section 4 (last sentence) of the Bylaws of the Society.
Arthur M. Jaffe 2/91–1/95
Hugo Rossi 1/89–1/93
William P. Thurston 1/90–1/92

PUBLICATIONS AND COMMUNICATIONS COMMITTEES
Bulletin Editorial Committee
Richard S. Palais 1/90–1/93
Frank S. Quinn 2/91–1/94

Colloquium Editorial Committee
Charles L. Fefferman 1/86–1/92
G. D. Mostow 2/91–1/94

Journal of the AMS
Wilfried Schmid 1/87–1/94

Mathematical Reviews Editorial Committee
B. A. Taylor 1/90–1/93

Mathematical Surveys and Monographs Editorial Committee
Victor W. Guillemin 1/87–1/92
Marc A. Rieffel 1/90–1/95

Mathematics of Computation Editorial Committee
Walter Gautschi 1/84–1/93

Chair, Committee on Science Policy
Michael C. Reed 1/90–1/92
Frank W. Warner III 2/92–1/93

Chair, Committee to Monitor Problems in Communication
Judy Green 1/92–1/93
Arthur M. Jaffe 2/91–1/92

Proceedings Editorial Committee
William J. Davis 1/88–1/92
Irwin Kra 2/91–1/95

Representative on the American Journal of Mathematics
M. Salah Baouendi 1/88–1/93

Transactions and Memoirs Editorial Committee
James E. Baumgartner 1/88–1/95
David J. Saltman 1/90–1/92

BOARD OF TRUSTEES
Steve Armentrout
(ex officio) 7/77–1/93
Michael Artin
(ex officio) 2/91–1/93
Frederick W. Gehring 1/83–1/93
Ronald L. Graham 1/82–1/92
Maria M. Klawe 2/92–1/97
M. Susan Montgomery 1/86–1/96
Franklin P. Peterson
(ex officio) 8/73–1/93
John C. Polking 1/90–1/95
Paul J. Sally, Jr., 1/84–1/94

AMS Reports and Communications
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).

<table>
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### Research Journals Backlog

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Contains expositions of some of the main trends in research in Lie groups, representation theory and their applications, and shorter articles that contain new results in related fields. All articles are based on lectures given at an international conference that was attended by both graduate students and researchers in the field; the lectures were geared to both levels of the audience, which means that the material in this volume has been "pretested" on an audience of precisely the type for which it is aimed.

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A. Isidori, Università di Roma "La Sapienza"; and T. J. Tarn, Washington University (Eds.)
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Editor: R. Lowen, University of Antwerp, Belgium
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The primary goal of the journal is to promote communication and increased dissemination of new results and ideas among mathematicians and computer scientists who use categorical methods in their research.

The journal focuses on applications of results, techniques and ideas from Category Theory to Mathematics, in particular Algebra, Analysis, Order and Topology and to Computer Science.

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