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In Honor of Jacques Carmona
P. Delorme, Institut de Mathématiques de Luminy, Marseille, France, and M. Vergne, École Polytechnique, Palaiseau Cedex, France (Eds.)

This volume is devoted to the theme of noncommutative harmonic analysis and honors Jacques Carmona, whose scientific interests range through all aspects of Lie group representations. Topics include the theory of representations of reductive Lie groups, and especially the determination of the unitary dual, the problem of geometric realizations of representations, harmonic analysis on reductive symmetric spaces, the study of automorphic forms, and results in harmonic analysis that apply to the Langlands program. General Lie group matters are also discussed, particularly from the orbit method perspective. Also covered is Kottwitz quantization, which has appeared in recent years as a powerful tool. Contributors include Baldoni, Barbasch, Barchini, Bieliavsky, Bouaziz, Delorme, Van Den Ban, Harinck, Hersant, Khalgui, Knapp, Kostant, Llibre, Mantini, Pevzner, Rossmann, Rubenthaler, Schmidt, Torasso, and Vergne.

2003/APPX: 384 PP./HC./$54.95 (TENT.)
ISBN 0-8176-4333-8
PROGRESS IN MATHEMATICS

Forthcoming!

Rigid Analytic Geometry and its Applications
Second Edition
J. Fresnel, Université de Bordeaux 1, Talence, France, and M. Van Der Put, University of Groningen, The Netherlands

This new English edition of Rigid Analytic Geometry and its Applications has been revised and expanded from the original French text of the 1980s. Apart from a thorough introduction to the basics of rigid analytic spaces, this work presents new developments and applications to "points of rigid spaces," (local) topology, Drinfeld modular curves, Shimura varieties, and symmetric spaces. A final chapter treats rigid methods, which led to the solution of Abhyankar's problem and other results on the Galois theory of function fields. The exposition is concise, self-contained, rich in examples and exercises, and will serve as an excellent graduate-level introductory text for the classroom or for self-study. It will also benefit researchers in areas of mathematics such as valuation theory, number theory, and algebraic geometry.

2003/APPX: 320 PP., 10 ILLUS./HC./$59.95 (TENT.)
ISBN 0-8176-4206-4
PROGRESS IN MATHEMATICS

Forthcoming!

Coxeter Matroids
A. Borovik, University of Manchester, Institute of Science and Technology (UMIST), Manchester, UK, I. M. Gelfand, Rutgers University, Piscataway, NJ, and N. White, University of Florida, Gainesville, FL

Matroids appear in diverse areas of mathematics, from combinatorics to algebraic topology and geometry, and this text provides an intuitive and interdisciplinary treatment of their theory. Matroids are examined in terms of symmetric and finite reflection groups; also, symplectic matroids and the increasingly general Coxeter matroids are carefully developed. The Gelfand-Serganova theorem is presented and in the final chapter matroid representations and combinatorial flag varieties are discussed. With its many exercises and ample references to current research, Coxeter Matroids can be used as an introductory survey, as a graduate course or seminar text, or as a reference.

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ISBN 0-8176-4333-8
PROGRESS IN MATHEMATICS

New!

An Introduction to Dirac Operators on Manifolds
J. Cnops, Gent Polytechnic, Gent, Belgium

This volume explores the basic ideas underlying the concept of Dirac operators. Starting with Clifford algebras and the fundamentals of differential geometry, the text focuses on two main properties, namely, conformal invariance, which determines the local behavior of the operator, and the unique continuation property dominating its global behavior. Spin groups and spinor bundles are covered, as well as the relations with their classical counterparts, orthogonal groups and Clifford bundles. The book's treatment requires very little prior knowledge beyond complex analysis. The material on Clifford algebras and differential geometry is a suitable introduction for senior undergraduate and graduate students; more advanced readers will appreciate the fresh theoretical approach and the many new results.

2002/224 PP./HC./$49.95
ISBN 0-8176-4298-6
PROGRESS IN MATHEMATICAL PHYSICS, VOL. 24

New!

Mathematical Methods in Physics
Distributions, Hilbert Space Operators, and Variational Methods
P. Blanchard, University of Bielefeld, Germany; and E. Brüning, University of Darms­tadt-Winterberg, Darmstadt, South Africa

Driven by historic motivations, excellent examples, detailed proofs, this volume focuses on the mathematics needed for more advanced courses on quantum mechanics and classical and quantum field theory. Includes a comprehensive bibliography and index. Aimed primarily at a broad community of graduate students in mathematics, mathematical physics, physics, and engineering, as well as researchers in these disciplines.

2002/496 PP., 20 ILLUS./HC./$79.95
PROGRESS IN MATHEMATICAL PHYSICS, VOL. 26

New!

Foundations of Classical Electrodynamics
F. H. Hehl, University of Cologne, Germany; and Y. N. Obukhov, Moscow Lomonosov State University, Russia

This book presents the foundations of classical electrodynamics with particular attention to mathematical axioms based on physical concepts. The text is divided into four parts and unfolds systematically at a level suitable for advanced undergraduates and graduate students in mathematics and physics. Includes rigorous proofs, examples, open questions for new research, exercises, bibliography and index.

2003/APPX: 330 PP., 20 ILLUS./HC./$59.95 (TENT.)
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Attracting Ph.D.'s to K-12 Education

Are you—or is someone you know—a current Ph.D. student or new Ph.D. with an interest in K-12 education? Would you want to have a two-year postdoctoral fellowship to test your interest and ability in K-12 education? A recent report by a committee of the National Research Council of the National Academy of Sciences (available at http://www.nap.edu/catalog/10433.html) highlights the positive impact of a new program to attract science, mathematics, and engineering Ph.D.'s to careers in K-12 education. This report represents the second phase of a three-phase project to explore the possibilities of attracting Ph.D.'s to K-12 education in formal educational settings as well as informal ones, such as science museums. The first phase of the project surveyed recent Ph.D.'s in science and mathematics to gauge their interest in pursuing careers in secondary education. Analysis of this data suggests that a significant percentage of Ph.D.'s would be interested under the right circumstances.

The second phase of the project presents the case for pilot programs for preparing Ph.D.'s to be productive members of the K-12 mathematics and science education community. The focus is not on unemployed Ph.D.'s. Rather, the focus is on those who toward the end of their Ph.D. studies develop a strong interest in K-12 education and wish to reorient their career intentions in this direction. These Ph.D.'s may become K-12 teachers but more than likely would become mathematics and science specialists who help improve teachers' content knowledge and understanding of the processes of mathematics and science. Such specialists may also be the next generation of college faculty in arts and sciences or engineering who work closely with schools of education to prepare teachers with strong mathematical-content knowledge.

In phase three, pilot programs will be sponsored in some states to support new and recent Ph.D.'s as postdoctoral fellows for two years as they learn classroom practice and pedagogy and work under supervision as teachers in schools. It is expected that federal agencies and foundations will fund the national program, which will support the first year of the fellowships; the school systems will support the second year.

Both in the phase one survey and in focus groups convened by the committee for the second phase, many current Ph.D. students and recent Ph.D. recipients conveyed a great deal of interest in K-12 education. They also indicated that working in K-12 education does not garner much respect. However, those surveyed and consulted believe that a prestigious national fellowship could have an enormous impact on the way Ph.D.'s in K-12 education would be perceived by the mathematics and science community at large. Extraordinary mathematicians, like AMS President Hyman Bass, who have turned their attention to elementary mathematics education, are providing great validity for research mathematicians who work in K-12 education. Since September 11, 2001, more and more young people are searching for ways to serve society, and teaching is one such way; thus teaching has become a much more appealing profession. Nationally, the number of bachelor's degree recipients returning to college to obtain teaching certification has nearly doubled this year. The teaching licensure program at the University of Colorado at Denver enrolled more than 350 students in fall 2002, compared to 150 the previous year, and half of them want to teach mathematics and science at the middle and high school levels. The downturn in the technology economy accounts for some of this increase, but surveys indicate that more of it comes from the response to 9-11.

Is it possible for someone to move into the K-12 education arena after having gone through a long, demanding, difficult Ph.D. program in mathematics that required a narrow concentration on problems at the cutting edge of his or her subfield? The committee that wrote this report believes the answer is yes, with help. The ingredients necessary for such a transition include a thorough grounding in how to teach, whether or not the Ph.D.'s actually become teachers, and a fundamental understanding of schools and classrooms in this country.

Fully one-third of the graduate students and postdocs surveyed in phase one have considered K-12 education. What are the "right" circumstances that would encourage mathematics Ph.D.'s to participate in a pilot program of the type described in the report? One is the opportunity to secure a prestigious national fellowship that would give them credibility with their peers and with mathematics faculty. Secondly, they need support and encouragement from people who are in the K-12 education system and from researchers so that the fellows can continue their research should they choose to do so.

Planning for the pilot programs is now under way, and an announcement about the availability of the fellowships should appear in spring 2003. Mathematics Ph.D. students and recent Ph.D. recipients are encouraged to apply for these fellowships. The rewards are great.

—Margaret (Midge) Cozzens
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Letters to the Editor

Galois Fields

I would like to do justice to Évariste Galois, whose role in introducing finite fields has been misrepresented in Shreeram S. Abhyankar's charming article "Three ways of measuring distance, three orbits, three subdegrees, or the great theorems of Cameron and Cantor" [August 2002]. In fact, not only the finite fields of prime order were discovered by Galois, but full credit should be given to him for constructing finite fields in general. In one of the few papers published during his short lifetime, entitled "Sur la théorie des nombres", which appeared in the Bulletin des Sciences Mathématiques in June 1830, Galois— at that time not even nineteen years old—defined finite fields of arbitrary prime power order and established their basic properties, e.g. the existence of a primitive element. So it is fully justified when finite fields are called Galois fields and customarily denoted by \( GF(q) \). It is also worth mentioning that he used this concept for investigating the solvability of primitive equations.

—Péter P. Pálfy
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(Received October 29, 2002)

Shortage of Doctorates in Mathematics Education: An Update

During the last two years the shortage of doctorates in mathematics education has been reported in the Notices (see November 2000 and February 2002). This letter provides a brief report from a recent survey of positions in mathematics education. About 95 percent of the 88 institutions announcing 111 positions for doctorates in mathematics education responded. The findings were consistent with survey results reported for the two previous years; namely, the shortage of doctorates in mathematics education continues. In fact, it may be getting worse.

More specific findings include: (1) The positions are about evenly split between appointments in mathematics departments or schools of education. (2) Of the positions announced, about 40 percent of the positions in mathematics departments and 35 percent of the positions in departments or schools of education were unfilled for the 2002-2003 academic year. (3) About one-third of the new hires that were made resulted from a faculty member moving from one institution to another. (4) Salaries for assistant professors ranged from \$30,000\) to \$70,000, but the most frequent salary was between \$40,000 and \$50,000.

The above findings are consistent with the current supply line of new doctorates in mathematics education. Typically, there are less than 100 new graduates in the United States each year with a doctorate in mathematics education. Research suggests that due to other job opportunities, only about one-half of these new graduates seek new positions in higher education in the United States. One new finding from this survey is the number (about one-third) of mathematics education faculty that changed institutions. That is, they had a mathematics education position in one institution but applied for and accepted a similar position in a different institution. While this represented a hire for one institution, it created a new position for another institution and likely means that institution will be short a faculty member for the next year while they conduct a search.

The job opportunities for doctorates in mathematics education (whether new graduates or faculty interested in changing positions) are great. The projected openings for doctorates in mathematics education for the 2003-2004 academic year will continue to exceed the number of new doctorates entering the profession.

These results can be viewed as good news for folks with doctorates in mathematics education who are looking for jobs and chilling news for institutions that are competing for these people. One bit of good news on the horizon is that the Centers for Teaching and Learning being supported by the National Science Foundation are getting established, and if successful, several of these centers will be significantly increasing the number of new doctorates in mathematics education. In the meantime, I hope the mathematics community will continue to alert graduate students in mathematics to the opportunities available for those interested in pursuing careers in mathematics education.

—Robert Reys
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(Received November 18, 2002)
New releases

Hans Föllmer, Alexander Schied

[Stochastic Finance]
An Introduction in Discrete Time
Cloth US$ 59.95
ISBN 3-11-017119-8
(de Gruyter Studies in Mathematics, 27)

This book is an introduction to financial mathematics. It is intended for graduate students in mathematics and for researchers working in academia and industry. The focus on stochastic models in discrete time has two immediate benefits. First, the probabilistic machinery is simpler, and one can discuss right away some of the key problems in the theory of pricing and hedging of financial derivatives. Second, the paradigm of a complete financial market, where all derivatives admit a perfect hedge, becomes the exception rather than the rule. Thus, the need to confront the problems arising in incomplete financial market models appears at a very early stage.

The first part of the book studies a simple one-period model that serves as a building stone for later developments. Topics include the characterization of arbitrage-free markets, the representation of preferences on asset profiles by expected utility theory and its robust extensions, monetary measures of risk, and an introduction to equilibrium analysis. In the second part, the idea of dynamic hedging of contingent claims is developed in a multiperiod framework. Such models are typically incomplete. They involve intrinsic risks that cannot be hedged away completely. Topics include martingale measures, pricing formulas for derivatives, American options, superhedging, and hedging strategies with minimal shortfall risk. Markets are modeled on general probability spaces. Thus, the text captures the interplay between probability theory and functional analysis, which has been crucial for recent advances in mathematical finance.

Contents:

Part I. Mathematical finance in one period: Arbitrage theory - Preferences · Optimality and equilibrium · Monetary measures of risk · Part II. Dynamic hedging: Dynamic arbitrage theory · American contingent claims · Superhedging · Efficient hedging · Hedging under constraints · Minimizing the hedging error · Appendix · Notes · References · List of symbols · Index

Valerii Gromak, Ilpo Laine, Susumu Shimomura

[Painlevé Differential Equations in the Complex Plane]
Hardcover. US$ 89.95
ISBN 3-11-017379-4
(de Gruyter Studies in Mathematics, 28)

This book is the first comprehensive treatment of Painlevé differential equations in the complex plane. Starting with a rigorous presentation for the meromorphic nature of their solutions, the Nevanlinna theory will be applied to offer a detailed exposition of growth aspects and value distribution of Painlevé transcendents.

The main part of the book is devoted to topics of classical background. These include representations and expansions of solutions; solutions of special type, such as rational and special transcendental solutions; Bäcklund transformations and higher analogues, treated separately of each of the Painlevé equations. The final chapter offers short overview of applications of the equations, including an introduction to their discrete counterparts.

Due to the present important role of Painlevé equations in physical applications, this monograph should be of interest to researchers in both mathematics and physics and to graduate students interested in mathematical physics and the theory of differential equations.

Contents:

Meromorphic nature of solutions · Growth of Painlevé transcendents · Value distribution of Painlevé transcendents · The first Painlevé equation (P₁) · The second Painlevé equation (P₂) · The fourth Painlevé equation (P₄) · The third Painlevé equation (P₃) · The fifth Painlevé equation (P₅) · The sixth Painlevé equation (P₆) · Applications of Painlevé equations

Please place your order with your local bookseller or order directly from us. Prices are subject to change.
In May 2002 Stephen Wolfram finally unveiled his self-proclaimed masterpiece, *A New Kind of Science* (hereinafter referred to as ANKS). Published by Wolfram's own company, the 1,280-page volume contains his thoughts on everything from the physics of the universe to the mysteries of human behavior, all based on the results of several years of analyzing the graphical output of some very simple computer programs.

The scope of the book is impressive, covering a bewildering variety of mathematical models and illustrated by 973 high-resolution black and white pictures. There are whole chapters devoted to biology, physics, and human perception, with shorter sections touching on such unexpected subjects as free will and extraterrestrial art. The extensive historical and technical notes at the end of the book (349 pages of small print) provide fascinating background material.

The primary mathematical focus of the book is a class of discrete-time dynamical systems called cellular automata, or "CAs." (See the next section for definitions and examples.) Back in the 1980s, Wolfram introduced several ideas that had a significant impact on CA research, and he also discovered a number of specific CAs with intriguing properties. His activities in this direction were interrupted when he became occupied with the development and promotion of Mathematica. But he felt that the ideas in several of his CA papers had never really been "absorbed" by other scientists (ANKS, p. 882), so in 1991 he began work on the book that he hopes will start a scientific revolution.

Do we need this revolution? According to Wolfram, "traditional" mathematics and science are doomed: mathematics because of its emphasis on rigorous proof, and science because of its preference for models that can make accurate predictions. He says that the most interesting problems presented by nature are likely to be formally undecidable or computationally irreducible (ANKS, pp. 7, 794-5, and 1138), rendering proofs and predictions impossible. Mathematicians and scientists have managed to keep busy only by carefully choosing to work on the relatively small set of problems that have simple solutions (ANKS, p. 3).

There is more: most mathematical models in science are based on the assumption that time and space are continuous, whereas Wolfram says that time and space are discrete. He would have us
abandon models based on calculus and Euclidean geometry in favor of discrete systems like CAs (ANKS, p. 8). Indeed, he sees the entire universe as a CA-like system that likely follows a simple dynamical rule, and the better part of Chapter 9 consists of some clever speculation on the exact nature of such a rule.

To make his argument convincing, Wolfram needed a simple CA that was capable of highly complex behavior. Enter the CA known as "Rule 110", whose dynamical rule is about as simple as possible, as you will see later in this review. The model was discovered by Wolfram in the 1980s, when he conjectured that its behavior was "universal", meaning that it could be used to simulate a universal Turing machine. The conjecture was proved in the 1990s by Matthew Cook, a former employee of Wolfram Research.

Rule 110 is featured prominently throughout ANKS, and it provides the primary motivation for Wolfram's scientific philosophy, which is that the key to understanding complex behavior can be found in very simple discrete systems. He has been pushing this idea for twenty years. But in ANKS we find a much more provocative version, the "Principle of Computational Equivalence", which we are told is a "new law of nature" that "has vastly richer implications than...any [other] single collection of laws in science" (ANKS, pp. 720 and 726). The entire final chapter of the book is devoted to this principle, but, surprisingly, Wolfram does not provide us with a definitive statement of it. Here is my attempt, pieced together from various phrases in Chapter 12 of ANKS:

Except for those trajectories that are obviously simple, almost all of the trajectories of a (natural or theoretical) dynamical system can be viewed as computations of equivalent sophistication, which is to say that they are universal (see ANKS, pp. 716–9).

Thus, if you observe a trajectory of some system, such as a CA or a differential equation or the weather or even a bucket of rusting nails, then either you will see something that is obviously simple, or else arbitrarily complex computations will pass before your eyes.

Wolfram's attitude toward traditional mathematics and science is consistent with his principle. After all, if everything nontrivial behaves like a universal Turing machine, then it is a waste of time to try to find ways to predict anything that is not already obvious. He advises scientists to start doing what he has been doing for the past two decades, which is to systematically explore simple CAs and related discrete systems, searching for models to match various interesting natural phenomena. The Principle of Computational Equivalence seems to suggest that such models are out there somewhere, and Wolfram provides many examples from all areas of science to try to show us that they can actually be found.

Am I convinced? Not really. Wolfram's brand of computer experimentation is a potentially powerful scientific tool. Indeed, I find that by far the most valuable aspect of the book is that it brings together so many interesting examples of CAs and related models that first found the light of day in one of his computer searches. But can he really justify statements like this: "...the new kind of science that I develop in this book is for the first time able to make meaningful statements about even immensely complex behavior" (ANKS, p. 3)?

Wolfram loves to tell us why other scientific theories cannot handle complexity. But in these discussions, he badly mischaracterizes his competition. Here is a typical example: "The field of nonlinear dynamics is concerned with analyzing more complicated equations [than linear ones]. Its greatest success has been with so-called soliton equations for which careful manipulation leads to a property similar to linearity. But the kinds of systems that I discuss in this book typically show much more complex behavior, and have no such simplifying properties" (ANKS, pp. 15–6). He is particularly hard on chaos theory, which he more or less reduces to a trivial observation about sensitive dependence on initial conditions: "Indeed, all that it shows is that if there is complexity in the details of the initial conditions, then this complexity will eventually appear in the large-scale behavior of the system" (ANKS, p. 13). He claims to have examples of dynamical systems that exhibit chaotic behavior without sensitive dependence on initial conditions. But his examples are highly questionable, as I will later explain when I discuss his notion of "intrinsic randomness generation".

Wolfram provides very little hard evidence for the Principle of Computational Equivalence. The key phrase "obviously simple" is pretty much left undefined, except to say that it covers systems that are attracted to periodic orbits or follow some other easily detectable pattern. Even when the principle is taken at face value, serious doubts about both its validity and practical significance have been raised (see the list of reviews given below). I will raise a few more later on, when I discuss his notion of fault-tolerant computation and universal CAs.

Despite the provocative attitude and high-minded speculation, there is plenty to enjoy in the book, especially the very accessible and very extensive coverage of so many different kinds of discrete models. In addition to CAs, we find mobile cellular automata, Turing machines, substitution systems, sequential substitution systems, tag systems, cyclic tag systems, register machines, and causal networks. For each type of system, Wolfram presents
and carefully explains numerous examples, expertly illustrated by instructive and thought-provoking graphics. I am familiar with Turing machines, for example, but had not seen their workings graphically depicted as in ANKS. Interesting statistics are given about the range of behaviors in these systems, based on Wolfram's own computer experiments.

It is also a lot of fun watching Wolfram find connections with the real world. Some of them are original to Wolfram, many are not, and it is unfortunately not always so easy to determine which is which. But it is great having them all together in one book. Particularly impressive is the chapter where he attempts to capture modern physics, including relativity theory and quantum mechanics, in a CA-like system. Scott Aaronson's review (see below) points out a serious mathematical flaw in this section, and Wolfram's model bears similarity to earlier work that is not acknowledged, but the result is impressive and intriguing nonetheless.

In general, the book is easy for the nonexpert to read but difficult for the expert to use. The main part of the text provides a nice nontechnical introduction to many topics, but the accompanying notes in the back of the book are hampered by Wolfram's preference for expressing formulas and equations in the language of Mathematica. Bibliographic references are entirely lacking, except for a list of Wolfram's own publications. The historical notes are quite thorough, but at the same time they are heavily biased towards Wolfram's own accomplishments.

My review, like others that have appeared, cannot cover all aspects of ANKS. So I recommend that you also look at the following (given in the approximate order in which I learned of them). All of them can be easily found online.

1. "Reflections on Stephen Wolfram's A New Kind of Science" by Ray Kurzweil. (Ably criticizes the conclusions that Wolfram draws from his Principle of Computational Equivalence.)

2. Book review by Leo Kadanoff for Physics Today, July 2002. (Provides a balanced perspective on Wolfram's contributions to science while questioning whether they add up to a whole new kind of science.)

3. Book review by Scott Aaronson for Quantum Information and Computing, September 2002. (Proves that Wolfram's proposed discrete model for the universe cannot accommodate both special relativity and Bell's inequality violations.)

4. Book review by Henry Cohn for MAA Online, June 2002. (Addresses the existence of levels of complexity that lie between the two extremes found in the Principle of Computation Equivalence.)

5. Book review by Ben Goertzel for Extropy, June 2002. (Amplifies and strengthens Kurzweil's criticisms and questions Wolfram's rejection of natural selection as a significant factor in evolution.)


7. "Blinded by Science" by Jordan Ellenberg, in Slate, posted on July 2, 2002. (This is a most entertaining and intelligent review.)

8. "Is the Universe a Universal Computer?" by Melanie Mitchell, in Science, October 4, 2002. (Takes Wolfram to task for several of his grandiose assertions.)

Each of these articles finds something significant to praise in ANKS (clarity, enthusiasm, expert coverage, fresh perspectives, etc.) while at the same time drawing attention to serious difficulties.

In the remainder of my review, I will focus on various mathematical issues raised by Wolfram's presentation of the theory of CAs. I have some familiarity with CAs, since my own area of research centers on their stochastic cousins, known as probabilistic cellular automata, or PCAs. My current research concerns PCA models of traffic jams.

**Cellular Automata**

A CA is a deterministic dynamical system, consisting of an array  of identical finite machines or cells that repeatedly change states or colors by following an update rule $U$. This rule is applied simultaneously to all of the cells in $\Lambda$ at discrete time units. When $U$ is applied to a particular cell $x \in \Lambda$, the new color for $x$ is determined by the current colors of the cells in the neighborhood of $x$, denoted by $N_x$.

Although there are many interesting choices for $\Lambda$, I will restrict my attention to the $d$-dimensional integer lattice $\mathbb{Z}^d$, usually with $d = 1$ or $d = 2$. When $d = 1$, the neighborhood of a cell $x$ is the interval $N_x = \{ y \in \mathbb{Z} : |x - y| \leq \rho \}$, where $\rho$ is a positive integer parameter called the range. When $d = 2$, a common choice is the Moore neighborhood with range $\rho$, which is the $(2\rho + 1) \times (2\rho + 1)$ square block centered at the cell $x = (x_1, x_2)$. More precisely, it is the set

$$N_x = \{ y = (y_1, y_2) : |x_1 - y_1| \leq \rho \quad \text{and} \quad |x_2 - y_2| \leq \rho \}.$$  

Another choice in the 2-dimensional case is the diamond-shaped von Neumann neighborhood:

$$N_x = \{ y = (y_1, y_2) : |x_1 - y_1| + |x_2 - y_2| \leq \rho \}.$$  

In general, the cells in a CA can take on one of $k$ different colors, where $k \geq 2$. In my examples I will take $k = 2$, and I will refer to the two colors as white and black. In pictures and most verbal descriptions, white will be depicted as $\square$ and black
as \( \boxed{\text{■}} \). But in cases where I want to write down a formula for the update rule \( U \), I will use 0 for white and 1 for black.

Let us look at two important families of CAs:

**The Simplest Case:** \( d = 1, p = 1, k = 2 \)

This family of CAs is essentially the one that put Wolfram on the map, so it is a good place for us to start. For these CAs the update rule at a cell \( x \) depends on the current colors of the three cells in the neighborhood of \( x \), so that we may denote the new color of \( x \) by \( U(p, q, r) \), where \( p, q, r \) denote the current colors of \( x-1, x, x+1 \) respectively. Since we have \( 2^3 = 8 \) different possible inputs for \( U \) and 2 possible outputs, we get \( 2^8 = 256 \) different possible update rules \( U \).

To get an idea of what can happen, we will look at five rules, labeled by Wolfram as Rules 30, 110, 170, 184, and 254. Table 1 gives the formula for \( U(p, q, r) \) in each case. In these formulas each of the inputs \( p, q, r \) can be either a 0 or a 1. The formulas are found by first expressing \( U \) as a logical function (using And, Or, Not) and then converting the logical function to a polynomial, using identities like \( p \text{ Or } q = p + q - pq \).

For two of these rules, the behavior is fairly easy to describe. Rule 170 simply shifts the entire sequence of colors to the left, one unit at each update. In Rule 254 \( \boxed{\text{■}} \) never changes to \( \boxed{\square} \), and, furthermore, \( \boxed{\text{■}} \) spreads from one cell to the next in both directions at each update. So for all initial states except the one with all \( \boxed{\square} \)'s, Rule 254 goes to the state with all \( \boxed{\text{■}} \)'s as time goes to infinity.

Rule 184 is sometimes used as a very simple traffic model in which \( \boxed{\text{■}} \) represents a car and \( \boxed{\square} \) represents a space. At each update, cars move one unit to the right whenever possible. More precisely, if there is a car at cell \( x \) and a space at cell \( x+1 \), then the car moves from \( x \) to \( x+1 \) at the next update, leaving behind a space at \( x \). This model has been extensively studied, and its behavior is well understood.

Rule 30 is one of the most interesting CAs ever studied. The first 100 updates for Rule 30 are shown in Figure 1, using the initial state \( \ldots \text{D D D D D D D D} \ldots \).

You can see this initial state in the top row of the figure, with later states appearing in successive rows, working from the top downward, so that the bottom row in the figure depicts the state after 100 updates. This convention for showing trajectories in 1-dimensional CAs is quite common, and it is the one followed by Wolfram in ANKS.

Towards the left edge of the picture for Rule 30, quite a bit of regularity can be seen. But the rest of the pattern seems quite unpredictable, and there is no known formula for predicting the colors at any given position. In fact, the sequence of colors attained by

### Table 1. Some update rules.

<table>
<thead>
<tr>
<th>Rule number</th>
<th>( U(p, q, r) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>( p + (1 - 2p)(q + r - qr) )</td>
</tr>
<tr>
<td>110</td>
<td>( q + r - qr - pqr )</td>
</tr>
<tr>
<td>170</td>
<td>( r )</td>
</tr>
<tr>
<td>184</td>
<td>( qr + (1 - q)p )</td>
</tr>
<tr>
<td>254</td>
<td>( 1 - (1 - p)(1 - q)(1 - r) )</td>
</tr>
</tbody>
</table>
Anyone who has used a pseudorandom number generator in computer simulations should have some sympathy for this approach, even though it ignores interesting recent work that brings mathematical rigor to the notion of pseudorandomness (for an introduction, see [3]).

Wolfram also gives a lot of attention to something he calls intrinsic randomness generation, which I will refer to as "IRG." This idea first appeared in his 1985 paper entitled "Origins of randomness in physical systems," and it is one of those that he says were not adequately understood by the rest of the scientific community.

According to Wolfram, IRG is one of three different "sources" of randomness in dynamical systems. The other two are (i) randomness in the initial conditions, which he says is the primary preoccupation of chaos theory; and (ii) random noise in the environment, which can be considered the reason for stochastic process theory. These two types of randomness are considered to come from "outside" of a dynamical system. IRG is something that is supposed to arise "within" a deterministic dynamical system without any help from the outside. Wolfram speculates that since the universe is a deterministic CA-like system, all randomness must be ultimately traceable to IRG. And, of course, he claims IRG as his own discovery.

Rule 30 provides Wolfram's favorite example of IRG. It is a deterministic system, so random noise is not an issue. And, as seen in Figure 1, it does not seem to need randomness in the initial conditions to behave in an apparently random fashion. By all of the standard tests, Rule 30 produces better random sequences than any of the other pseudorandom number generators in common use, and Wolfram has every right to be proud of it.

But in what way is IRG different from, say, the kind of behavior that can be observed in models familiar from chaos theory? Here is Wolfram's answer:

...How can one tell in an actual experiment on some system in nature to what extent intrinsic randomness generation is really the mechanism responsible?

...The clearest sign is a somewhat unexpected phenomenon: ...if intrinsic randomness generation is...at work, then the precise details of the behavior can...be repeatable (ANKS, p. 323).

The subsequent discussion makes it clear that Wolfram intends this repeatability to be present even if small random perturbations are made to the system, as will inevitably happen in physical experiments.

The point of this criterion is to make a clear distinction between IRG and the kind of unpredictable behavior typically found in chaos theory, which is always closely linked to "sensitive dependence". In chaos theory sensitive dependence is not sufficient for chaotic behavior, but it has always been considered necessary. Wolfram's repeatability criterion implies that sensitive dependence is not necessary when IRG is the dominant force.

If Wolfram could produce a legitimate example of this kind of repeatability, then he would have something very surprising. And indeed, he claims to have both theoretical and physical examples. Unfortunately, his one theoretical example contains a fatal mathematical error (as I will explain shortly).

Wolfram mentions a few physics and biology experiments (ANKS, p. 976) that are supposed to demonstrate repeatedly random behavior, but since no references are given, we are forced to take his word for it. In his 1983 paper there is an actual reference to a physics experiment that was run five times with nominally identical initial conditions. For an initial time segment, there are two different outputs: one that is shared by three of the runs and another that is shared by two of the runs. After the initial time period, all five outputs diverge from one another. This is a sort of weak repeatability that is interesting, but it is not a completely convincing example of Wolfram's idea. A plausible explanation is given in the experimental report that reminds me somewhat of a phenomenon observed in models of billiards, where trajectories with similar initial conditions can stay close to one another until some crisis (a collision) causes them to diverge. Such models are considered to have sensitive dependence, as Wolfram himself explains with a similar example involving mirrors on p. 311 of ANKS. So I do not buy into Wolfram's physical examples.

For his theoretical example of repeatability, Wolfram naturally turns to Rule 30. He admits that this model does in fact exhibit sensitive dependence (and hence nonrepeatability) when it is perturbed by randomly changing the color of one or more cells. But then he introduces a second "less drastic" kind of perturbation and finds that the trajectories of Rule 30 are repeatable under such perturbations. Unfortunately, it turns out that these perturbations are so mild that this kind of repeatability occurs for every CA, as I will now show.

For CAs having the two colors \( \square = 0 \) and \( = 1 \), Wolfram's perturbation works as follows. First, enlarge the color "palette" to be an interval \( I \), producing a continuous "gray scale". Then extend the update rule \( U \) to all of \( I \) in some smooth way. For example, one can use a polynomial expression for \( U \), as in Table 1. Each update is now performed in two steps: first, the color at each cell is randomly perturbed by a small amount, and then the extended update rule is applied.

This "less drastic" perturbation scheme would be convincing, except that Wolfram has a very special way of extending the update rule. His extended rule takes the form \( f \ast V \), where \( V \) is a polynomial...
for the color of the cell itself, giving $2 \times 9$ total possible inputs and 2 possible outputs for the update rule. Thus, there are $2^{18}$ different outer-totalistic CAs for this case.

In general, for outer-totalistic rules with $k = 2$, it is common to refer to black cells as alive and white cells as dead. When a white cell changes to black, the transition is called a birth. The opposite transition is called a death. If a live cell does not die during a given update, we say that it survives. Outer-totalistic update rules are commonly specified by giving the conditions for the birth and survival of a given cell $x$. By the definition of outer-totalistic, these conditions depend only on the number of live cells in the neighborhood of $x$ (not counting $x$ itself).

The most famous CA of all is outer-totalistic, with $d = 2$, $k = 2$, and the $\rho = 1$ Moore neighborhood. It is called the Game of Life. The birth condition for this rule is that exactly 3 of the 8 neighbors be alive, while the survival condition is that exactly 2 or 3 neighbors be alive.

The Game of Life was discovered in 1970 by John Conway, who was primarily interested in finding a simple CA that could simulate a universal Turing machine. (In Wolfram's version of history, "Conway treated the system largely as a recreation." See ANKS, p.877.) During the next decade Conway, Gosper, and others discovered that the Game of Life had all of the features that were considered necessary for the Turing machine simulation. A sketch of their argument can be found in the 1982 book Winning Ways for Your Mathematical Plays, by Berlekamp, Conway, and Guy. Conway’s argument was deemed acceptable by Wolfram when he cited it in his paper "Twenty problems in the theory of cellular automata" (1985), but by the time ANKS appeared his view had changed:

"The fact remains that a complete and rigorous proof of universality has apparently still never been given for the Game of Life. Particularly in recent years elaborate constructions have been made of for example Turing machines. But so far they have always had only a fixed number of elements on their tape, which is not sufficient for universality (ANKS, p.1117).

It is hard to know what is meant by this statement. An explicit implementation of a Turing machine in the Game of Life can be found at the website of Paul Rendell. The "tape" in this construction can be made arbitrarily long, with up to 8 different symbols available for each cell on the tape. On an infinite lattice, the tape can be infinitely long. Rendell's design for the "head" is expandable to allow for up to 16 states, making it more than adequate for the head of a universal Turing machine. Rendell says his construction was put together "in 1999-2000 mainly using patterns that I created in the 1980s". Rendell’s configuration even looks like a Turing machine (the tape and the head are clearly visible), and it runs in "real time", up to a constant multiple factor.

In the 1982 book cited above, Conway says: "Life is Universal...It's remarkable how such a simple system of genetic rules can lead to such far-reaching results." So it seems that somebody besides Wolfram deserves credit for discovering that simple computer programs can produce highly complex behavior. And yet Wolfram says that this idea is the "pivotal discovery that I made some eighteen years ago," and he considers it to be "one of the more important single discoveries in the whole history of theoretical science" (ANKS, p. 2).

There are many other families of CAs in ANKS. There are also a few significant ones that cannot be found there. Outside of ANKS, a good place to start exploring CAs is David Griffeath's website, where you can find a lot of good, genuine mathematics and beautiful color pictures.

Do the Math

Wolfram tells us in ANKS that he has very little use for mathematicians:

Over the years, I have watched with disappointment the continuing failure of most scientists and mathematicians to grasp the idea of doing computer experiments on the simplest possible systems...[Mathematicians] tend to add features to make their systems fit in with complicated and abstract ideas—often related to continuity—that exist in modern mathematics. ...One might imagine that the best way to be certain about what could possibly happen in some particular system would be to prove a theorem... But in my experience... it is easy to end up making implicit assumptions that can be violated by circumstances one cannot foresee. And indeed, by now, I have come to trust the correctness of conclusions based on simple systematic computer experiments much more than I trust all but the simplest proofs (ANKS, pp. 898-9).

Given this dismissive attitude, it should not be surprising that some of Wolfram's ideas do not hold up so well when examined under the harsh light of rigorous mathematics.

Wolfram's Four Classes of CA Behavior

In 1984 Wolfram introduced a classification scheme for CAs that separated them into four classes. This idea created quite a bit of excitement, and for several years serious attempts were made to refine the definitions of these classes and to develop various criteria for determining the class of a CA from numerical or statistical features of its trajectories.
Nowadays these classes remain useful for describing certain general features of CA behavior, but beyond that they have “proved neither subtle nor fruitful” (to quote Leo Kadanoff). But they play a significant role in ANKS, and some discussion here will be useful.

Rule 254 is a typical Class 1 CA. It has an attracting fixed point, the all \( \blacklozenge \) state, that attracts all other states, except for one repelling fixed point, which is the all \( \blacksquare \) state. In general, Class 1 CAs have a single attracting fixed point or periodic orbit whose basin of attraction is all but a few isolated states. Another way to characterize a Class 1 CA is to say that “information about initial conditions is always rapidly forgotten” (ANKS, p. 252).

Rule 170 is in Class 2. Another Class 2 CA is Rule 204, otherwise known as the identity map. A more interesting example is Rule 178, which happens to be outer-totalistic. The birth condition for Rule 178 is that at least one of the two neighbors be alive, and the survival condition is that both neighbors be alive. This rule has two repelling fixed points (all \( \blacksquare \) and all \( \blacklozenge \)). It has infinitely many states with period 2, in which intervals with \( \blacklozenge \)'s at the even cells and \( \blacksquare \)'s at the odd cells alternate with intervals of the opposite type.

From all initial states except the two fixed points, the system rapidly converges to one of the period 2 orbits. In general, a Class 2 CA has many fixed or periodic orbits (possibly modulo a shift, as in Rule 170), and from most initial states it will quickly converge to one of those orbits. In a Class 2 CA “some information in the initial state is retained in the final configuration...but this information always remains completely localized” (ANKS, p. 252). CAs in both Class 1 and Class 2 are considered to be “obviously simple” as far as the Principle of Computational Equivalence is concerned.

Rule 30 is a Class 3 CA. This class is characterized by trajectories that have apparent randomness. But not all Class 3 CAs are as unpredictable as Rule 30. Consider, for example, Rule 90, whose update rule is given by \( U(p, q, r) = p + r \pmod{2} \).

Because of the linear nature of this rule, it turns out to be easy to find an explicit formula for any given trajectory of Rule 90. Wolfram places both Rule 30 and Rule 90 into Class 3, primarily on the basis of the visual appearance of their trajectories, which is very similar for most initial states. This appearance reflects the way in which Class 3 CAs “show long-range communication of information—so that any change made anywhere in the system will almost always eventually be communicated even to the most distant parts of the system” (ANKS, p. 252).

Rule 110 is in Class 4, as is the Game of Life. Class 4 is described as being the borderline between Classes 2 and 3, because typical trajectories have regions with apparently random mixing (somewhat like Class 3) and regions with localized structures that either stay stationary or move linearly (somewhat like Class 2). When two such structures collide, various interesting things can happen, as seen in Figure 2, and it is these interactions that make Rule 4 special. The proofs of universality for both Rule 110 and the Game of Life make heavy use of the variety that is found in the interactions. Wolfram conjectures (on the basis of his Principle of Computational Equivalence) that all Class 4 CAs are capable of simulating universal Turing machines.

Do these classes exhaust all the possibilities? Wolfram thinks they do. But there are some problems with this view. First of all, there are many CAs that can be assigned to more than one class, depending on the initial state. For example, Rule 184 can act like it is in Class 1 with some initial states and like it is in Class 2 with others. There are even initial states that make it behave more like a Class 3 CA. Wolfram is aware of this fact (as shown by his discussion of Rule 184 on pp. 272 and 338), but he mostly ignores it.

A second problem is that some CAs cannot be assigned to any class at all. A good example is the 2-dimensional outer-totalistic CA shown in Figure 3. Births occur if 4, 6, 7, or 8 of the neighbors are alive, and deaths occur if 4, 6, 7, or 8 of the neighbors are dead. Thus, there is a symmetry between the two colors. For this example, the initial state was a random uniform mixture of the two colors \( \blacksquare \) and \( \blacklozenge \) throughout the entire lattice. Since it is not practical to work on an infinite lattice with such an initial state, the size of the lattice in this example has been restricted to 200 x 200, with “wrap-around” boundary conditions.

The remaining pictures in the figure show the states after 10, 100, and 1000 updates respectively. Extensive simulations give convincing evidence for the conjecture that clustering occurs. In other words, starting from a very noisy initial state, the system organizes itself into larger and larger regions, each of which primarily contains a single color. This behavior does not fit any description that I have seen of Classes 1–4. Wolfram discusses this example in ANKS (p. 336), but he does not say anything about how to classify it.

In some ways the system in Figure 3 is like a Class 3 CA running backwards, because the "long-range communication of information" seems to happen in reverse, as a complicated initial state becomes increasingly simplified through clustering. Perhaps Wolfram would place this CA on the borderline between Classes 1 and 2, because clustering could be interpreted as being midway between being attracted to a single fixed point and being attracted to a large set of fixed or periodic points. But in that case, a new “Class 5” is warranted, analogous to the other borderline case, which is Class 4.

In general, there are lots of interesting types of CA behavior, particularly in 2 dimensions and...
higher, that are not reflected in the four classes. Yet Wolfram would have us believe that "...at an overall level the behavior we see is not fundamentally much different in two or more dimensions than in one dimension" (ANKS, p. 170). I do not find this kind of oversimplification to be very useful.

In a sense, Wolfram's Principle of Computational Equivalence is an attempt to simplify things even further by separating all dynamical systems into only two classes: "Class A", containing the obviously simple systems, and "Class B", containing the universal ones. All of Class 4 and part of Class 3 (such as Rule 30) are supposed to be in Class B, and everything else is consigned to Class A. Wolfram says there is nothing more complex than Class A. But this view is only partially true, as I will explain in the next two subsections.

Universal CAs
It turns out that there is more than one kind of universality. So far we have talked about only the kind that primarily concerns Wolfram, which is the ability to simulate arbitrary Turing machines. But there is something known as a Universal CA, or UCA, that can do more. A UCA with lattice A must be able to simulate every other CA with lattice A. Furthermore, the space and time "costs" of the simulation must be bounded above by constant multiples of the space and time requirements of the CA being simulated.

What is the difference between simulating an arbitrary Turing machine and simulating an arbitrary CA? A Turing machine is essentially a computer with a single processor (the head), whereas a CA is a computer with infinitely many parallel processors (the cells). So even a universal Turing machine with an infinite tape cannot actually simulate a CA; it can simulate only larger and larger portions of it at a slower and slower pace. When a UCA simulates another CA, the cells of the UCA are thought of as being organized into a regular array of "blocks", with each block having the task of simulating a single cell. In this fashion a UCA can simulate the infinitely many processors (cells) of another CA, using "real time" and "real space" (up to a multiplicative constant), even if the CA being simulated has more colors or a larger range than the UCA. In practice, the distinction is important when one is trying to model something that involves a lot of parallel processing.

Wolfram gives a very nice example of a UCA on pp. 644-56 of ANKS. It is a 1-dimensional CA with \( k = 19 \) and \( p = 2 \). We are told that it is possible to reduce the number of colors to seven. The explanation is very clear and well illustrated. But on p. 676 he gets sloppy when he makes the transition from the discussion of UCAs to Rule 110. He never makes the distinction between the two types of universality, making it sound like Rule 110 is a UCA.

Because of certain details about the way in which data is processed in Matthew Cook's Rule 110 Turing simulation, I think it highly unlikely that Rule 110 is a UCA, although I have no proof. On the other hand, there are some explicit constructions, such as David Bell's so-called "Unit Life Cell", that seem to indicate that the Game of Life is a UCA. So there is a precise, mathematical sense in which the Game of Life is capable of performing more sophisticated computations than appear to be possible for Rule 110, contrary to the Principle of Computational Equivalence.

The issue of efficient simulation of massively parallel systems is an important one. One of Wolfram's main themes is that complicated mechanisms (such as Darwinian natural selection) are not required for explaining the complexity observed in nature. To put it simply, he says that mechanisms similar to Rule 110 abound in our physical environment (for example, in chemical reactions) and Rule 110 equals a universal Turing machine, which equals Einstein,
so how hard can it be for nature to produce Einstein? Raymond Kurzweil has done a fine job of attacking this argument by asking how nature is able to come up with the “software” needed to make Rule 110 act like Einstein. Ben Goertzel continued the attack by pointing out that nature could not find the time and space resources to run such software. Rule 110 pretty much has to be abandoned as Wolfram’s prime example of a simple system that can explain nature’s complexity.

But what about UCAs like the Game of Life? Presumably they can simulate something highly parallel like the human brain, since the brain could be considered to be some sort of CA on a rather irregular lattice. In the next subsection I will show that even a well-programmed UCA will not do nature much good if it wants to produce Einstein.

Fault-Tolerant UCAs

Even in the most carefully controlled environment, large-scale computing requires sophisticated error correction. How much more so in the hustle and bustle of our natural world? Most of the known UCAs, such as the Game of Life, are extremely sensitive to errors. Randomly changing the color of a single cell is often enough to turn an elaborate construction like Paul Rendell’s Life Turing machine into garbage. It seems highly unlikely that the Game of Life can carry on any sort of nontrivial simulation if it is subjected to random errors, even if the errors are quite rare. In other words, I do not believe that the software exists that can make some natural version of the Game of Life reliably simulate a complex living organism.

A fault-tolerant universal CA is a UCA whose ability to simulate other UCAs is not affected by random color changes throughout the lattice, provided such “errors” are sufficiently sparse. The existence of such systems was proved by Peter Gacs [2]. His 1-dimensional example is incredibly complicated, and the proof requires more than 200 pages. Gacs has also constructed examples in higher dimensions where matters are somewhat easier. But his 2-dimensional rule is still far more complicated than, say, the Game of Life. He has a 3-dimensional example (based on ideas of John Reif and Andrei Toom) which is relatively simple. It consists of a 2-dimensional array of synchronized 1-dimensional UCAs that perform mutual error correction. But such a construction does not seem like something that would easily arise in nature.

Thus, it is not clear that nature could easily find a mechanism that behaves like a fault-tolerant UCA without some “guiding hand” like natural selection. But Wolfram’s thesis seems to require nature to do just that. Until someone finds a simple fault-tolerant UCA, the main theme of ANKS remains wishful speculation.

At any rate, I consider fault-tolerant UCAs to be more powerful and sophisticated than UCAs, which are likely to be more powerful than Rule 110. I propose that we assign fault-tolerant UCAs to “Class 7”. There is even a further level of computational sophistication, Gacs’s so-called “self-organizing” fault-tolerant UCAs, which may also be important to nature. Life is not necessarily so simple after all!

Metastability

“Finite size effects” are the bane of computer experimentation with UCAs. It is not unusual to observe a particular behavior in a CA computer simulation only to find out much later that this behavior evaporates when the simulation is run on a computer with larger resources (space, time, or both). In the interim a lot of time can be wasted theorizing about the illusory behavior that seemed so intriguing in the smaller system.

The computer naturally restricts the lattice in any simulation to a finite size. For 1-dimensional systems it is possible to run simulations on very large finite lattices, and conclusions based on such experiments can be reasonably reliable. But for 2-dimensional systems, even simulations with modest lattice sizes like $1000 \times 1000$ can become unwieldy, and many phenomena require considerably larger lattices for reliable observation. Furthermore, the effects of “boundary conditions” (how to define the update rule at the edges of the finite lattice) can be quite pronounced in 2 dimensions. Thus, it is not too surprising that most of the examples in Wolfram’s book are either 1-dimensional or 2-dimensional with fairly small lattice sizes. Systems in 3 or higher dimensions receive very little attention.

Here is a simple example of a finite size effect in 2 dimensions that actually fooled some experimenta
tists. It is an outer-totalistic CA with two colors, using the range 1 von Neumann neighborhood. The birth rule is that at least 2 of the 4 neighbors be alive, and the survival rule is that all live cells survive. This model is called bootstrap percolation. It is not discussed in ANKS in spite of its importance.

If the initial population of live cells in bootstrap percolation is random but sparse, the system seems to rapidly converge to a fixed point, consisting of various rectangular “islands” of live cells, surrounded by a “sea” of dead cells. Run 100 experiments with this system on a $1000 \times 1000$ lattice, using initial states in which the live cells are randomly distributed with density $p = .03$, and you are likely to see this same Class 1 behavior over and over. Usually the system finds a fixed point within about 60 updates.

When the initial density is changed to $p = .05$ on a $1000 \times 1000$ lattice, we usually see Class 2 behavior. One or more of the islands continues to grow, feeding off of “debris” that consists of smaller islands and individual live cells. Eventually the system reaches the fixed point in which every cell is alive. This phenomenon led some experimenta
tists to believe that there is a critical value of $p$...
(in this case, somewhere between .03 and .05) that separates the two types of behavior. They were wrong. The Class 2 behavior observed for small \( p \) is only metastable; it is a finite size effect. The threshold for \( p \) goes to 0 as the lattice size \( L \) goes to infinity. The system was carefully analyzed by Michael Aizenman and Joel Lebowitz [1], who gave good quantitative information about the amount of space and time that is required to see the Class 1 behavior. More recently, Alexander Holroyd [4] proved a much more precise result, which is that the asymptotic threshold occurs when \( p - 0 \) and \( L \to \infty \) in such a way that \( \lim p \log L = \pi^2/18 \).

In retrospect, it is obvious that the Class 2 behavior of bootstrap percolation is a finite size effect, because there is a very simple argument, based on the Borel-Cantelli Lemma from probability theory, that in a large enough lattice a sufficiently large island will appear that will continue to grow without bound. But other finite size effects are not always so easy to detect.

Has Wolfram ever been fooled by a finite size effect? Possibly. Consider the 2-dimensional outer-totalistic system shown in Figure 4. It has two colors and uses the range 1 Moore neighborhood. The birth condition is the same as for the Game of Life (exactly 3 of the 8 cells must be alive), but the rule for survival is different: a live cell survives only if no more than 4 of its 8 neighbors are also alive. This example is featured on p. 178 of ANKS, although Wolfram's description there of the update rule is unfortunately incomplete. (This is not the only error that I have found in his descriptions of CA rules: one of the formulas that he gives for Rule 110 on page 869 is also incorrect.)

Wolfram says that this CA exhibits a growth pattern whose "shape closely approximates a circle." The picture in ANKS depicts the state of the system after 400 updates, starting from an initial state in which the "finite seed" is surrounded by an infinite sea of \( ≗ \)'s. I have run this example for several thousand more updates, and the disk-shaped pattern seems to continue to grow indefinitely. Similar behavior is found using many other such seeds.

But matters are not as simple as one might think. If we start the system with the seed \( ∞ ∞ ∞ ∞ ∞ \), we observe the familiar growing disk shape for roughly 2,700 updates. Then something strange happens. At the left boundary of the disk, a small but very distinct peak suddenly appears. This peak soon dominates the left side of the disk, and it appears to be a permanent feature.

What happened? The pattern of live cells around the edge of the growing shape fluctuates quite unpredictably. It happens that somewhere around 2,750 updates these fluctuations produce a rare configuration that generates a "spike" that grows rapidly, sticking straight out from the disk. As the spike lengthens, the area around it is filled in, and the peak is formed. I learned about the seed for this example from David Griffeath, who got it from Matthew Cook. As far as I know, Wolfram did not know about this seed when ANKS was published.

Will a similar peak eventually appear if we use Wolfram's seed? No one knows. I have run the system from that seed for more than 10,000 updates without seeing anything. After that, my computer slows down to a crawl. But I conjecture that the wild fluctuations around the edge of the shape must eventually produce the special pattern needed for the peak-producing spike, provided they do not first create some other strange feature.

Wolfram first considered the possibility of circular growth in his paper with Norman Packard, "Two-dimensional cellular automata" (1984). The examples in that paper were not very convincing, because the circular shapes were so rough. The example in ANKS is supposed to be an improvement. Wolfram's experiments convinced him that he had finally found a CA that exhibited an asymptotic growth pattern that was nearly perfectly circular. But it now seems likely that his conclusion is wrong. Computer experiments cannot be trusted.

**Intrinsic Randomness Generation**

Wolfram has a lot to say about randomness in ANKS. Much of Chapter 10 is devoted to the discussion of his practical definition of randomness, which is more or less that something is random if it looks random and passes the standard statistical tests for randomness.
Anyone who has used a pseudorandom number generator in computer simulations should have some sympathy for this approach, even though it ignores interesting recent work that brings mathematical rigor to the notion of pseudorandomness (for an introduction, see [3]).

Wolfram also gives a lot of attention to something he calls **intrinsic randomness generation**, which I will refer to as "IRG". This idea first appeared in his 1985 paper entitled “Origins of randomness in physical systems”, and it is one of those that he says were not adequately understood by the rest of the scientific community.

According to Wolfram, IRG is one of three different "sources" of randomness in dynamical systems. The other two are (i) randomness in the initial conditions, which he says is the primary preoccupation of chaos theory; and (ii) random noise in the environment, which can be considered the reason for stochastic process theory. These two types of randomness are considered to come from "outside" of a dynamical system. IRG is something that is supposed to arise "within" a deterministic dynamical system without any help from the outside. Wolfram speculates that since the universe is a deterministic CA-like system, all randomness must be ultimately traceable to IRG. And, of course, he claims IRG as his own discovery.

Rule 30 provides Wolfram's favorite example of IRG. It is a deterministic system, so random noise is not an issue. And, as seen in Figure 1, it does not seem to need randomness in the initial conditions to behave in an apparently random fashion. By all of the standard tests, Rule 30 produces better random sequences than any of the other pseudorandom number generators in common use, and Wolfram has every right to be proud of it.

But in what way is IRG different from, say, the kind of behavior that can be observed in models familiar from chaos theory? Here is Wolfram's answer:

> "...how can one tell in an actual experiment on some system in nature to what extent intrinsic randomness generation is really the mechanism responsible? ...The clearest sign is a somewhat unexpected phenomenon: ...if intrinsic randomness generation is at work, then the precise details of the behavior can be repeatable" (ANKS, p. 323).

The subsequent discussion makes it clear that Wolfram intends this repeatability to be present even if small random perturbations are made to the system, as will inevitably happen in physical experiments.

The point of this criterion is to make a clear distinction between IRG and the kind of unpredictable behavior typically found in chaos theory, which is always closely linked to "sensitive dependence". In chaos theory sensitive dependence is not sufficient for chaotic behavior, but it has always been considered necessary. Wolfram's repeatability criterion implies that sensitive dependence is not necessary when IRG is the dominant force.

If Wolfram could produce a legitimate example of this kind of repeatability, then he would have something very surprising. And indeed, he claims to have both theoretical and physical examples. Unfortunately, his one theoretical example contains a fatal mathematical error (as I will explain shortly).

Wolfram mentions a few physics and biology experiments (ANKS, p. 976) that are supposed to demonstrate repeatably random behavior, but since no references are given, we are forced to take his word for it. In his 1985 paper there is an actual reference to a physics experiment that was run five times with nominally identical initial conditions. For an initial time segment, there are two different outputs: one that is shared by three of the runs and another that is shared by two of the runs. After the initial time period, all five outputs diverge from one another. This is a sort of weak repeatability that is interesting, but it is not a completely convincing example of Wolfram's idea. A plausible explanation is given in the experimental report that reminds me somewhat of a phenomenon observed in models of billiards, where trajectories with similar initial conditions can stay close to one another until some crisis (a collision) causes them to diverge. Such models are considered to have sensitive dependence, as Wolfram himself explains with a similar example involving mirrors on p. 511 of ANKS. So I do not buy into Wolfram's physical examples.

For his theoretical example of repeatability, Wolfram naturally turns to Rule 30. He admits that this model does in fact exhibit sensitive dependence (and hence nonrepeatability) when it is perturbed by randomly changing the color of one or more cells. But then he introduces a second "less drastic" kind of perturbation and finds that the trajectories of Rule 30 are repeatable under such perturbations. Unfortunately, it turns out that these perturbations are so mild that this kind of repeatability occurs for every CA, as I will now show.

For CAs having the two colors 0 and 1, Wolfram's perturbation works as follows. First, enlarge the color "palette" to be an interval $I$, producing a continuous "gray scale". Then extend the update rule $U$ to all of $I$ in some smooth way. For example, one can use a polynomial expression for $U$, as in Table 1. Each update is now performed in two steps: first, the color at each cell is randomly perturbed by a small amount, and then the extended update rule is applied.

This "less drastic" perturbation scheme would be convincing, except that Wolfram has a very special way of extending the update rule. His extended rule takes the form $f \circ V$, where $V$ is a polynomial
version of the original update rule $U$ and $f$ is a smooth function on $\mathbb{R}$ with fixed points at 0 and 1. Furthermore, $f'(0) = f'(1) = 0$. (Actually, I have simplified things slightly from what Wolfram does. But my basic argument is still valid for his version.) So, in a sense, the update is actually performed in three steps: first do the random perturbation, then apply $V$, then apply $f$.

It is this extra step involving $f$ that invalidates the procedure as any sort of useful criterion. Using the properties of $f$, one can easily prove that for any given $V$, the size of the perturbations can be chosen small enough so that after $f$ is applied, the result is always extremely close to 0 and 1. In effect, the fixed points of $f$ are so stable that they virtually nullify the perturbations before they have any chance to impact the behavior of the system. The nature of the underlying CA rule is irrelevant.

Thus, ANKS contains no mathematical example of "intrinsically random" behavior without sensitive dependence, and the physical examples are either uncheckable or unconvincing. Rule 30 is merely a very good example of a dynamical system that has chaotic trajectories and sensitive dependence. The fact that some of these trajectories have "simple" initial conditions is interesting but not at all unprecedented. There are many well-known examples of simple dynamical systems for which a large set of initial conditions (including simple ones) lead to motion along a "strange attractor". Such motion can be quite unpredictable. If this is IRG, then Wolfram has merely "discovered" a fancy new name for a well-known phenomenon.

In ANKS Wolfram says that "...the core of this book can be viewed as introducing a major generalization of mathematics" (p. 7). In this he is entirely mistaken, but there are at least two ways in which he has benefited mathematics: he has helped to popularize a relatively little-known mathematical area (CA theory), and he has unwittingly provided several highly instructive examples of the pitfalls of trying to dispense with mathematical rigor.

For Further Study

The most immediate source for learning more about CAs is David Griffeath's website, psoup.math.wisc.edu. There you will find numerous links to other Web resources, including software for running CA simulations. For recent progress in explicit implementations of universal computation, see Paul Chapman's Game of Life version of a "Universal Minsky Register Machine" at www.anl.gov/ca. A classic book on CAs is [6]. It was written by two pioneers in the field and has a perspective that is quite different from Wolfram's. There is a lot more to CA theory than can be found in ANKS, as you can determine for yourself by randomly browsing the Web (for example, try investigating "cyclic cellular automata", which are not mentioned in ANKS). Wolfram's papers on CAs and complexity theory can be found at his website www.stephenwolfram.com. Another Wolfram website, www.wolframscience.com, contains a growing set of "interactive tools" that supplement ANKS.

I benefited from conversations with many mathematicians, including David Griffeath, Peter Gacs, Rick Moeckel, and Bill Casselman. David and Bill also helped me considerably with the figures, which were generated using the freely available software MCell and Life32. I am also grateful for several comments contributed by readers of the online version of this article.

References


About the Cover

The cover sequence—which should be read by columns, left to right—is based on a design due to Lawrence Gray, and accompanies his review of Stephen Wolfram's book, A New Kind of Science. Gray comments, "The heart-shaped patterns show a sequence of states visited by a simple 2-dimensional cellular automaton. The rules of the CA are these: at each update, a white cell turns red if exactly 3 of its 8 surrounding neighbors are red, and a red cell turns white if 5 or more of its 8 surrounding neighbors are red. Otherwise, the color of a cell remains unchanged."

"Starting with finitely many red cells, it is common for the system to quickly produce an amorphous growing blob of red cells whose shape becomes roughly circular with time. After watching numerous computer simulations, one is tempted to agree with Wolfram, who suggests in his book that such circular growth characterizes the asymptotic behavior of this cellular automaton."

"But more careful exploration reveals a surprise. Some special patterns, such as the heart-shaped shape show, produce growth only in one direction. If you look carefully, you can see 'heartbeats', each lasting 4 time units. With each heartbeat, the heart grows 2 units in the vertical direction. Matthew Cook discovered that a pattern of this type can suddenly appear, in a way that seems almost accidental, near the edge of a growing blob. As a result, the blob develops a distinct corner that appears to be permanent, and its asymptotically circular shape is spoiled."

"It may well be that it is inevitable (or at least very common) for such corners to develop on the shapes produced by this particular cellular automaton, but only if they are allowed to grow for a very long time. The phenomenon will not be captured by the typical computer simulation, which ends too soon."

—Bill Casselman (notices-covers@ams.org)
The Mathematical Work of the 2002 Fields Medalists

Eric M. Friedlander, Michael Rapoport, and Andrei Suslin

The Work of Laurent Lafforgue

Michael Rapoport

Laurent Lafforgue was awarded the Fields Medal for his proof of the Langlands correspondence for the general linear groups $GL_r$ over function fields of positive characteristic. His approach to this problem follows the basic strategy introduced twenty-five years ago by V. Drinfeld in his proof for $GL_2$. Already Drinfeld's proof is extremely difficult. Lafforgue's proof is a real tour de force, taking up as it does several hundred pages of highly condensed reasoning. By his achievement Lafforgue has proved himself a mathematician of remarkable strength and perseverance.

In this brief report I will sketch the background of Lafforgue's result, state his theorems, and then mention some ingredients of his proof. The final passages are devoted to the human factor.

The Background

The background of Lafforgue's theorem is the web of conjectures known as the Langlands philosophy, which is a far-reaching generalization of class field theory. Let $F$ be a global field, i.e., either a finite extension of $\mathbb{Q}$ (the number field case) or a finite extension of $\mathbb{F}_p(t)$ where $\mathbb{F}_p$ is the finite field with $p$ elements (the function field case). Let $A$ be the adele ring of $F$.

Global class field theory may be formulated as giving a bijection between the sets of characters of finite order of the Galois group $\text{Gal}(\overline{F}/F)$ on the one hand and of the idele class group $\mathbb{A}^\times/F^\times$ on the other hand. This is the reciprocity law of T. Takagi and E. Artin established in the 1920s as a far-reaching generalization of the quadratic reciprocity law going back to L. Euler. At the end of the 1960s, R. Langlands proposed a nonabelian generalization of this reciprocity law. It conjecturally relates the irreducible representations of rank $r$ of $\text{Gal}(\overline{F}/F)$ (or, more generally, of the hypothetical motivic Galois group of $F$) with cuspidal automorphic representations of $GL_r(A)$. In fact, this conjecture is part of an even grander panorama of Langlands (the functoriality principle), in which homomorphisms between $L$-groups of reductive groups over $F$ induce relations between the automorphic representations on the corresponding groups. These hypothetical reciprocity laws would imply famous conjectures, such as the Artin conjecture on the holomorphy of $L$-functions of irreducible Galois representations and the Ramanujan-Petersson conjecture on the Hecke eigenvalues of cusp forms for $GL_r$.

In the number field case, deep results along these lines have been obtained for groups of small rank, such as $GL_2$, by Langlands himself and by many others. And such results have already had spectacular applications, such as in the proof of Fermat's last theorem. However, the proof of the Langlands correspondence in any generality in the number field case seems out of reach at the present time. Lafforgue's result, which concerns the function field case, is the first general nonabelian reciprocity law.

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Lafforgue's Theorem

From now on let $F$ denote a function field of characteristic $p$. We also fix an auxiliary prime number $\ell \neq p$. For a positive integer $r$ let $G_r$ be the set of equivalence classes of irreducible $\ell$-adic representations of dimension $r$ of $\text{Gal}(\overline{F}/F)$. For each $\sigma \in G_r$, A. Grothendieck defined its $L$-function $L(\sigma, s)$, which is a rational function in $p^{-s}$ satisfying a functional equation of the form

$$L(\sigma, s) = \epsilon(\sigma, s) L(\sigma', 1 - s),$$

where $\epsilon(\sigma, s)$ is a monomial in $p^{-s}$ and $\sigma'$ denotes the contragredient representation. The $L$-function is an Euler product, $L(\sigma, s) = \prod_x L_x(\sigma, s)$, over all places $x$ of $F$, and for a place $x$ of degree $\deg(x)$, where $\sigma$ is unramified, we have

$$L_x(\sigma, s) = \prod_{i=1}^r \frac{1}{1 - z_i p^{-s \deg(x)}},$$

where $z_1, \ldots, z_r$ are the Frobenius eigenvalues of $\sigma$ at $x$.

Let $\mathcal{A}_r$ be the set of equivalence classes of cuspidal representations of $GL_1(A)$. For each $\pi \in \mathcal{A}_r$, R. Godement and H. Jacquet defined its $L$-function $L(\pi, s)$, which is a rational function in $p^{-s}$ satisfying a functional equation of the form

$$L(\pi, s) = \epsilon(\pi, s) L(\pi', 1 - s),$$

where $\epsilon(\pi, s)$ is a monomial in $p^{-s}$ and $\pi'$ denotes the contragredient representation. The $L$-function is an Euler product, $L(\pi, s) = \prod_x L_x(\pi, s)$, over all places $x$ of $F$, and for a place $x$ of degree $\deg(x)$, where $\pi$ is unramified, we have

$$L_x(\pi, s) = \prod_{i=1}^r \frac{1}{1 - z_i p^{-s \deg(x)}},$$

where $z_1, \ldots, z_r$ are the Hecke eigenvalues of $\pi$ at $x$. The main result of Lafforgue consists of the following theorems.

**Theorem 1 (the Langlands conjecture).** There is a bijection $\pi \rightarrow \sigma(\pi)$ between $\mathcal{A}_r$ and $G_r$, characterized by the fact that $L_x(\pi, s) = L_x(\sigma(\pi), s)$ for every place $x$ of $F$.

**Theorem 2 (the Ramanujan-Petersson conjecture).** Let $\pi \in \mathcal{A}_r$ with central character of finite order. Then for every place $x$ of $F$ where $\pi$ is unramified, the Hecke eigenvalues $z_1, \ldots, z_r \in \mathbb{C}$ are all of absolute value 1.

**Theorem 3 (the Deligne conjecture).** Let $\sigma \in G_r$ with determinant character of finite order. Then $\sigma$ is pure of weight 0, i.e., for any place $x$ of $F$ where $\sigma$ is unramified, the images of the Frobenius eigenvalues $z_1, \ldots, z_r$ under any embedding of $\overline{Q}_\ell$ into $\mathbb{C}$ are of absolute value 1.

Here Theorems 2 and 3 are consequences of Theorem 1 through P. Deligne's purity theorem and the estimate on Hecke eigenvalues of Jacquet and J. Shalika. Theorem 1 itself is proved by induction on $r$ (Deligne recursion principle). After what was known before (in addition to the functional equations, essentially the converse theorems of A. Weil and I. Piatetskii-Shapiro and the product formula for $\varepsilon$-factors of G. Laumon), it all boiled down to proving the existence of the map $\pi \rightarrow \sigma(\pi)$ with the required properties. This is exactly what Lafforgue did.

Before spending a few words on his proof, let us consider the question, What is it good for? The answer is that neither of the sets $G_r$ and $\mathcal{A}_r$ is simpler than the other in every aspect but that Theorem 1 can be used to transfer available information in either direction. Theorem 3 is an instance where information available on $\mathcal{A}_r$ implies results on $G_r$. In the other direction, Theorem 1 permits one to use constructions available on $G_r$ to prove various instances of Langlands functoriality for $\mathcal{A}_r$, such as the existence of tensor products, of base change, and of automorphic induction.

**About the Proof**

The strategy of constructing the map $\pi \rightarrow \sigma(\pi)$ is due to Drinfeld and is inspired by the work of Y. Ihara, Langlands, and others in the theory of Shimura varieties. It consists in analyzing the $\ell$-adic cohomology of the algebraic stack $\text{Sh}_{r,o}$ over $\text{Spec} F \times \text{Spec} F$ parametrizing shukas of rank $r$ or the algebraic stack $\text{Sh}_{r} = \lim_{\text{spec}} \text{Sh}_{r,N}$ parametrizing shukas of rank $r$ equipped with a compatible system of level structures for all levels $N$. The latter cohomology module is equipped with an action of $GL_r(A) \times \text{Gal}(\overline{F}/F) \times \text{Gal}(\overline{F}/F)$ and the aim is to isolate inside it a subquotient of the form

$$\bigoplus_{\pi \in \mathcal{A}_r} \pi \otimes \sigma(\pi) \otimes \sigma(\pi)^*$$

by comparing the Grothendieck-Lefschetz fixed-point formula and the Arthur-Selberg trace formula. The essential difficulty is that, in contrast to the case of Shimura varieties, the moduli stack $\text{Sh}_r$ is not of finite type, not even at any finite level $N$. To understand why, recall that a shuka of rank $r$ is a vector bundle of rank $r$ on $X$ with additional structure (essentially a meromorphic descent datum under Frobenius). Here $X$ is the smooth irreducible projective curve over $F_p$ with function field $F$. And, just as the moduli stack of vector bundles of rank $r$ on $X$ is not of finite type, neither are the stacks $\text{Sh}_{r,o}$ and $\text{Sh}_{r,N}$.

To deal with this difficulty, Lafforgue introduces the open substacks $\text{Sh}_{r,o}^P$ and $\text{Sh}_{r,N}^P$ of shukas where the Harder-Narasimhan polygon is bounded by $P$. These substacks are of finite type, and their union is the whole space. The trouble is that they are not stable under the Hecke correspondences. Therefore Lafforgue constructs in the case without level structure a smooth compactification $\text{Sh}_{r,o}^P$ of $\text{Sh}_{r,o}^P$ with a normal crossing divisor at infinity and extends the Hecke correspondences to it by simple normalization. He then applies the Grothendieck-Lefschetz fixed-point formula to these correspondences. However, only a part of this formula can be determined explicitly, and therefore
this seems a pointless exercise. Lafforgue circumvents this problem by isolating the \( r \)-essential part of the cohomology of \( Sht_{r,\emptyset} \) and by showing that the remainder, both the difference between the cohomology of \( Sht_{r,\emptyset} \) and of \( Sht_{r,\emptyset} \) and the cohomology of the boundary of \( Sht_{r,\emptyset} \), is \( r \)-negligible. Here the work of R. Pink on Deligne's conjecture on the Grothendieck-Lefschetz formula enters in a decisive way. In the case where a level structure is imposed, Lafforgue manages to push through his method by constructing a \( partial \) compactification of \( Sht_{r,\emptyset} \), which is smooth with a normal crossing divisor at infinity and which is stable under the Hecke correspondences and by supplementing Pink's theorem by K. Fujiwara's theorem.

The Months of Suspense

Lafforgue's first attempt at a proof of Theorem 1 used a compactification of \( Sht_{r,\emptyset} \). His construction was based on the compactifications of the quotient spaces \( X_r, n = (PGL_r)^{n+1}/PGL_r \) that he had defined in earlier work, generalizing the case \( n = 1 \) due to C. de Concini and C. Procesi. In June 2000, while lecturing on his proof, Lafforgue discovered that, contrary to what he had claimed, these compactifications of \( X_r, n \) and hence also the corresponding compactifications of \( Sht_{r,\emptyset} \), are not smooth in general. He was not even able to resolve their singularities. During two months of suspense in the summer of 2000, Lafforgue managed to fill the gap by finding the above-mentioned partial compactifications of \( Sht_{r,\emptyset} \) and was able to finesse the proof of Theorem 1 from them. Thus in the end, the modified argument is simpler than the original attempt.

Even though Lafforgue's compactifications of \( X_r, n \) are not used in the final proof, they are fascinating objects in themselves, with close relations to such diverse geometric objects as configuration spaces of matroids, thin Schubert cells, stable degeneration of \( n \)-pointed projective lines, and local models of Shimura varieties. It turns out that these compactifications are smooth for \( n = 1 \) (respectively toroidal for \( n = 2 \)) and arbitrary \( r \) (de Concini and Procesi, respectively Lafforgue) and for \( r = 2 \) and arbitrary \( n \) (G. Faltings), but can have arbitrarily bad singularities in general (N. Mnev). These compactifications constitute a new field of investigation, taken up by Lafforgue in a 265-page preprint (http://www.ihes.fr/PREPRINTS/M02/Resu/resu-M02-31.html).

Biographical Data

Laurent Lafforgue was born in 1966. He was a student at the École Normale Supérieure (1986-1990) before entering the Centre National des Recherches Scientifiques in 1990. His academic teacher is Gérard Laumon, with whom he obtained his thesis at the Université de Paris-Sud in 1994. It is in the famous Bâtiment de Mathématique ("le 425") on the Orsay campus that Lafforgue worked out his proof. Since 2000 he has been a professor at the Institut des Hautes Études Scientifiques.

Further Information

For excellent overviews of Lafforgue's proof, see Laumon's Bourbaki seminar No. 873, March 2000, which also contains an annotated bibliography, and Lafforgue's notes of a course at the Tata Institute (http://www.ihes.fr/PREPRINTS/M02/Resu/resu-M02-45.html).

The Work of Vladimir Voevodsky

Eric M. Friedlander and Andrei Suslin

In 1982 Alexander Beilinson stated conjectures which crystallized a vision of the relationship between algebraic \( K \)-theory and "integral motivic cohomology theory" of algebraic varieties over a field \( F \) and between mod-\( \ell \) algebraic \( K \)-theory and mod-\( \ell \) étale cohomology, where \( \ell \) is a prime invertible in \( F \). These conjectures, more detailed and specific than the earlier "Quillen-Lichtenbaum Conjecture", provided a challenging program that explains a great deal about Quillen's algebraic \( K \)-theory [Q]. Although one of Beilinson's conjectures remains unsolved (and may well prove to be false in general), Vladimir Voevodsky has made great strides in completing Beilinson's program.

Voevodsky's achievements are remarkable. First, he has developed a general homotopy theory for algebraic varieties. Second, as part of this general theory, he has formulated what appears to be the "correct" motivic cohomology theory and verified many of its remarkable properties. Third, as an application of this general approach, he has proved a long-standing conjecture of John Milnor relating the Milnor \( K \)-theory of a field to its étale cohomology (and to quadratic forms over the field).

We provide below a brief sketch of Voevodsky's contributions, proceeding from the specific Milnor Conjectures to the more general theory.

Milnor Conjecture

Given a field \( F \), we define (following Milnor) the graded ring \( K^M_r(F) \) to be the tensor algebra over the integers \( \mathbb{Z} \) of the group \( F^* \) of nonzero elements in \( F \), modulo the ideal generated by the Steinberg relations in \( F^* \otimes F^* \) (so that \( \{a, 1 - a\} \), the image of \( a \otimes (1 - a) \), is set equal to \( 0 \in K^M_r(F) \) for all \( a \neq 1 \in F^* \)). Thus, \( K^M_0(F) = K_0(F) = \mathbb{Z} \), \( K^M_1(F) = K_1(F) = F^* \), and (thanks to a theorem of Matsumoto) \( K^M_2(F) = K_2(F) = F^* \otimes F^*/(a \otimes (1 - a); a \neq 1 \in F^*) \).

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By definition, the $n$-th Milnor $K$-group $K^n_n(F)$ is generated by products of elements in degree 1 (so-called symbols \( \{a_1, \ldots, a_n\} \)), thereby being much simpler than Quillen's $K$-group $K_n(F)$.

The following theorem, conjectured by Milnor [Mi], has been proved by Voevodsky.

**Theorem 1.** [V4] Let $F$ be a field of characteristic different from 2. Then the natural map

\[
K^n_n(F) \otimes \mathbb{Z}/2\mathbb{Z} \to H^n(F, \mathbb{Z}/2\mathbb{Z})
\]

is an isomorphism of graded rings. In particular, for every $n > 0$, the Galois cohomology group $H^n(F, \mathbb{Z}/2\mathbb{Z})$ is generated by $n$-fold cup products of cohomology classes of degree 1.

One can marvel at this result from many points of view. For example, it says there is something very special about graded rings that arise as Galois cohomology of fields.

Voevodsky, in collaboration with D. Orlov and A. Vishik, has also proved the following closely related theorem conjectured by Milnor [Mi]. The Grothendieck-Witt ring $GW(F)$ has an underlying abelian group given by isomorphism classes of finite-dimensional $F$-vector spaces equipped with a quadratic form and ring structure given by tensor product. The Witt ring $W(F)$ is obtained by dividing $GW(F)$ by the ideal generated by the 2-dimensional $F$-vector space with the hyperbolic quadratic form. The Witt ring $W(F)$ admits an augmentation map $W(F) \to \mathbb{Z}/2\mathbb{Z}$ induced by the rank map $GW(F) \to \mathbb{Z}$. Milnor investigated the successive quotients $I^n/I^{n+1}$, where $I \subset W(F)$ denotes the kernel of the augmentation map, and the resulting associated graded ring $gr_*(W(F)) = \oplus_{n \geq 0} I^n/I^{n+1}$.

**Theorem 2.** [OVV] Let $F$ be a field of characteristic different from 2. Then the natural homomorphism of graded rings $K_n(F) \otimes \mathbb{Z}/2\mathbb{Z} \to gr_*(W(F))$ is an isomorphism.

Theorems 1 and 2 show that the three graded rings $K^n_n(F) \otimes \mathbb{Z}/2\mathbb{Z}$, $gr_*(W(F))$, and $H^n(F, \mathbb{Z}/2\mathbb{Z})$, which arise in very different manners, are canonically isomorphic for any field of characteristic different from 2.

**Motivic Cohomology**

In algebraic topology, singular cohomology with integral coefficients has many good properties and satisfies a tight relationship with topological $K$-theory. One has known for many years that one cannot define "algebraically" the integral (or even rational) singular cohomology of complex algebraic varieties. On the other hand, étale cohomology with mod-$\ell$ coefficients, as developed by Alexander Grothendieck and Michael Artin, when applied to varieties over a field $F$, succeeds admirably in providing a substitute for singular cohomology mod-$\ell$ whenever $\ell$ does not equal the characteristic of $F$.

Beilinson conjectured the existence of motivic complexes $Z(q)$ leading to bigraded motivic cohomology groups $H^p(X, Z(q))$ which should relate to the algebraic $K$-theory of a smooth variety $X$ over a field $F$. (This relationship has recently seen various proofs, beginning with work of Bloch-Lichtenbaum, then Friedlander-Suslin, Levine, and finally Grayson-Suslin.) Moreover, he conjectured that these complexes, when reduced modulo $\ell$ for $\ell$ invertible in $F$, should be related in a completely precise way to étale cohomology.

In [Bl] Spencer Bloch produced an ingenious construction yielding "higher Chow groups", which are excellent candidates for the cohomology of Beilinson's conjectured motivic complexes. Somewhat later, Suslin introduced algebraic singular complexes which led Suslin and Voevodsky to an alternate algebraic model of singular cohomology with mod-$\ell$ coefficients [SV1]. A major achievement of Voevodsky has been to formulate a natural category (of abelian presheaves with transfers on the big Nisnevich site of all smooth varieties $X$ over $F$) which in conjunction with the algebraic singular complex construction leads to a good formulation of motivic complexes $\mathbb{Z}(n)$ developed by Suslin and Voevodsky [SV2]. Recently Voevodsky has proved that the resulting cohomology groups are isomorphic to Bloch's higher Chow groups [V2].

Voevodsky's formulation of motivic cohomology is crucial, for it has led Voevodsky to prove various important properties essential for his proof of the Milnor Conjectures. We mention perhaps the most important general theorem concerning motivic cohomology, a theorem for which Voevodsky has recently found a most elegant proof.

**Theorem 3.** [FV], [V5] Let $X$ be a smooth variety over a field $F$, and let $Y \subset X$ be a smooth closed subvariety everywhere of codimension $d$. Then there is a canonical Gysin isomorphism

\[
H^n(X, \mathbb{Z}(n)) \cong H^{p-2d}(Y, \mathbb{Z}(n-d))
\]

**Operations in Motivic Cohomology and the Proof of the Milnor Conjecture**

Steenrod operations in mod-$\ell$ motivic cohomology are at the heart of Voevodsky’s proof of the Milnor Conjecture. The construction of these operations given in [V3] turned out to be much more subtle than the topological counterpart, and their properties in the special case $\ell = 2$ differ somewhat from the corresponding properties of Steenrod operations in topological singular cohomology.

Following the approach for $n = 2$ introduced by A. Merkurjev and Suslin, Voevodsky investigated what happens when one splits a symbol $\{a_1, \ldots, a_n\} \in K^n_n(F) \otimes \mathbb{Z}/\ell$. For any such symbol, there exists a universal splitting variety $X_\alpha$. Earlier
work of Suslin and Voevodsky [SV2], together with several ingenious arguments introduced by Voevodsky, reduces the proof of the Milnor Conjecture (and the more general Bloch-Kato Conjecture) to a specific vanishing calculation in motivic cohomology associated to $X_a$: $H^{n+1}(\mathcal{C}(X_a), \mathbb{Z}/(2)(n)) = 0$, where $\mathcal{C}(X_a)$ is a simplicial scheme with $\mathcal{C}_n(X_a) = X_n^{2n+1}$ and all face (respectively, degeneracy) maps given by projections (respectively, diagonal embeddings).

Associated to Voevodsky's Steenrod operations are the corresponding Milnor operations

$$Q_i : \widetilde{H}^n(-, \mathbb{Z}/(2)(q)) \to \widetilde{H}^{n+2i-1}(-, \mathbb{Z}/(2)(q + i - 1)).$$

As in algebraic topology, these operations satisfy the property $Q_i^2 = 0$, so motivic cohomology provided with the operator $Q_i$ forms a complex, whose homology is known as Margolis homology. As a next step, Voevodsky proved the following remarkable theorem concerning the vanishing of Margolis homology.

**Theorem 4.** [V3] Let $X$ be a smooth projective variety over a field $k$ of characteristic different from $2$. Assume that there exists a morphism $Y \to X$ from a smooth projective variety $Y$ of dimension $\dim Y - 1$ to $X$, and further assume that the characteristic number $\deg(s_{2n-1}(Y))$ is not congruent to 0 modulo $2^n$. Then all of the Margolis homology groups of the simplicial sheaf $\mathcal{C}(X)$ (the unreduced suspension of $\mathcal{C}(X)$) corresponding to the operation $Q_m$ are 0.

For $q = 2$, one can represent the splitting variety $X_a$ by the quadric $Q_a$ defined by the Pfister neighbor $q = \langle (a_1, \ldots, a_{n-1}) \rangle \cong \langle -a_n \rangle$ of $\langle (a_1, \ldots, a_n) \rangle$, which is a smooth projective variety of dimension $2n-1$ and satisfies the condition that $\deg(s_{2n-1}(X_a))$ is not divisible by 4. We now apply Theorem 4 with $X = X_a$ and $Y = Q_{\langle (a_1, \ldots, a_{m-1}) \rangle} \langle -a_m \rangle$ for $1 \leq m \leq n$ to conclude the vanishing of the Margolis homology of $\mathcal{C}(X_a)$ with respect to each of the operations $Q_1, \ldots, Q_n$.

Using dimension considerations, Voevodsky observes that the operation $Q_{n-2} \circ \cdots \circ Q_1$ and its integral counterpart

$$Q_{n-2} \circ \cdots \circ Q_1 : \widetilde{H}^{n+2}(\mathcal{C}(X), \mathbb{Z}/(2)(n)) \to \widetilde{H}^{2n}(\mathcal{C}(X), \mathbb{Z}/(2)(2n-1))$$

are monomorphisms. This reduces the proof of the vanishing of $H^{n+1}(\mathcal{C}(X), \mathbb{Z}/(2)(n))$ to the vanishing of the group $H^{n-1}(\mathcal{C}(X), \mathbb{Z}/(2)(2n-1))$. Fortunately the latter group is much easier to understand: Using [R1], Voevodsky shows that this group is closely related to the group of 0-dimensional $K_1$-cycles studied closely by M. Rost in [R2]. To finish the proof, Voevodsky then applies the main theorem of [R2].

### The Homotopy Category of Schemes

Beginning with his Harvard Ph.D. thesis, Voevodsky has had the goal of creating a homotopy theory for algebraic varieties amenable to calculations as in algebraic topology. Much of this homotopy theory, both stable and unstable, has been developed in collaboration with Fabien Morel (see [MV]). In this abstract context one can realize motivic cohomology and algebraic K-theory as representable functors. One can view motivic Steenrod operations as a special case of operations on "generalized stable cohomology theories". When Voevodsky localizes to obtain a homotopy category of schemes, he is forcing "homotopy invariance", the property that a homotopy type (e.g., represented by a scheme) is viewed as equivalent to the product of itself and the affine line. A key insight of Voevodsky is that there are two types of "circles" in algebraic geometry determining two types of suspension. One type of circle arises when one considers an affine nodal curve (tracing out a curve which crosses itself) and the other when one considers the punctured affine line (which is simply real 2-space minus the origin in the special case the ground field is the complex numbers).

Although Voevodsky has given us a relatively streamlined proof of the Milnor Conjecture which does not rely on this homotopy category, his original conception of the proof relied heavily on such a homotopy-theoretic point of view. Moreover, the expected proof of the odd-prime analogue of the Milnor Conjecture (the so-called "Bloch-Kato Conjecture") fully utilizes this appealing formalism.

We conclude by observing that not only has Voevodsky's work much influenced how algebraic geometers are approaching certain classical questions but also algebraic topologists have begun to produce considerable foundational material in this new homotopy theory.

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WHAT IS... a Gerbe?

Nigel Hitchin

One of the achievements of algebraic topology is to breathe life into obstructions: to turn what prevents us from doing something into an object with structure which allows us to see why we can't do it. Can't get a single-valued solution to a differential equation? Look at the monodromy, a representation of the fundamental group. Algebraic geometry is similar. Can't find an elliptic function with a zero at \( p \) and a pole at \( q \)? Look at \( p - q \) in the group of divisor classes \( H^1(M, \mathcal{O}^*) \), where \( M \) is the elliptic curve and \( \mathcal{O}^* \) is the sheaf of nonzero holomorphic functions on it.

But there is another level of understanding beyond this, which is the territory where the notion of gerbe lies. Much of the theory of Riemann surfaces established in the nineteenth century treated divisor classes by using meromorphic functions and periods of integrals, but nowadays we find it much easier to use the language of line bundles: an element in \( H^1(M, \mathcal{O}^*) \) is an equivalence class of holomorphic line bundles, and the group structure is defined by tensor product for multiplication and dual for the inverse. A modern geometer finds it much easier to deal with these objects, which can be manipulated and conceptualized. A holomorphic gerbe is then the geometrical object whose equivalence classes are elements in the next sheaf cohomology group \( H^2(M, \mathcal{O}^*) \).

A holomorphic line bundle is defined by transition functions relative to open sets \( U_\alpha \nabla U_\beta \nabla U_\gamma \rightarrow \mathbb{C}^* \) of a covering. They are holomorphic functions

\[
g_{\alpha\beta} : U_\alpha \cap U_\beta \rightarrow \mathbb{C}^*
\]

which satisfy \( g_{\beta\alpha} = g_{\alpha\beta}^{-1} \) and the cocycle condition on threefold intersections \( g_{\alpha\beta} g_{\beta\gamma} g_{\gamma\alpha} = 1 \) for \( \alpha \), \( \beta \), \( \gamma \) indices.

The holomorphic gerbe is analogously defined by functions \( h_{\alpha\beta\gamma} : U_\alpha \cap U_\beta \cap U_\gamma \rightarrow \mathbb{C}^* \) satisfying skew-symmetry in the indices and a cocycle condition on fourfold intersections. Although this literal translation of the definition of \( H^2 \) in Čech cohomology is not the best way to understand gerbes, it is adequate to understand the following simple case. Suppose that \( P \) is a holomorphic bundle of projective spaces over \( M \). It is defined by patching together the local products \( U_\alpha \times \mathbb{C}^n \) by transition functions \( g_{\alpha\beta} \) on \( U_\alpha \cap U_\beta \) with values in the projective linear group \( \text{PGL}(n+1, \mathbb{C}) \). Over each open set we can choose a lift \( \tilde{g}_{\alpha\beta} \) to the general linear group \( \text{GL}(n+1, \mathbb{C}) \) and set \( h_{\alpha\beta\gamma} = \text{det}(\tilde{g}_{\alpha\beta} \tilde{g}_{\beta\gamma} \tilde{g}_{\gamma\alpha}) \). This defines a gerbe: its cohomology class in \( H^2(M, \mathcal{O}^*) \) is the obstruction to finding a rank \( n+1 \) vector bundle \( V \) such that our given projective space over a point \( m \in M \) is the projective space of \( V_m \).

Unfortunately threefold intersections cause a conceptual block. With the transition functions \( g_{\alpha\beta} \) of a line bundle, we can patch the local products \( U_\alpha \times \mathbb{C} \) to get a complex manifold, the total space of the line bundle. A gerbe, however, is not a space, because we can't patch together in threes. There is an alternative to the \( h_{\alpha\beta\gamma} \), which is to use line bundles \( L_{\alpha\beta} \) over \( U_\alpha \cap U_\beta \) satisfying relations like those above for the transition functions \( g_{\alpha\beta} \) (see [2]). The price to pay is that although we can take products and inverses of line bundles, unlike functions they do not form a group—only the set of equivalence classes \( H^1(M, \mathcal{O}^*) \) does. Line bundles themselves belong instead to a category. In particular, the equality \( g_{\beta\alpha} = g_{\alpha\beta}^{-1} \) must be replaced by a choice of isomorphism \( L_{\alpha\beta} \cong L_{\beta\alpha}^{-1} \). This road leads to a gerbe being described as in [1] by a sheaf of categories, or groupoids in this case.

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One way to get a more concrete idea of a gerbe is to break away from its origins in algebraic geometry and see it more as a differential geometric object, as its recent appearance in theoretical physics suggests. We now replace local holomorphic functions $h_{ab}$ on a complex manifold by smooth functions and assume that the values lie in the group $U(1)$ of unit complex numbers. There is then the notion of a unitary connection on the gerbe, provided by real differential 1-forms $A_{ab}$ and 2-forms $A_{abc}$ such that

\[ iA_{ab} + iA_{bc} + iA_{ca} = h_{ab}^{-1} dh_{bc} + h_{bc}^{-1} dh_{ca} + h_{ca}^{-1} dh_{ab}. \]

Then $H = dA_{abc}$ is a global closed 3-form, which is defined to be the curvature of the connection. The de Rham class $[H/2\pi] \in H^3(M, \mathbb{R})$ is integral, just as $[\mathcal{F}/2\pi]$ is the first Chern class if $\mathcal{F}$ is the curvature form for a connection on a line bundle. In another language, equivalence classes of gerbes with connection like this have been around for decades in the theory of Cheeger-Simons differential characters in degree 2.

The best-known example of a gerbe with connection arises when the manifold $M$ is a compact simple Lie group $G$. There is a natural gerbe on $G$ whose curvature is a multiple of the bi-invariant 3-form $B(X, [Y, Z])$, where $B$ is the Killing form—for $G = U(n)$ this is $tr(g^{-1}dg)$. Whereas a line bundle has holonomy around a closed curve, a gerbe has holonomy around a closed surface. More generally, if the curvature of the gerbe vanishes, then there is holonomy in $H^3(M, U(1))$. As an example, $B(X, [Y, Z])$ vanishes on a maximal torus $T \subset G$ because $T$ is abelian, so the gerbe is flat there, but the holonomy is nonzero—it is a rather subtle mod 2 invariant of the group. For a map of a closed surface $f : \Sigma \rightarrow G$, the curvature is zero on the 2-manifold $\Sigma$; in this case the holonomy evaluated on the fundamental cycle of $\Sigma$ is the $R/Z$ invariant which physicists call the Wess-Zumino term.

The integral cohomology class in $H^3(M, \mathbb{Z})$ defined by the curvature form of a gerbe with connection exists for topological reasons: in Čech cohomology it is represented by $\delta \log h_{ab}/2\pi i$. Since the homotopy classes $[X, K(Z, 3)]$ of the Eilenberg-MacLane space $K(Z, 3)$ are just the degree 3 cohomology, a topologist who wants to understand gerbes has to ask himself the question: what structure does this space have? One model for $K(Z, 3)$ which is currently providing the basis for developments of gerbes both in topology and physics is the classifying space $BP\text{U}(H)$ for the projective unitary group of Hilbert space. A map $X \rightarrow BP\text{U}(H)$ defines a bundle of projective Hilbert spaces over $X$, and this provides a gerbe just as the earlier finite-dimensional example did. The difference is that the class in $H^3(X, \mathbb{Z})$ is $(n+1)$-torsion for $P\text{GL}(n+1, \mathbb{C})$, whereas any class can be represented by a projective Hilbert space bundle. This approach forms the basis of the active area of twisted K-theory. To a bundle of projective Hilbert spaces one can associate a bundle of Fredholm operators $Fred(P)$, since the scalars act trivially by conjugation and the twisted $K$-group $K_P(M)$ is defined to be the space of homotopy classes of sections of $Fred(P) - M$. This group, a module over $K(M)$, has generated much interest recently, particularly in the theory of D-brane charges in superstring theory, but quite often explicit calculations using Mayer-Vietoris sequences are handled by using the line bundles $L_{ab}$ defining the gerbe rather than appealing to the infinite-dimensional projective bundle.

There is clearly a larger picture here: unitary gerbes take their place in a hierarchy, beginning with functions to the circle, then principal circle bundles, then gerbes and next 2-gerbes, and so on. The canonical line bundle of a complex manifold is the object underlying the first Chern class, and understanding the geometry of the 2-gerbe behind the first Pontryagin class is one of the challenges for understanding the next level.

References


Olga Arsen' evna Olelnik (1925–2001)

Willi Jäger, Peter Lax, and Cathleen Synge Morawetz

Her Life

On October 13, 2001, Olga Arsen' evna Olelnik, one of a handful of truly exceptional women mathematicians of the twentieth century, died in Moscow at the age of seventy-six, succumbing, after a long struggle, to cancer.

Olga Olelnik was born in the Ukraine on July 2, 1925. In 1941 the Ukraine was invaded by Germany, and the machine factory where Olga's father was bookkeeper was evacuated to Perm in the Urals. The sixteen-year-old Olga accompanied him and finished high school there. Her mother, her sister, and her nephew remained in the Ukraine. Olga then attended the University of Perm, to which the mathematics and mechanics faculty of the Moscow State University had also been evacuated. There her talents came to the attention of professors Sof'ya Yanovskaya and Dynnikov, who arranged in 1944 for her to become a student in Moscow at the university. She was married briefly and had one son, to whom she was devoted and who predeceased her.

Olelnik continued at the university, receiving her doctor's degree in 1954 with a thesis in partial differential equations (PDEs) under the guidance of I. G. Petrovskii. The topic, partial differential equations with small coefficients multiplying the highest-order terms, heralded some of the underlying approaches to much of her future work. Although she also made contributions to algebraic geometry, to Hilbert's sixteenth problem, and to other topics, her forte and lifetime contributions were focused on PDEs that arise in very important applications such as boundary-layer theory and elasticity. In fact, she constantly emphasized the role of PDEs in applications [01].

She remained a devoted student and disciple of Petrovskii and his memory for her whole life. She succeeded him to the chair of differential equations, and despite the political difficulties of the seventies and eighties, she steered the department forward successfully throughout her tenure. Olelnik received many prizes and awards in her lifetime; she was named a member of the Russian Academy of Sciences in 1990 but had earlier been made an honorary member of too many foreign academies and societies to list here. She was also awarded many honorary degrees as well as prizes both in her native land and abroad. In all, she published more than three hundred papers and eight monographs.

She was deeply involved in improving and extending contacts between Russian and Western scientists. She was particularly eager to bring the Western world to Russian mathematicians and was therefore anxious to see Western mathematical literature translated into Russian. An early beneficiary of such a translation was the new edition of Courant-Hilbert, Vol. 2, which appeared in Russian in 1962, the same year it appeared in English. When Courant died in 1972, Olelnik and Paul Aleksandrov wrote a long obituary in Uspekhi2 emphasizing

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1 CSM. The author (CSM) is indebted to Tatiana A. Shaposhnikova of Moscow University for much of this information.

Courant's contributions to American mathematics through his institute at New York University. Oleinik loved to travel. In 1960 she met Courant and Lax in Moscow on their visit to Alexandrov, an old friend of Courant's. Thus when she was invited to a women's congress in California shortly afterwards, she was able to accept Courant's invitation to visit New York. It is hard now to remember how unusual such a visit was in the decade following Stalin's death. She retained an abiding affection and interest in those working in Courant's group: K. O. Friedrichs, F. John, P. D. Lax, and L. Nirenberg. I met her then for the first time, but I became close to her only when, at G. Fichera's invitation, she and I spent a month in 1965 together at the University of Rome. The university was "under siege" by the student body, and it was only Fichera's political skill that made it possible for Oleinik to give her talks. We were excluded from the campus much of the time, so together we happily toured the wonderful sights of Rome instead.

Oleinik was a very private person. In the latter part of her life she suffered badly from knee trouble, which prevented her from walking properly and sometimes kept her hospitalized. During one such long stay she kept occupied by writing another book. For a woman who had been so active as a mathematician and with her students (she supervised fifty-six dissertations), these spells of inactivity were trying. She told me once that as a young student she had worked in what we would call a lumber camp and how much she, in contrast to the other girls, had enjoyed doing the hard physical work.

The life span of Olga Oleinik was from the early days of the sovietization of Russia to the complete collapse of communism. I never heard her express a political opinion nor make a complaint about how things were going. She clearly tried to live within the system she had been raised in, and her model was always her teacher, Petrovskii. Uprooted from the Ukraine by the war, she identified herself as a Russian, not as a Ukrainian. Of one thing I am sure: she believed a larger picture of her country was the right one.

Oleinik was devoted to mathematics. She drove her theorems to their absolute limits. She never seemed happier than when she was doing mathematics or working with her students, the most important elements in her life. She left a great deal of unfinished work, although she had published so much. We may hope that this work will be completed by her students and colleagues.

Oleinik was one of the major figures in the study, during the fifties and sixties, of elliptic and parabolic equations. This study was the major field of partial differential equations at the time, and many mathematicians such as Agmon, John, Ladyzhenskaya, Morrey, Nirenberg, and Vishik were involved in it. It would make this article too technical to describe Oleinik's most significant achievements in this area, and we will confine the scientific description to some of the many other areas to which she made even more significant contributions.

Nonlinear Hyperbolic Equations

During the years 1954-61, Olga Oleinik studied the theory of nonlinear hyperbolic conservation laws and the propagation of shock waves. Her contributions were basic and extremely original. Her 1957 paper in the Uspekhi [O2] was particularly influential. The starting point of her work, like much in this field, was Eberhard Hopf's fundamental paper of 1950 [H].

Oleinik's results deal mainly with the existence, uniqueness, and properties of solutions of the initial-value problem for single conservation laws. She showed that solutions satisfy one-sided Lipschitz conditions and formulated for flux functions that have points of inflection what today is called the Oleinik entropy condition.

Her principal tool was the parabolic perturbation of a conservation law. She proved that as the coefficient of viscosity tends to zero, the solution of the initial-value problem for the parabolic equation tends to a solution, in the sense of distributions, of the conservation law, and that this limit satisfies the Oleinik entropy condition.

In 1957 Oleinik and Vvedenskaya considered a discretized form of a conservation law and proved the convergence of their solutions to solutions of the conservation law, as the discretization parameter tends to zero [OV]. This provided another approach to the problem.

Oleinik also studied special systems of pairs of conservation laws, which are derivable from second-order equations; in 1966 she proved uniqueness of the initial-value problem in the class of solutions that satisfy a one-sided Lipschitz condition [O4].

Boundary Layer Theory

In their simplest form, Prandtl's steady 2D boundary-layer equations are obtained from the Navier-Stokes equations by stretching the variables appropriately. If $x$ is distance along the boundary,
and $y$, a depth variable, is distance from the boundary, the equations become after rescaling:
\[
\begin{align*}
    u_x + v_y &= 0 \quad \text{(mass)}, \\
    uu_x + vu_y &= -p_x + \mu uu_{xx} \quad \text{(x-momentum)}, \\
    p_y &= 0 \quad \text{(y-momentum)}.
\end{align*}
\]

The standard boundary conditions are $u = v = 0$ on $y = 0$ and $u - U(x)$ as $y \to \infty$. The function $U$ is the speed of the flow "along the body" given by inviscid incompressible flow and is related to the pressure by Bernoulli's law,

\[ p + \frac{1}{2}u^2 = \text{constant}. \]

Upstream, say $x = 0$, the incoming flow is prescribed. Experimental observations confirm the scaling.

Thus we have a nonlinear parabolic equation for $u$ with the role of time derivative played by the Lagrangian along the particle path. The coefficient $v$ is to be found from the mass equation.

The crucial question of how the separation or breaking away of the boundary layer from the boundary takes place is still not resolved. Oleinik's work concentrated on where and why separation does NOT take place by proving that there exists a unique boundary flow and hence one without separation, provided in our simple case that $p_x \neq 0$ [03]. In real life on an airplane wing this is achieved by artificial suction, and Oleinik examined this question in detail (see [04]). In 1997, after many papers with others from 1963 on concerning many different kinds of flow from magneto-hydrodynamics to non-Newtonian fluids, she wrote a book on the subject summarizing and proving many background results and her own key theorems [05].

**Singular Elliptic and Parabolic Theory**

Equations of elliptic or parabolic type enjoyed a great deal of attention in the decades following World War II, and Oleinik's thesis was in this area. She followed it with many other results, but she may well be best remembered for her work on degenerate problems where an elliptic equation becomes parabolic at points or segments on the boundary or even in whole patches of a domain. One of the simplest examples is for the solutions $u$ of the wave equation depending only on $x/t$. Thus with $r = |x|, \rho = r/t$, the equation for $w = ru$ is $(\rho^2 - 1)w_{\rho\rho} + \rho w_{\rho} - \Lambda w = 0$, where $\Lambda$ is the angular part of the Laplacian, and the degeneracy, not surprisingly, occurs on the light cone $\rho = 1$.

Oleinik determined the conditions for well-posedness in many cases and in 1964 generalized and completed the problems posed by G. Fichera [F] (see [06]). The technique was to add a term so that the equation remains elliptic and to obtain estimates for the limiting case when this term vanishes. By 1977, however, Oleinik was directly using a priori energy estimates [07].

**Homogenization of Differential Equations**

Oleinik's contributions to homogenization and her impact on this field were very broad. Mathematical modelling leads naturally to systems with multiple scales, for example in electromagnetism, mechanics, material science, and flows through porous media or biological tissues. The resulting underlying structures may be highly oscillatory in space and time. To analyze the transition between the different scales and to derive effective model equations are great challenges to mathematical research and imply many practical consequences. The main problem lies in identifying the proper scaling and, if possible, deriving effective equations for limits when a "scale" goes to 0 or $\infty$. The random situation especially, the most important in real life, poses a lot of difficult questions.

The challenge is to derive quantitative results, including estimates for the approximations. Homogenization, a special kind of averaging, started as a mathematical discipline only about thirty years ago, although in physics and engineering such averaging methods had been used for many years to determine effective properties and effective laws for heterogeneous media.

The theory of homogenization is strongly linked to Oleinik's name. An impressive group of mathematicians from the Department of Differential Equations at Moscow State University formed a leading team, and with them Oleinik developed a fruitful cooperation with France, Germany, and Italy, especially after the fall of the iron curtain. The list of contributions of Oleinik and her coworkers, covering all of the main areas of homogenization, can be found in the monographs by Oleinik, Shamaev, and Yosifian [OSY] and by Jikov, Kozlov, and Oleinik [JKO]. These books are important sources of information and original ideas, and cover important topics in theory and applications.

Oleinik's contributions were mainly in developing the necessary tools to control the scale limit for initial and boundary value problems for systems with oscillatory coefficients or in domains with complex structures, holes, or oscillatory boundaries. Essentially two methods are available: energy methods, based on proper estimates of the solutions and compactness results; and multiscale expansions.

Introducing fast and slow (microscopic and macroscopic) variables, one starts from a formal expansion with respect to the scale parameter, obtaining a recursive system for the coefficients.
of the expansion. Oleinik and her coworkers developed a systematic technique for determining approximations and validating the expansion. In the case of periodic structures, the approximation problem in the interior of the domain is reduced to approximations and validating the expansion. Effective equations can often be obtained by such averaging. The cited monographs contain many examples.

The analysis at the boundary or at interfaces is more complicated, and here the contributions of Oleinik have been especially important. She and her coworkers did pioneering work on the approximation near the boundary. The analysis of boundary layers is a nontrivial problem in the case of periodic structures. Oleinik and her coworkers obtained optimal results when the boundary is flat and in rational position with respect to the periodicity lattice. In this situation an unbounded boundary-layer cell has to be considered. Ideas developed in the papers of Oleinik and Yosifian can be used to study problems in domains where the scale changes across an interface. Typical examples are processes in partially porous or perforated domains where the derivation of effective transmission conditions and the estimate of the errors at the interface are the main aims. Flow and transport through filters are practical, important examples. During her last years, despite her serious health problems, Olga Oleinik was also involved with such multiscale problems, strongly motivated by the many possible applications. Oleinik also developed a spectral theory adapted to homogenization.

Stochastic homogenization, mainly in the case of random coefficients, is the main topic in [JKO]. Several important contributions were obtained in Oleinik's group. Homogenization of stochastic processes, also in random geometry, is a crucial topic of ongoing research, and here Oleinik's influence is clear.

**Problems in Elasticity**

Traditionally the links between mathematics and mechanics are very strong in Russia, and Oleinik's mathematical research reflected this. Prominent examples are Korn-type inequalities, basic in proving existence and estimating the solutions of the main boundary-value problems in elasticity. Consider the tensor $e(u)$ defined by

$$e_{ij}(u) = \partial_j u_i + \partial_i u_j.$$  

Korn inequalities relate the $L^2$-norm of $e(u)$ with the $L^2$-norm of $\nabla u$, for instance in the form of the inequality

$$\|u\|_{H^1(\Omega)} \leq C (\|u\|_{L^2(\Omega)} + \|e(u)\|_{L^2(\Omega)}).$$

In general, assumptions on the domain are necessary: for example, the assumption that $\Omega$ is bounded and a Lipschitz domain. Also, an optimal constant $C$ is wanted, with the constant depending on $\Omega$. Kondrat'ev and Oleinik obtained the estimate by a rather simple proof, with asymptotically sharp constants in the case of star-shaped domains. As Oleinik liked to say, the original proof was nineteen pages, Friedrichs's proof was nine pages, and they had reduced it to four pages [OSY, Chapter 1, §2]. They also proved further Korn-type inequalities that are even more useful.

**References**


[H] Eberhard Hopf, The partial differential equation $u_t + \mu u_{xx} = \mu_{xx}$, Comm. Pure Appl. Math. 3 (1950), 201-30.


Mathematical Reflections and Mathematical Vistas
Reviewed by T. W. Körner

Mathematical Reflections
Peter Hilton, Derek Holton, and Jean Pedersen
Springer-Verlag, New York, 1997
351 pp., ISBN 0-387-94770-1, $44.95

Mathematical Vistas
Peter Hilton, Derek Holton, and Jean Pedersen
Springer-Verlag, New York, 2002
335 pp., ISBN 0-387-95064-8, $59.00

Mathematical Reflections and Mathematical Vistas are two books of mathematical essays intended for able "secondary students of mathematics, undergraduate students of mathematics or adults seeking to extend their mathematical competence." The authors have tried to make the two books independent, but anyone who likes one will like the other, and it makes sense to read them in the order in which they were written (that is, first Reflections and then Vistas). A list of chapters is given in the sidebar.

The readers of this review will not, in the main, form part of the specified audience, but they do choose books to stock the libraries used by that audience. The important part of my review is thus contained in the next sentence. These are excellent books which should be in every university, college, or school library used by actual or potential students of mathematics. When you have ensured that your institution's library has obtained the two books, you should look at them and decide for yourself whether (as may well be the case) you might learn something by reading them. Let me add that Springer has done an excellent job of presentation and that though one would wish the prices of these books lower, they are not unreasonable.

There are many difficulties involved in the project the authors have undertaken, and most of the rest of the review is an extended reflection on them. This may give the review a slightly somber tone, so let me emphasise that I believe that the authors have done a splendid job of overcoming the difficulties. If I could write books like these, I would.

Now let us look at some difficulties.

Reviewers: Who should review books of this type? (From now on I shall call them semipopular books.) Obviously not students. They have no standard of comparison and no way of telling if the authors achieve their intended goal. Professors trying to be the eighteen-year-olds they once were? "So far as I can remember my eighteen-year-old self, I think he would have enjoyed these books but failed to understand much of what was said. Much of what the eighteen-year-old did understand would be later forgotten, but some arguments would remain, like beacons illuminating his mathematical life. In other words, these books would be a splendid experience. However, my middle-aged self cannot tell which bits would be the beacons—perhaps the idea of a contraction mapping from the chapters on paperfolding or perhaps the Pólya enumeration theorem. The only remaining reviewers are professors. But professors read like jackdaws, picking out the glittering bits. (I have never been good at explaining why

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Euler's totient function is multiplicative. After reading the appropriate part of Chapter 2 of Reflections, I now know how to do it.) They also read what they think is written and not what is written. It is impossible to find completely appropriate reviewers for semipopular mathematics texts.

Where to start: The lecturer to a second-year or third-year university class knows what the students are supposed to know and what notation can be safely used. The writer of a semipopular text enjoys no such advantage. The authors of this text have used two classical techniques to get round the problem. The first is to make the various essays independent, so that a student who does not get on with one topic can switch to another. The second, which they employ extremely gracefully, is to start each chapter at a fairly low level and gradually increase the difficulty. Of course, however smoothly the increase in difficulty is handled, the student must eventually reach the limit of his or her capabilities, and this means that few will reach the end of any chapter with full understanding. My eighteen-year-old self tells me that this does not matter, and my middle-aged self agrees.

The problem of where to start can be mitigated, but there is no way of resolving it entirely. In the first chapter of Reflections the authors need a polar equation of the form \( r = \theta \). If \( \theta \) is measured in degrees, the picture is peculiar. If \( \theta \) is measured in degrees and the equation replaced by \( r = \theta / 100 \), we have introduced an artificial constant. Instead, the authors choose to be consistent with standard practice and measure \( \theta \) in radians. They give a brief explanation of radian measure, but, whilst their explanation would function well as a reminder, I doubt whether it would work as an introduction. Elsewhere they assume that the student can easily use the sum symbol \( \sum_{i=1}^{n} \), and more generally they require a quite high level of fluency in algebraic manipulation. It seems to me that overall their choices are wise and consistent but limit the readership to "university-ready" school children and above.

Where to finish: The lecturer to a first-year or second-year class knows what the students are supposed to know at the end of the course. The structure that the lecturer builds is primarily intended as a foundation for some well-defined future course. The writer of a semipopular text has no such well-defined goal. The authors of these two books have tried to make each chapter complete in itself and have, I think, succeeded, but inevitably tensions remain.

Some of the chapters introduce topics that form part of every mathematician's education (polar coordinates, modular arithmetic, countability, groups, and graphs). I would be delighted if my own students had read these chapters before they arrived at university. Other chapters, although enjoyable in themselves, would be less useful. As the most extreme example, there are two chapters on mathematical constructions using paper-folding. These have many virtues. They bring the student into direct contact with new research, for the results were obtained by two of the authors. The ideas could form the basis of delightful hands-on classes for school children of all ages. However, the mathematics involved is real mathematics and like all real mathematics takes hard work to really understand. It would be a valuable experience for my students to master this material, but it would be both a valuable and useful experience for my students to master div, curl, and grad before they arrived at university. If the authors were to reply that prospective school teachers need exposure to the idea of mathematical research much more than a lot of tedious manipulation of vector calculus identities, I would not disagree. Different audiences have different needs, and a semipopular book cannot confine itself to one audience.

The professor over your shoulder: There is a romantic opinion among American mathematics students and many of their teachers that authors of mathematics textbooks should think only of their readers and never of their peers. The gigantic, now-with-2,000-more-routine-exercises-and-examples-from-business-studies, available-in-early-transcendental-and-late-transcendental, four-coloured, answers-to-odd-exercises, all-American calculus text stands as a monument to this ideal of consumer power.

I do not find it hard to accept that Beethoven cared more for the opinion of Haydn than for that of his paying audiences. I find it easy to imagine Shakespeare laying down his pen at the end of Hamlet's "To be or not to be" and saying, "That will show them how to write a soliloquy" or Silvanus P. Thompson muttering from time to time "And this is the way to teach calculus." In the same way, I could hear the three authors gently chorusing, "This is how you give a proper lecture on fractals, and this is how you give a talk on the proof of Fermat's last theorem." However, the "lessons for teachers" are left implicit and nowhere interfere
Below are the chapter titles for the two books under review.

**Mathematical Reflections**
- Going Down the Drain
- A Far Nicer Arithmetic
- Fibonacci and Lucas Numbers
- Paper-Folding and Number Theory
- Quilts and Other Real-World Decorative Geometry
- Pascal, Euler, Triangles, Windmills...
- Hair and Beyond
- An Introduction to the Mathematics of Fractal Geometry
- Some of Our Own Reflections

**Mathematical Vistas**
- Paradoxes in Mathematics
- Not the Last of Fermat
- Fibonacci and Lucas Numbers: Their Connections and Divisibility Properties
- Paper-Folding
- Polyhedra-Building and Number Theory
- Are Four Colors Enough?
- From Binomial to Trinomial Coefficients and Beyond
- Catalan Numbers
- Symmetry
- Parties

with the authors' duties towards their primary audience.

The only point where they address the professor directly is in the chapter entitled "Some of Our Own Reflections". My preferences go elsewhere, but many people will find it one of the most interesting chapters in the two volumes. The first half is addressed to the student and asks, How should mathematics be done? The advice is unobjectionable (particularly if one adds the words "however, there are many exceptions" to each recommendation) but does not produce the impact that Pólya achieves by a happy marriage of precept and example.

The second half states some "Principles of mathematical pedagogy". The final recommendation "Never cut short an explanation or exposition in order to complete an unrealistically inflated syllabus" should be inscribed in letters of gold above the blackboard of every mathematical classroom. Indeed, I would save money on gold leaf by leaving out the two penultimate words. However, I would hesitate to send prospective university teachers out into the real world armed only with the rest of the authors' somewhat optimistic advice. (I would recommend instead the more worldly *How to Teach Mathematics* by Steven Krantz.)

The authors state their "basic principle of mathematical instruction" as follows: "Mathematics should be taught so that students have a chance of comprehending how and why mathematics is done by those who do it successfully." Obviously there are problems in applying this advice when teaching the class described in Berlinski's *Tour of the Calculus* (not the class from hell but the class from *The Education of Hyman Kaplan*) or, at the other extreme, the young wolves of the Independent University of Moscow, but there are also problems for more usual classes. Suppose that we ask mathematics students what they want from their mathematics class. Human beings being what they are, some students will have contradictory or deeply unrealistic expectations. Others will have clear and achievable goals. "I need an A to go to medical school." "I need to master calculus to do physics." "University represents the only freedom I expect to have in my life. I need a C to stay on." These goals are not ignoble, but they do not run in parallel with the goals implied by the "basic principle".

To this objection the authors could well reply that the clash between what people want and what they need occurs everywhere in human life and though easy to state is impossible to resolve. They might also remark that "Drive as though everyone else is drunk" is a good precept even though based on a false premise. Even those who disagree with their theories must admit the excellence of the authors' practice.

*Exercises:* There is a *New Yorker* cartoon in which a mother tells her child, "It's broccoli, dear," and the child replies, "I say it's spinach, and I say the hell with it." The authors use a device which they call a "break", but which I would call an exercise. As far as I could judge, these breaks are well chosen and would be useful if the chapters were used as part of a course or as the base for lectures with audience involvement.

I am less clear if exercises are useful for the individual reader. I suspect that my eighteen-year-old self would have skipped them or peeked at the answers. These are books which demand to be read with paper and pencil at the ready, and any serious reader will find plenty of work to do in understanding the contents without looking for further challenges. Remember that books like these are meant to be read for pleasure and not as a kind of weightlifting exercise. More generally, I cannot help reflecting that whilst professors are strongly in favour of lots of exercises for their students, the books they write for each other rarely contain exercises.

*Ideology:* If it is not already evident from my earlier comments, let me state my opinion that a book with a strongly held point of view is likely to be better than one that tries to satisfy everyone. The authors believe that mathematics is to be valued for its beauty rather than its utility, and although the introduction to Vistas claims that the examples are drawn from both pure and applied mathematics, this British critic would classify almost all the
material as pure. The only point where I thought that the authors' point of view weakened their exposition was in the chapter on "Paradoxes in Mathematics", more particularly in Section 1.5 (on Simpson's paradox in statistics) and Section 1.6 (can "physical" models use "unphysical" elements). These were the only places in the two books where I felt like wresting the pen from the authors and saying, "You have a good point, but you are not making it properly." In both cases I felt that the presentation was too abstract to convince students that the arguments had any relevance outside the classroom.

Reaching the audience: When I discussed the authors' views on pedagogy, I used a crude rhetorical device to imply that because most students failed to share the ideals of their "basic principle of mathematical instruction", no students shared those ideals. Now let me apologise and admit that there are many people in the world who wish to know "how and why mathematics is done by those who do it successfully."

Such people are a small minority in most mathematics classes, but there are many mathematics classes in the world. Such people may also be found, as a still smaller proportion but now of a much larger number, among nonmathematicians. Many among these interested outsiders recall the reported lament of Shostakovitch, "I would want my music only played by amateurs...if only amateurs could play." However, many others...
In the late 1980s the press was filled with stories about an epidemic of crack babies, addicted at birth and afflicted with irreparable mental handicaps, that would create insurmountable problems for our medical, educational, and social systems. Years later it turned out that the crack baby problem, albeit serious, was only about one-tenth that which experts had predicted.

Similar hyperbole abounds in the media and professional literature: Reports that serial killers are responsible for as many as 4,000 homicides a year turned out to be exaggerated by a factor of ten. Reports that anorexia leads to 150,000 deaths a year were exaggerated by a factor of 20. And reports that white males would soon make up only 15 percent of U.S. workers turned out to be wrong by a factor of three. (Actually, the 15 percent refers to “net additions”, not to the work force itself or even to new entrants to the work force.)

That many published “facts” are wrong (and often by an order of magnitude) would not surprise those who were raised on Darrell Huff’s classic How to Lie with Statistics (Huff, 1954). The association of lies with statistics—carried on by the title of Joel Best’s book—goes back at least to nineteenth-century British Prime Minister Benjamin Disraeli’s reputed characterization of three kinds of lies in political life: “lies, damned lies, and statistics.” Today this association remains as strong as in earlier centuries: Huff’s book is still in print fifty years after its first publication, and Disraeli’s “lies” quotation is, according to the popular BBC quiz show Quote...Unquote, the most quoted remark in the British media (Rees, 2002).

Educated citizens are rightly skeptical of statistics, especially when used by politicians, advertisers, and other advocates to promote particular causes. Mathematicians often have an additional reason to be suspicious: professional caution about the applicability of statistical inference, knowing that reality rarely conforms to assumptions on which these inferential models are constructed. Even when deployed in the most neutral and professional manner, the inexactitude of...
statistical inference contrasts sharply (and for many, negatively) with the deductive certainty that is the hallmark of mathematical reasoning.

The reality is, however, that statistics have become the "facts" on which modern society is built. "After all, facts are facts," noted Leonard Henry Courtney, the British economist and politician in a speech on proportional representation at Saratoga Springs in August 1895. "Although we may quote one to another with a chuckle the words of the Wise Statesman, 'Lies—damn lies—and statistics,' still there are some easy figures the simplest must understand and the astutest cannot wriggle out of" (cited in Baines, 1896, p. 87). [It was this speech, supposedly, that led Mark Twain to attribute the "lies" quotation to Disraeli (Twain, 1924) and that has led many others to attribute the quotation to Twain.]

Much as we now take them for granted, "facts" were not always facts—at least not as we know them today, and certainly not described in quantitative terms. For the first several millennia of recorded history, most humans lived in a qualitative rather than quantitative milieu. Hours were not one-twenty-fourth of a day but times for monastic prayers; feet were not twelve inches but an anatomical comparison. Yet as early as the thirteenth century people began learning the value of imposing standardized measures (of length, of time, of money) through such innovations as mechanical clocks, perspective drawing, and double-entry bookkeeping (Crosby, 1997). Gradually numbers lost their ancient metaphysical meanings and became simply quantities devoid of qualities, which made them useful as tools for measuring just as the value of measuring things became apparent and the means to measure became available.

The increasing prominence of numbers (used to measure specifics) and arithmetic (used to aggregate individual numbers) enabled rudimentary statistics to mediate the transition from the Aristotelian tradition of facts as universals awaiting recognition to the modern scientific understanding of facts as particulars—specific, empirical, and individualistic. In the seventeenth and eighteenth century facts became "nuggets of experience detached from theory," and numbers came to epitomize (modern) facts, because they began to be seen as "preinterpretive or even noninterpretive" at the same time as they became "the bedrock of systematic knowledge" (Poovey, 1998).

In the early nineteenth century, when revolutions threatened social stability, the reporting of societal data (births, marriages, and deaths) and economic measures (agriculture, manufacturing, shipping) offered welcome hints of underlying social order. Decennial censuses became conventional, and counting things—populations, incomes, properties, jobs, crops—became a common and accepted political activity. Thus was statistics born as the "science of the state", but not without considerable contention. For example, the 1840 census, conducted on the eve of the Civil War and just one year after the founding of the American Statistical Association, generated intense political debate because an apparent gradient of black insanity rising from south to north seemed to support slave owners' arguments that slaves could not survive freedom (Cohen, 1982). Many years later this was discovered to be a statistical artifact that magnified certain routine errors of enumeration, but at the time emotions were too intense and statistical understanding too meager for anyone to see this.

The desire to comprehend society through quantitative facts lent the new field of (social) statistics considerable influence. Statistics offered an effective means of creating new universals by making separate facts "hold together". It appeared to make real such social abstractions as fertility, wealth, unemployment, and inflation. By focusing on objects purged of the "unlimited abundance of the tangible manifestations of individual cases," statistics helped objectify the social world (Desrosières, 1998). Slowly, numbers came to be believed simply because they were numbers.

Contrary to widespread belief, the drive for quantitative rigor during the last two centuries has been due not so much to increased demands of natural science as to social pressure for objectivity in political, economic, and social affairs (Porter, 1995). Indeed, the increased propensity (oftentimes demand) to offer numbers in support of arguments of all kinds gives at least the appearance of objectivity. Our contemporary drive for objective data—what we now think of as "facts"—is principally a recent cultural phenomenon. Witness the headlines featuring refinements about the death toll at the World Trade Center: surely the individual deaths significant digits have any newsworthy meaning? This drive to count everything is so strong that numbers used to certify facts often take on what Porter calls "totic" significance, the antithesis of the "lies" reputation that worried Disraeli, Twain, Huff, and now Best.

So how is it that so many widely disseminated facts are not facts at all? Followers of the lies-and-statistics school of thought would probably attribute common howlers either to deliberate misrepresentation or to innumerate reporting. This is the implicit message of Huff's masterpiece: it is so easy to lie with statistics that (almost) everyone does it. Joel Best's brief monograph, written for journalists and lay persons, makes a different and more subtle argument: Statistics not only measure but also create ("objectify") social issues, and the dynamics of objectifying social structures is inherently skewed in the direction of bad statistics.
Here's why, according to Best, a professor of sociology and criminal justice at the University of Delaware:

People who are concerned about some new social issue (e.g., child abductions) seek to justify their concern using the contemporary standard of objective fact, statistics. However, precisely because their concern is new, no one will have collected accurate, systematic data on the problem they are worried about. What little data there may be on child abductions are byproducts of other work, for example, police reports gathered in varied jurisdictions, subject to disparate definitions and uneven standards, or journalistic accounts of cases that appear specially newsworthy.

Faced with the lack of sound data in a political environment that demands numbers for legitimacy, those who are concerned about the new issue of child abductions choose from whatever numbers are available those that will draw greatest attention to their cause. Big numbers will justify their concern; small numbers will not. The media play along, because big numbers make more compelling news. Even experts favor big numbers, because it makes their work seem more important and justifies research grants. Small differences do not produce publishable results; big ones do. (This scenario assumes the best of intentions by all parties. Best's argument is not about the relatively few who fabricate or deliberately misrepresent data but about the way data flows through the hands of those who are trying to be fair and honest.)

As the problem (of child abductions) takes on public significance, better data becomes available and is reported in various sources. Inevitably, secondary sources introduce misinterpretations which make the statistics seem more dramatic. These “mutant statistics” get repeated precisely because they are compelling. Accidental transformations that make a statistic seem less dramatic are likely to be forgotten. Few can escape the Darwinian pressure that confers survival value on dramatic numbers.

Whether motivated by sincerity or opportunity, whether honestly enraged about some social ill or merely hired to advocate a new position in the press or the courts, those who speak for new causes prefer large numbers to make the problem seem serious and the need urgent. To achieve this end, advocates typically favor inclusive rather than well-focused definitions. (Does an abduction of a child by a divorced parent count the same as by a stranger? What about runaways?) Then there is the ever-present unaccounted “dark figure”, which, like the dark matter in the universe, we know must exist but which we cannot see or measure. For every one abduction that gets officially counted, there may be two (or ten) that do not.

Once in circulation, mutant statistics are difficult to retract, especially when the number is large and dramatic: drama ensures repetition, while public innumeracy inhibits critical thinking, even if the number is wrong by an order of magnitude (Paulos, 1988; Dewdney, 1993). Three centuries ago Samuel Johnson quipped that “round numbers are always false.” Now Joel Best explains why and updates Gresham’s Law: Bad statistics drive out good ones.

According to Best’s analysis, social problems are constructed through the activity of people who identify, name, describe, measure, and promote their significance. A widely recognized name turns a condition we take for granted into something we consider troubling and worth measuring. Most commonplace statistics (e.g., the consumer price index, minority unemployment, breast cancer rates) evolved in this manner: only after someone (or some organization) agitated about their importance did systematic measurement begin. In other words, (social) statistics are a product of social activity, not just a representation of society. All statistics are social constructs: they are how we make the world meaningful. Yet too often we treat socially constructed numbers as nuggets of indisputable truth.

Mathematicians will recognize that the “statistics” under discussion here is the plural of the word statistic (meaning “numerical fact”), not the singular “science of data” that is the subject of high school and college courses in statistics. Most popular attempts at demystifying statistics are about the latter; Best’s monograph is almost entirely concerned with the former. Best eschews standard topics such as probability, polls, correlation, and regression in favor of case studies ranging from AIDS and alcoholism to traffic fatalities and victims of crime. As Best amply illustrates, every such statistic is the result of human choices and thus is as much the product as the reflection of social reality.

_Damned Lies and Statistics_ thrives on relevance: nearly all its examples are about important contemporary issues where competing claims about statistics have shaped policy debates in Congress and state legislatures. Recognizing the statistical and mathematical illiteracy of his intended audience, the author rarely discusses any mathematical idea more complicated than a percentage. Instead, Best uses a wide variety of examples to illustrate the manifold ways in which bad statistics can so easily be created: bad guesses, deceptive definitions, confusing questions, biased samples, inadequate measurement, overgeneralization, incomparable comparisons (different times, places, or social groups), public innumeracy, and more.

The aim of Best’s book is similar to Cynthia Crossen’s _Tainted Truth: The Manipulation of Fact_
in America (Crossen, 1994). But Best’s book differs in two important respects: First, it is half as long as Crossen’s, thus more accessible to a broad audience. More important, whereas Crossen relentlessly documents distortions related to research for hire (where the research design produces results favored by sponsors of the research), Best focuses on natural and mostly innocent forces that distort data. In many respects, Best’s analysis is the more alarming, since it illustrates how “mutant facts” can infiltrate where one least suspects.

Despite its brevity—170 small pages—Damned Lies and Statistics is a slow read. It is somewhat repetitive and lacks both the humor that made Huff’s monograph a classic and the passion of Crossen’s treatment. Readers will gain a good deal of caution but will not learn much about how one should create good statistics nor how to transform bad ones into better ones. Best says next to nothing about inferential statistics, the subject of virtually every introductory course on the subject. There are very few good examples in the book: it is not a handbook about creating good statistics.

Best’s goal is different from these other treatments and in some ways more scholarly. He sets out to document a sobering social theory of facts in our number-crazed age, namely, that statistics—the plural word, not the singular—are primarily social products (not social measures) subject to inherent forces that skew numbers in the direction of the large and the dramatic. As such, statistics must be approached first, not with the tools of Minitab or SPSS, but with the skepticism of a good investigative reporter: who created them, why were they created, what was their intended purpose, and how accurate might they be?

One might wonder why a monograph devoted to data that is virtually devoid of standard inferential or quantitative analysis should stir up so much interest in higher education—a lengthy excerpt was printed in the Chronicle of Higher Education (Best, 2002)—or be reviewed in the Notices. I suspect that one reason is the recent widespread recognition that numeracy is a failing of our educational system parallel to, but different from, the system’s well-known weaknesses in mathematics (e.g., Steen, 2001; Madison, 2002).

But another reason, noted by Best, is a poorly recognized paradox of our educational priorities: the quantitative devices subject to the deceptions that Best analyzes depend on only the simplest of mathematics—averages, percentages, rates—yet our educational strategies focus primarily on more advanced aspects of statistics (and mathematics), overlooking many sources of corrupt data simply because the underlying mathematics appears too simple to worry about. To help students deal with the deluge of quantitative facts, we need to find some way to reinforce and extend their sophistication in using the most elementary aspects of mathematics to think about data while at the same time continuing to advance their knowledge and skills in more advanced mathematics. Without such skills for thinking about data, students will be left to the mercy of numbers as totems, forever thinking of statistics “as facts we discover not as numbers we create” (Best, p. 160).

References
Presidential Views: Interview with Hyman Bass

Every other year when a new AMS president takes office, the Notices publishes interviews with the incoming and outgoing presidents. What follows is an edited version of an interview with AMS president Hyman Bass, whose term ended on January 31, 2003. The interview was conducted in November 2002 by Notices senior writer and deputy editor Allyn Jackson. Bass is professor of mathematics education and Roger Lyndon Collegiate Professor of Mathematics at the University of Michigan, Ann Arbor. An interview with AMS president elect David Eisenbud will appear in the March 2003 Notices.

Notices: You have had a lot of contact with mathematicians during your presidency. Based on those contacts, what do you see as the biggest challenges facing the profession?

Bass: There are two perennial issues. One has to do with resources to support the research enterprise. That is a constant campaign with federal and public agencies. And the other is whether we are drawing enough talent into the field to maintain quality and productivity.

The Carnegie Foundation [for the Advancement of Teaching] has begun an initiative to examine the doctorate and it has commissioned essays by people in different areas. I wrote one of the essays, in which I draw attention to a distinction between mathematics as a discipline and mathematics as a profession. The “discipline” refers to our traditional concept of the field as a body of knowledge and an intellectual heritage to which people contribute: They generate new knowledge, they warrant and document that knowledge, they assimilate it, they record it in the literature, and they transmit it through education. This has happened throughout the history of mathematics in different forms and at different levels of intensity. Until the middle of the twentieth century, mathematicians, as a community, were sociologically pretty much at the level of a village. There were very small numbers of highly dedicated people whose involvement in the field grew from a love of knowledge and a philosophical commitment.

Mathematics has now grown into a profession. This is driven partly by the growing recognition of the importance of mathematics in social and economic needs and partly by the building up of a professional, intellectual community that is vastly larger in size than anything before in history. We are a much larger, more complex community. A lot of the problems facing mathematics are the persistent problems of maintaining a large professional community and maintaining its standards and norms. We also have to make sure that supporting resources from public institutions remain robust and that our commitment to serve the public needs remains strong and effective. Related to this is capacity building, the need to bring talent into the field. We need to make the significance and importance and beauty of the field apparent to the public and to make mathematics as a profession attractive to talented young people.

Notices: What is the AMS doing to try to make the profession more attractive?

Bass: The AMS has a proud record of intervening when outside conditions put some of our valued cultural institutions at risk, something that it has been able to do through a combination of using corporate income and member contributions. When the community perceived gaps in federal programs for mid-career support, the AMS established the Centennial Fellowship program. At the time of the collapse of the Soviet regime, the U.S. mathematics community contributed generously to protective measures for the remarkable Russian mathematical community. At a time when public institutions held back on resources to encourage talented and highly motivated young people—for example, termination of the NSF Young Scholars Program—the AMS took some small but important initiatives to fill in those resources, for example by creating the AMS Young Scholars Fund. This “Epsilon Fund”, which is symbolically and materially quite important, enhances support for enrichment programs for young people. This kind of gesture is very congenial and recognizable to mathematicians because, in our educational roles, nur-

1 See http://www.carnegiefoundation.org/CID/index.htm.
turing young talent is in some sense our favorite activity. In some ways these enrichment programs are at odds with prevailing ideologies in education, which argue that such programs are elitist. Strangely, there is not the same disposition toward encouraging high talent in athletics, or music. Actually, everyone benefits from very high performance in mathematics; it is a public good. A lot of people mistakenly believe that anything dedicated to very high performance is inherently inequitable. Not only is that wrong, but I think it is a disservice to underprivileged students in education because the premise is that somehow they are not going to be capable of performing in the same way.

The AMS has spent a lot of time on building a better public image of mathematics, to make it better appreciated by the public: getting better press coverage, writing popular material, and staging various kinds of public displays of what mathematics does. But we fail to recognize adequately that we have a fantastic slave audience right at our feet. Much of people's attitudes toward the discipline and toward the profession is formed in the classrooms that we control. Of course we do not want to conduct our classrooms as PR enterprises. But implicitly, the way we instruct provides huge opportunities for giving our field a better public face.

Saying that does not offer a solution to the problem, because doing the kind of teaching and instruction that would really make a difference is a pretty demanding professional undertaking in its own right. This is a part of our professional culture to which, historically, we have not greatly attended. We have assumed that if you have expert knowledge of the subject matter, good expository skills, and a reasonably friendly personality, then you have all the necessary resources for effective instruction. Education, like clinical medicine, is a profession of human improvement. The latter requires not only a knowledge of biochemistry, drugs, and bedside manner, but also a detailed and practiced knowledge of the human body and the ways it can malfunction. Similarly, mathematics teaching requires not only a sound and comprehensive knowledge of the subject matter and good presentation skills, but also a knowledge of student thinking and of how to usefully assess student understanding of what is being taught.

Education is a body of knowledge and a field of expert practice where there are things to be learned. Unfortunately, given the way the political environment has evolved, there is a tendency in many quarters to completely discredit the field of education or not even to acknowledge that it exists, much less that we have something to learn from it. So this is difficult territory right now.

**Notices: Are the "math wars" over? And if so, who won?**

**Bass:** No, they are not over. Right now two things are going on. One is a contest of ideas: what are the problems in education (most people agree that the fundamental problem is that U.S. students are not becoming mathematically proficient), and what are the best ideas to help solve them? The other is a contest of power and authority. Here the issue is not, What are the best ideas? but, Who is best qualified and who is appropriately authorized to make decisions about what should be done? For example, some mathematicians believe that research mathematicians, with perhaps some advice from a few friendly school teachers, are the sole and final authority in fashioning policies in school mathematics education. (The history of school reforms authored mainly by mathematicians, for example the New Math, is hardly something to celebrate.) Unfortunately, a lot of energy is spent on the latter kinds of issues.

We need to push the politics into the background and try to frame things so that ideology does not play such an important role. The fundamental problem is that the learning and teaching of mathematics is not happening at the quality levels and scale that we need. Everybody agrees that that is pretty much what the problem is. So one strategy is to focus attention on the specific educational problems. Deborah Ball and I have tried to do this in our work. For example, we show a group of mathematicians and educators a video of a math class. In the video a teacher is trying to teach some topic. A kid says something, and it is obviously mathematically significant, but it is not clear what is going on in the kid's head and it is not clear what the teacher should do with it. This is the kind of decision making teachers have to do every day, and it draws on mathematical knowledge and understanding. If we present a scenario like that to an audience of mathematicians and educators, ideology completely disappears. The range of opinions and views is totally unpredictable, based on public stances people have taken. This shows two things. First, there is less disagreement about real fundamentals than one might think, and there is a lot of earnest interest. And secondly, it makes people realize that there is a huge amount of work to be done before we understand these problems well.

**Notices: What is the AMS doing in education right now?**
Bass: The official instrument for educational issues in the AMS is the Committee on Education. It has been carrying on some very good work. It functions in a mode somewhat parallel to the Committee on Science Policy. It meets with representatives of organizations and federal agencies to find out about things happening in the field, it undertakes initiatives of its own, and it stages presentations by experts at the Annual Meetings and venues like that. In contrast with the MAA [Mathematical Association of America], the AMS has not been a very active agent in education. But I think the AMS has done quite a bit to raise awareness in the field.

The AMS has collaborated with other organizations on projects like the Mathematical Education of Teachers [MET] report. That is a natural site for us to be involved, because part of the instructional mission of mathematics departments consists of courses for pre-service teachers. Mathematics departments feel pretty strongly that those courses should be taught in mathematics departments, not in schools of education. On the other hand, the level of quality of attention that has been dedicated to those courses has been highly variable. As the debates in education have heated up, we have come to recognize that the mathematical knowledge of teachers is really a crucial factor. This recognition draws a lot of focus on the quality of those courses. The MET report was a way of mobilizing the field to make it clear publicly, not only to the outside but to our own community, that this is a very important problem site that has to be met responsibly and that resources are needed to help the profession address it.

Another effort is a project we are tentatively calling MIME, for Mathematicians in Mathematics Education. The premise is that research mathematicians have important things to contribute to public education. These contributions might be in, for example, developing or critiquing curricula or assessment instruments, or in professional development for in-service teachers to strengthen their mathematical background. This activity is not unlike other kinds of interdisciplinary work, where mathematicians can function as consultants: They work with other people to try to understand the nature of the mathematical aspects of the problems at hand, and they try to communicate so that the mathematics can be understood and used by other people. In areas other than education, we take it for granted that to do that kind of work productively you need to know something about the other field. We have not treated education that way.

The first step of the MIME project is to assemble a group of mathematicians who are interested in the possibility of contributing in these ways. The second step is to conduct workshops to provide professional development to these mathematicians. For example, suppose we want to focus on curriculum development. That is a field in which there is a lot of expert knowledge. The workshop could address such questions as, How are curricula actually used by teachers and in schools? What characteristics of them besides mathematical accuracy are important to consider? How do you contextualize mathematics problems appropriately?

And the third step relates to the fact that in some sense we are marketing something. We have to make it known to the potential client communities, the people who make policy decisions in educational environments. We also have to make sure that what we are doing meets their needs. The AMS plans to apply to the federal government for funding for the MIME project.

Notices: Just to sum up, can you say a few words about how you see the AMS overall? How is it functioning? What does it need to work on further? What is it doing well?

Bass: I think the AMS is just great. It is one of my favorite organizations, period. It is extremely well run. [Executive Director] John Ewing is an absolute gem. The leadership, the morale of the staff, the whole culture of the organization is absolutely fabulous. I think it is underappreciated by the field. The Washington office, Math Reviews—each of these is exemplary in professional quality and effectiveness.

As I mentioned earlier, in my essay for the Carnegie Initiative on the Doctorate, I focus on the distinction between mathematics as a discipline and mathematics as a profession. The professional organizations are a big part of that professional life. How does a new doctorate, someone coming into the field, think about membership in the AMS? I think the AMS does a huge amount that benefits that person, but often in invisible ways. This brings to mind John F. Kennedy’s invocation, “Ask not what your country can do for you—ask what you can do for your country.” I think we have to get across that message, that we are part of a community, and a whole lot of what holds that community together and really keeps it going and healthy is carried by the professional organizations. In some sense, the invisibility of the AMS is a virtue. This is similar to how a well-run department protects young people from administrative burdens. The young people should appreciate what is being done for them and know that some day they are going to have to do the same for the next generation. We have to develop a more holistic sense of what we are as a profession and as a professional community.

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Three recent reports contain important and sometimes conflicting data on undergraduate mathematics majors. The first is the Conference Board of the Mathematical Sciences (CBMS) report CBMS2000: Statistical Abstract of Undergraduate Programs in the Mathematical Sciences in the United States [4], published by the AMS and available online at http://www.ams.org/cbms/. The second is part three of the AMS-IMS-MAA-ASA Joint Data Committee annual report [1], [2], available online at http://www.ams.org/employment/surveyreports.html. The third is the National Science Foundation (NSF) report Science and Engineering Indicators 2002 (SEI-02) [5], available at http://www.nsf.gov/sbe/srs/seind02/start.htm.

The first two reports deal directly with the mathematical sciences, while NSF’s SEI-02 report [5] deals with science, very broadly defined. As a result, to get data on the nation’s effort in undergraduate mathematics, one must consult the report’s appendix tables, available at http://www.nsf.gov/sbe/srs/seind02/pdf_v2.htm.

Unfortunately the three reports disagree with each other, sometimes markedly, and it is a challenge to understand what the facts about mathematics majors really are. But even with their conflicts, the three reports identify some common trends and have something important to say about how many undergraduate students major in mathematics, where they study, and who they are.

**Majoring in Mathematics**

According to SEI-02 (Chapter 2, p. 18) about 25%-30% of entering freshmen intend to major in a science (including mathematics) or engineering field. SEI-02 does not present separate data on the percentage of entering freshmen who plan to major in mathematics, but combining certain figures in different parts of SEI-02 allows us to estimate that about 0.6% of entering freshmen intend to be mathematics majors.

SEI-02 Appendix Table 2-11 presents data on the intended major of entering freshmen by ethnic group. It shows some differences between ethnic groups as well as a decline in every ethnic group since 1985 among freshmen who want to major in mathematics (see Table I).

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>1.1%</td>
<td>0.9%</td>
<td>0.7%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Asian American</td>
<td>1.1</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Black</td>
<td>0.7</td>
<td>0.5</td>
<td>0.7</td>
<td>0.5</td>
</tr>
<tr>
<td>Mexican American and Puerto Rican American</td>
<td>0.7</td>
<td>0.8</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Other Latinos</td>
<td>NA</td>
<td>NA</td>
<td>0.5</td>
<td>0.3</td>
</tr>
<tr>
<td>American Indian</td>
<td>1.0</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Of course, incoming freshmen often change their minds about their majors by the time they graduate. SEI-02 Appendix Table 2-17 allows us to compare the number of bachelors’ degrees in mathematics (not
Table II: SEI-02: Bachelors' Degrees Awarded

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>All U.S. bachelors' Degrees</td>
<td>990,877</td>
<td>1,107,997</td>
<td>1,174,436</td>
<td>1,199,579</td>
</tr>
<tr>
<td>Mathematics bachelors' Degrees</td>
<td>15,267</td>
<td>14,784</td>
<td>13,759</td>
<td>12,363</td>
</tr>
<tr>
<td>% of Mathematics Degrees Among All bachelors' Degrees</td>
<td>1.54%</td>
<td>1.33%</td>
<td>1.17%</td>
<td>1.05%</td>
</tr>
</tbody>
</table>

including computer science) with the total number of bachelor's degrees awarded in all disciplines.

While the decline in the percentage of baccalaureates awarded in mathematics is disappointing, it is still worth noting that the percentage of undergraduate students receiving mathematics degrees remains higher than the percentage of freshmen intending to major in mathematics. One optimistic interpretation is that students' college mathematics experience attracts them to major in mathematics and that, to some degree, freshman and sophomore mathematics courses are acting as a pump rather than a filter.

Data from SEI-02 Appendix Table 2-16 show that the percentage of women among mathematics majors has held steady at the 46%-47% range since 1985. This is consistent with, but slightly higher than, the 41%-42% range reported by CBMS surveys in 1995 and 2000.

The CBMS survey reports [3], [4] disagree with SEI-02 data about the total number of mathematics baccalaureates granted, and the CBMS surveys give much more detailed data (see Table III). The annual reports of the Joint Data Committee [1], [2] present a third picture of the number of mathematics majors. The Joint Data Committee estimates the number of junior and senior mathematics majors based on its annual survey of departments (see Table IV).

It is not surprising that the three estimates—from CBMS, NSF, and the Joint Data Committee—are different, if only because they use different data sources. SEI-02 draws its data from reports by colleges and universities to the U.S. Department of Education, and in these reports only primary majors are considered. Thus a physics major who added mathematics as a second major would not be included in the mathematics major total. By contrast, both CBMS2000 and the Joint Data Committee rely on surveys completed at the department level, and these surveys do not distinguish between primary and secondary majors. Another contrast is that both CBMS and SEI-02 data count the number of mathematics bachelor's graduates, while Joint Data Committee figures are based on departmental reports of the total number of junior and senior mathematics majors. Thus, to compare Joint Data Committee reports on the number of majors with SEI-02 and CBMS figures, presumably one would need to divide the Joint Data Committee figures by about 2. But even after this division, a very large disparity remains, and the extent of the disagreement among the three data sources about the number of mathematics majors in the U.S. is perplexing.

Where Do Undergraduates Major in Mathematics?

SEI-02 uses Carnegie Classifications to subdivide colleges and universities into groups. (The precise definitions of these Carnegie groups appear on page 10, Chapter 2, of the SEI-02 report.) SEI-02 reports that, while Research I and II universities enroll only 19% of the nation's students, they grant about 42% of all science and engineering bachelor's degrees.

To determine the situation in mathematics, the best we can do is to look at Appendix Table 2-5. Unfortunately, SEI-02 lumps mathematics and computer science together when studying which kinds of universities give bachelor's degrees in various disciplines. Table V shows the Carnegie classifications, the number of universities in each classification, and SEI-02's estimate of the percentage of all U.S. mathematics and computer science bachelor's degrees given by each type of school. The data come from SEI-02, Chapter 2, p. 9, and from Appendix Table 2-5 and deal with 1998.

CBMS2000 [4] also presents data on the number of mathematics bachelor's degrees awarded by various kinds of departments, based on the departmental classification (Groups I, II, III, M, and B).
typically used in AMS data. The CBMS2000 data deal with the 1999–2000 academic year and lead to conclusions that are quite different from those suggested by SEI-02 data for 1998 (see Table VI).

There are many possible explanations for the disparity between SEI-02 data and CBMS data about where mathematics bachelors' degrees are granted. The first is that SEI-02 lumps together mathematics and computer science majors, while the CBMS surveys do not. Second, the highest degree offered by a school's mathematics department might not be the same as the school's Carnegie Classification: for example, a Carnegie doctoral school might have only a bachelors'-level mathematics department.

Third, as noted earlier, CBMS surveys count all mathematics majors, both primary and secondary, while most federal data count only primary majors. Fourth, SEI-02 data did not include mathematics education majors as mathematics majors, while the CBMS report did.

What Percentage of Mathematics Majors Get Ph.D.'s?
The SEI-02 report shows the number of mathematics bachelors' degrees awarded to U.S. citizens. When combined with information from the Joint Data Committee on mathematical science doctoral degrees granted to U.S. citizens, the SEI-02 data allow us to give a rough estimate of the percentage of U.S. mathematics majors who eventually get a doctoral degree in the mathematical sciences. One approach is to compare the number of U.S. citizens receiving mathematics bachelors' degrees with the number of U.S. citizens receiving Ph.D. degrees in the mathematical sciences about six years later. Appendix Table 2–17 of SEI-02 shows that in the mid-1990s, about 13,000 U.S. citizens received bachelors' degrees each year in mathematics and statistics, a figure that is generally consistent with the number of bachelors' degrees in mathematics and statistics found by CBMS1995 [3]. Joint Data Committee figures (available in the 2000 Third Report at http://www.ams.org/employment/deptprof.html) show that 566 U.S. citizens received doctoral degrees in 1999–2000, and preliminary estimates show that at least 496 U.S. citizens received mathematical sciences Ph.D. degrees in 2000–2001. Computing the ratio 566/13,000 suggests that about 3.8% of U.S. citizen mathematics majors go on to receive doctoral degrees in the mathematical sciences about six years later.

Clearly, that 3.8% estimate is very rough: for example, it ignores students who might have an undergraduate major other than mathematics and who move into mathematical sciences during graduate school. It would be interesting to have better estimates of the percentage of U.S. mathematics majors who go on to complete various levels of graduate education in the mathematical sciences.

References
2002 Annual Survey of the Mathematical Sciences

(First Report)

Faculty Salary Survey

Don O. Loftsgaarden, James W. Maxwell, and Kinda Remick Priestley

The First Report of the 2002 Annual Survey gives a broad picture of 2001–02 new doctoral recipients from U.S. departments in the mathematical sciences, including their employment status in fall 2002. The First Report also presents salary data for faculty members in U.S. departments of mathematical sciences in four-year colleges and universities. This report is based on information collected from two questionnaires distributed to departments in May 2002. A follow-up questionnaire was distributed to the individual new doctoral recipients in October 2002. This questionnaire will be used to update and revise results in this report, which are based on information from the departments that produced the new doctorates. Those results will be published in the Second Report of the 2002 Annual Survey in the August 2003 issue of the Notices of the AMS. Another questionnaire concerned with data on fall 2002 course enrollments, majors, graduate students, and departmental faculty was distributed to departments in September 2002. Results from this questionnaire will appear in the Third Report of the 2002 Annual Survey in the September 2003 issue of the Notices of the AMS.

The 2002 Annual Survey represents the forty-sixth in an annual series begun in 1957 by the American Mathematical Society. The 2002 Survey is conducted by staff at the American Mathematical Society with guidance from the Data Committee, a joint committee of the American Mathematical Society, the American Statistical Association, the Institute of Mathematical Statistics, and the Mathematical Association of America. The current members of this committee are Lorraine Denby, J. Douglas Faires, Mary W. Gray, Alexander Hahn, Peter E. Haskell, G. Samuel Jordan, Stephen Kennedy, Ellen E. Kirkman, Don O. Loftsgaarden (chair), and James W. Maxwell (ex officio). The committee is assisted by AMS survey analyst Kinda Remick Priestley and survey coordinator Colleen Rose. Comments or suggestions regarding this Survey Report may be directed to the members of the Data Committee.

The 2002 Annual Survey represents the forty-sixth in an annual series begun in 1957 by the American Mathematical Society. The 2002 Survey is conducted by staff at the American Mathematical Society with guidance from the Data Committee, a joint committee of the American Mathematical Society, the American Statistical Association, the Institute of Mathematical Statistics, and the Mathematical Association of America. The current members of this committee are Lorraine Denby, J. Douglas Faires, Mary W. Gray, Alexander Hahn, Peter E. Haskell, G. Samuel Jordan, Stephen Kennedy, Ellen E. Kirkman, Don O. Loftsgaarden (chair), and James W. Maxwell (ex officio). The committee is assisted by AMS survey analyst Kinda Remick Priestley and survey coordinator Colleen Rose. Comments or suggestions regarding this Survey Report may be directed to the members of the Data Committee.

Table 1: Doctorates Granted Response Rates

<table>
<thead>
<tr>
<th>Group</th>
<th>No of Departments</th>
<th>No of Doctorates</th>
<th>Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (Pu)</td>
<td>25</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>I (Pr)</td>
<td>23</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>51</td>
<td>56</td>
<td>4</td>
</tr>
<tr>
<td>III</td>
<td>71</td>
<td>73</td>
<td>28</td>
</tr>
<tr>
<td>IV</td>
<td>72</td>
<td>86</td>
<td>9</td>
</tr>
<tr>
<td>Va</td>
<td>21</td>
<td>22</td>
<td>2</td>
</tr>
<tr>
<td>Vb</td>
<td>No longer surveyed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 provides the departmental response rates for the 2002 Survey of New Doctoral Recipients. See page 253 for a description of the groups. No adjustments were made in this report for nonresponding departments.

This preliminary report will be updated, using information gathered from the new doctoral recipients, in the Second Report of the 2002 Annual Survey. It will appear in the August 2003 issue of the Notices of the AMS.
Changes in the Annual Survey occur over time, and these changes need to be considered when comparing results in this report to those in prior years. Information about changes that occurred in 1997 or later can be found in the First Report for the 2000 Annual Survey in the February 2001 issue of the Notices of the AMS.

In this First Report's tables referring to new doctoral recipients, “Fall” refers to results based on information about new doctoral recipients received from departments granting their degrees. This information is gathered in the first fall following the academic year in which the degrees were granted. “Final” refers to results based on supplemental information received from the new doctoral recipients themselves as well as additional new doctoral

<table>
<thead>
<tr>
<th>Group</th>
<th>I (Pu)</th>
<th>I (Pr)</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>Va</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995-96</td>
<td>325</td>
<td>174</td>
<td>222</td>
<td>124</td>
<td>172</td>
<td>81</td>
<td>1098</td>
</tr>
<tr>
<td>1996-97</td>
<td>297</td>
<td>187</td>
<td>238</td>
<td>132</td>
<td>197</td>
<td>72</td>
<td>1123</td>
</tr>
<tr>
<td>1997-98</td>
<td>306</td>
<td>174</td>
<td>264</td>
<td>129</td>
<td>213</td>
<td>77</td>
<td>1163</td>
</tr>
<tr>
<td>1998-99</td>
<td>292</td>
<td>152</td>
<td>241</td>
<td>136</td>
<td>243</td>
<td>69</td>
<td>1133</td>
</tr>
<tr>
<td>1999-00</td>
<td>256</td>
<td>157</td>
<td>223</td>
<td>132</td>
<td>284</td>
<td>67</td>
<td>1119</td>
</tr>
<tr>
<td>2000-01</td>
<td>233</td>
<td>129</td>
<td>203</td>
<td>125</td>
<td>237</td>
<td>81</td>
<td>1008</td>
</tr>
<tr>
<td>2001-02</td>
<td>218</td>
<td>139</td>
<td>164</td>
<td>124</td>
<td>222</td>
<td>81</td>
<td>948</td>
</tr>
</tbody>
</table>

* Does not include Vb. See “Definitions of the Groups” on page 253.

Figure 1: New Doctoral Degrees Awarded by Combined Groups, Fall Count

Don O. Loftsgaarden is professor emeritus of mathematics at the University of Montana. James W. Maxwell is AMS associate executive director for Membership, Meetings, and Programs. Kinda Remick Priestley is AMS survey analyst.

Highlights

- There were 948 new doctoral recipients reported for 2001-02 by departments responding in time for the 2002 First Report. This is the fourth consecutive drop in the number of new doctoral recipients. The counts for the preceding four years starting in 1997-98 were 1,163, 1,133, 1,119, and 1,008.
- The number of new doctoral recipients from Groups I (Pu), I (Pr), and II combined has dropped from 744 in 1997-98 to 521 this year, a decrease of 223 (30%).
- Only 418 (44%) of the new doctoral recipients for 2001-02 are U.S. citizens, a drop of 76 (15%) from 2000-01 and down 168 (29%) from 586 in 1997-98.
- The numbers of various types of graduate students in U.S. doctoral departments in the mathematical sciences were dropping from 1992 to 1997 or 1998 and have been increasing since then. This is true for first-year full-time and first-year U.S. citizen full-time graduate students. Based on these numbers and the recent numbers of new doctoral recipients, it appears likely that the downward trends in new doctoral recipients mentioned above will continue for another two years or so, probably at a slower rate. By then the increasing number of first-year full-time graduate students since 1997 should result in a gradually increasing number of new doctoral recipients.
- Based on responses from departments alone, the fall 2002 unemployment rate for the 756 new doctoral recipients whose employment status is known is 4.3%, down from 5.6% for fall 2001 and the lowest fall unemployment rate in the past thirteen years.
- Sixty-one new doctoral recipients hold positions at the institution that granted their degree, although not necessarily in the same department. This is 8.1% of the new doctoral recipients who are currently known to have jobs and 12% of those who have academic positions in the U.S. Nine new doctoral recipients have part-time positions.
- Of the 664 new doctoral recipients taking positions in the U.S., 123 (19%) have jobs in business and industry, down from 168 in fall 2001 and 206 in fall 2000.
- The number of new doctoral recipients taking U.S. academic positions was 503 in fall 2002, down 7 from fall 2001 and down 48 from fall 2000.
- Among the 266 new doctoral recipients hired by U.S. doctoral-granting departments, 44% are U.S. citizens. Among the 237 having other academic positions in the U.S., 58% are U.S. citizens.
- Of the 948 new doctoral recipients, 290 (31%) are females, down just 2 from fall 2001. Of the 418 U.S. citizen new doctoral recipients, 127 (30%) are females, down 24 from fall 2001. The all-time high was 187 in fall 1998.
- Among the 418 U.S. citizen new doctoral recipients, 18 are Asians, 12 are Blacks or African Americans, 8 are Hispanics or Latinos, 370 are Whites, and 10 are other.
- Group IV produced 222 new doctorates, of which 92 (41%) are females, compared to all other groups combined, where 198 (27%) are females.
- Two hundred eighty-eight new doctorates had a dissertation in statistics/biostatistics (253) and probability (35). The next highest number was in algebra and number theory with 126. Those with dissertations in statistics/biostatistics and probability accounted for 30.4% of the new doctorates in 2001-02.
Table 3: Full-Time Graduate Students in Groups I, II, III, & Va by Citizenship, Fall 1992 to Fall 2001
(* Data Reprinted from Table 68 in Fall 2001 Third Report)

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total full-time*</td>
<td>10595</td>
<td>10525</td>
<td>10185</td>
<td>9761</td>
<td>9476</td>
<td>9003</td>
<td>8791</td>
<td>8838</td>
<td>9637</td>
<td>9361</td>
</tr>
<tr>
<td>First-year full-time*</td>
<td>2906</td>
<td>2762</td>
<td>2668</td>
<td>2601</td>
<td>2443</td>
<td>2386</td>
<td>2510</td>
<td>2664</td>
<td>2839</td>
<td>2875</td>
</tr>
<tr>
<td>U.S. citizen full-time*</td>
<td>6020</td>
<td>5865</td>
<td>5945</td>
<td>5623</td>
<td>5445</td>
<td>4947</td>
<td>4831</td>
<td>4668</td>
<td>5085</td>
<td>4631</td>
</tr>
<tr>
<td>First-year U.S. citizen</td>
<td>1801</td>
<td>1700</td>
<td>1664</td>
<td>1551</td>
<td>1465</td>
<td>1316</td>
<td>1349</td>
<td>1401</td>
<td>1527</td>
<td>1517</td>
</tr>
</tbody>
</table>

Figure 2: Percentage of New Doctoral Recipients Unemployed (as reported in the respective Annual Survey Reports 1991–2002)

<table>
<thead>
<tr>
<th>Report</th>
<th>Fall</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990-91</td>
<td>12</td>
<td>5.0</td>
</tr>
<tr>
<td>1991-92</td>
<td>13</td>
<td>6.7</td>
</tr>
<tr>
<td>1992-93</td>
<td>12</td>
<td>8.9</td>
</tr>
<tr>
<td>1993-94</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>1994-95</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>1995-96</td>
<td>15</td>
<td>11</td>
</tr>
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Table 4A: Employment Status of 2001-02 U.S. New Doctoral Recipients in the Mathematical Sciences by Field of Thesis

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*Includes those whose status is reported as "unknown" or "still seeking employment".

Table 4B: Employment Status of 2001-02 U.S. New Doctoral Recipients in the Mathematical Sciences by Type of Degree-Granting Department

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*Includes those whose status is reported as "unknown" or "still seeking employment".
Table 4C: Field of Thesis of 2001–02 New Doctoral Recipients by Type of Degree-Granting Department

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<th>APPLIED MATH.</th>
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<td>11</td>
<td>12</td>
<td>35</td>
<td>7</td>
<td>89</td>
</tr>
<tr>
<td>Government</td>
<td>5</td>
<td>8</td>
<td>6</td>
<td>4</td>
<td>8</td>
<td>7</td>
<td>38</td>
</tr>
<tr>
<td>Business and Industry</td>
<td>15</td>
<td>12</td>
<td>19</td>
<td>6</td>
<td>56</td>
<td>15</td>
<td>123</td>
</tr>
<tr>
<td>Total</td>
<td>140</td>
<td>103</td>
<td>116</td>
<td>96</td>
<td>156</td>
<td>53</td>
<td>664</td>
</tr>
</tbody>
</table>

Employment Status of 2001–02 New Doctoral Recipients

Table 4A gives a cross-tabulation of the 948 new doctoral recipients in the mathematical sciences: Type of Employer by Field of Thesis. Table 4B gives a cross-tabulation of the same data: Type of Employer by Type of Degree-Granting Department (Group). Table 4C gives a cross-tabulation of these same data: Type of Degree-Granting Department (Group) by Field of Thesis. This table gives a picture of the type of doctoral students being trained in the various groups. These tables contain a wealth of information about these new doctoral recipients, some of which will be discussed in this report. Note that these tables also give a breakdown by sex for type of employer, type of degree-granting department, and field of thesis. Keep in mind that the results in this report come from the departments giving the degrees and not from the degree recipients themselves. These tables will be revised using information from the doctoral recipients themselves and will appear in the 2002 Second Report in August 2003.

The last column (Total) in Table 4A can be used to find the overall unemployment rate. In this and other unemployment calculations in this report, the individuals whose employment status is not known (Unknown (U.S.) and Unknown (non-U.S.)) are first removed, and the unemployment fraction is the number still seeking employment divided by the total number of individuals left after the "Unknowns" are removed. The overall unemployment rate for these data is 4.3%. This figure will be updated later with information gathered from the individual new doctoral recipients. The figure for fall 2001 was 5.6%. Figure 2 shows how this unemployment rate compares with other years over the past decade. The unemployment rates, calculated using Table 4B, vary from group to group, with a high of 12% for Group Va and lows of 1.6% and 1.7% for Groups I (Private) and I (Public), respectively.

There are 664 new doctoral recipients employed in the U.S. Table 5A gives a breakdown of type of employer by type of degree-granting department for these 664 new doctoral recipients. Of these, 503 (76%) hold academic positions, 38 (5.7%) are employed by government, and 123 (19%) hold positions...
Table 5G: 2001-02 New Doctoral Recipients Having Employment in the U.S. by Type of Employer and Citizenship

<table>
<thead>
<tr>
<th>Type of Employer</th>
<th>U.S. Employer</th>
<th>U.S. Academic</th>
<th>Groups I, II, III, and Va</th>
<th>Group IV</th>
<th>Non-Ph.D. Department</th>
<th>Research Institute/Other Nonprofit</th>
<th>U.S. Nonacademic</th>
<th>Non-U.S. Academic</th>
<th>Non-U.S. Nonacademic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic, Groups I-Va</td>
<td>116</td>
<td>100</td>
<td>16</td>
<td>133</td>
<td>67</td>
<td>116</td>
<td>110</td>
<td>8</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>Academic, Other</td>
<td>138</td>
<td>18</td>
<td>1</td>
<td>130</td>
<td>46</td>
<td>138</td>
<td>19</td>
<td>1</td>
<td>4</td>
<td>237</td>
</tr>
<tr>
<td>Nonacademic</td>
<td>67</td>
<td>67</td>
<td>9</td>
<td>5</td>
<td>11</td>
<td>67</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>161</td>
</tr>
<tr>
<td>Total</td>
<td>321</td>
<td>321</td>
<td>293</td>
<td>15</td>
<td>321</td>
<td>321</td>
<td>456</td>
<td>27</td>
<td>456</td>
<td>948</td>
</tr>
</tbody>
</table>

*Includes those whose status is reported as “unknown” or “still seeking employment”.

Table 5D: U.S. Academic Positions Filled by New Doctoral Recipients by Type of Hiring Department, Fall 1998 to Fall 2002

<table>
<thead>
<tr>
<th>Group</th>
<th>I-III</th>
<th>IV</th>
<th>Va</th>
<th>M&amp;B</th>
<th>Other</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 1998</td>
<td>177</td>
<td>35</td>
<td>7</td>
<td>177</td>
<td>105</td>
<td>501</td>
</tr>
<tr>
<td>Fall 1999</td>
<td>221</td>
<td>49</td>
<td>17</td>
<td>175</td>
<td>102</td>
<td>554</td>
</tr>
<tr>
<td>Fall 2000</td>
<td>209</td>
<td>46</td>
<td>13</td>
<td>158</td>
<td>125</td>
<td>551</td>
</tr>
<tr>
<td>Fall 2001</td>
<td>199</td>
<td>41</td>
<td>12</td>
<td>161</td>
<td>97</td>
<td>510</td>
</tr>
<tr>
<td>Fall 2002</td>
<td>213</td>
<td>46</td>
<td>7</td>
<td>138</td>
<td>99</td>
<td>503</td>
</tr>
</tbody>
</table>

in business and industry. In the First Report for 2000-01, there were 517 new doctoral recipients employed in the U.S., of which 510 (71%) held academic positions, 39 (5.4%) were in government, and 168 (23%) were in business and industry.

Table 5B shows the number of new doctoral recipients who took positions in business and industry by the type of department granting their degree for fall 1998 to fall 2002. The number of new doctoral recipients taking jobs in business and industry, which had been rising steadily in the mid-1990s and oscillating in the late 1990s, has now had drops of 38 in fall 2001 and 45 in fall 2002. Among the 664 new doctoral recipients known to have employment in the U.S. in fall 2002, Group III has the smallest percentage taking jobs in business and industry at 6.3% and Group IV the highest at 36%.

Table 5C shows the number of new doctoral recipients who took academic positions in the U.S. by type of department granting their degree for fall 1998 to fall 2002. Among the 664 new doctoral recipients employed in the U.S. in fall 2002, 76% have academic positions. This percentage is highest for Group III at 90% and lowest for Groups IV at 59% and Va at 58%.

Table 5E: Females as a Percentage of 2001-02 New Doctoral Recipients Produced by and Hired by Doctoral-Granting Groups

<table>
<thead>
<tr>
<th>%</th>
<th>I (Pu)</th>
<th>I (Pr)</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>Va</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Produced</td>
<td>22</td>
<td>28</td>
<td>31</td>
<td>37</td>
<td>41</td>
<td>20</td>
<td>31</td>
</tr>
<tr>
<td>Hired</td>
<td>20</td>
<td>27</td>
<td>30</td>
<td>48</td>
<td>33</td>
<td>14</td>
<td>28</td>
</tr>
</tbody>
</table>

Table 5F: Employment Status of 2001-02 U.S. New Doctoral Recipients by Citizenship Status

<table>
<thead>
<tr>
<th>Type of Employer</th>
<th>U.S. Citizens</th>
<th>Non-U.S. Citizens</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Employer</td>
<td>321</td>
<td>18</td>
<td>218</td>
</tr>
<tr>
<td>U.S. Academic</td>
<td>254</td>
<td>18</td>
<td>218</td>
</tr>
<tr>
<td>Groups I, II, III, and Va</td>
<td>100</td>
<td>8</td>
<td>109</td>
</tr>
<tr>
<td>Group IV</td>
<td>16</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Non-Ph.D. Department</td>
<td>133</td>
<td>9</td>
<td>72</td>
</tr>
<tr>
<td>Research Institute/Other Nonprofit</td>
<td>5</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>U.S. Nonacademic</td>
<td>67</td>
<td>17</td>
<td>75</td>
</tr>
<tr>
<td>Non-U.S. Employer</td>
<td>11</td>
<td>2</td>
<td>76</td>
</tr>
<tr>
<td>Non-U.S. Academic</td>
<td>11</td>
<td>2</td>
<td>55</td>
</tr>
<tr>
<td>Non-U.S. Nonacademic</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Not Seeking Employment</td>
<td>4</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Still Seeking Employment</td>
<td>17</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>SUBTOTAL</td>
<td>353</td>
<td>39</td>
<td>390</td>
</tr>
<tr>
<td>Unknown (U.S.)</td>
<td>65</td>
<td>6</td>
<td>31</td>
</tr>
<tr>
<td>Unknown (non-U.S.)</td>
<td>0</td>
<td>2</td>
<td>35</td>
</tr>
<tr>
<td>TOTAL</td>
<td>418</td>
<td>47</td>
<td>456</td>
</tr>
</tbody>
</table>
Table 6: Sex, Race/Ethnicity, and Citizenship of 2001–02 U.S. New Doctoral Recipients

<table>
<thead>
<tr>
<th>RACIAL/ETHNIC GROUP</th>
<th>MALE</th>
<th></th>
<th></th>
<th></th>
<th>FEMALE</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U.S. CITIZENS</td>
<td>NON-U.S. CITIZENS</td>
<td>Total Male</td>
<td>U.S. CITIZENS</td>
<td>NON-U.S. CITIZENS</td>
<td>Total Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Permanent Visa</td>
<td>Temporary Visa</td>
<td>Unknown Visa</td>
<td></td>
<td>Permanent Visa</td>
<td>Temporary Visa</td>
<td>Unknown Visa</td>
<td></td>
</tr>
<tr>
<td>American Indian or Alaska Native</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Asian</td>
<td>14</td>
<td>10</td>
<td>159</td>
<td>9</td>
<td>192</td>
<td>4</td>
<td>7</td>
<td>79</td>
</tr>
<tr>
<td>Black or African American</td>
<td>6</td>
<td>4</td>
<td>6</td>
<td>0</td>
<td>16</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>6</td>
<td>1</td>
<td>17</td>
<td>0</td>
<td>24</td>
<td>2</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Native Hawaiian or Other Pacific Islander</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>White</td>
<td>258</td>
<td>12</td>
<td>133</td>
<td>6</td>
<td>409</td>
<td>112</td>
<td>10</td>
<td>48</td>
</tr>
<tr>
<td>Unknown</td>
<td>2</td>
<td>0</td>
<td>5</td>
<td>3</td>
<td>10</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>291</td>
<td>27</td>
<td>322</td>
<td>18</td>
<td>658</td>
<td>127</td>
<td>20</td>
<td>134</td>
</tr>
</tbody>
</table>

employees who are currently employed and 12% of the U.S. academic positions held by new doctoral recipients. In fall 2001 there were 58 such individuals making up 7.1% of the new doctoral recipients who were employed at the time of the First Report. Nine new doctoral recipients have taken part-time positions in fall 2002.

Information about 2001–02 Female New Doctoral Recipients

Tables 4A and 4B give male and female breakdowns of the new doctoral recipients in 2001–02 by Field of Thesis, by Type of Degree-Granting Department, and by Type of Employer.

Overall, 290 (31%) of the 948 new doctoral recipients in 2001–02 are female. In 2000–01, 292 (29%) of the new doctoral recipients were female. This percentage varies over the different groups, and these percentages are given in the first row of Table 5E. Following the same trend as in recent years, the percentage is highest for Group IV, statistics/biostatistics departments, at 41%. While the lowest percentage last year was for Group I (Pr) at 17%, this year it is for Group Va, at 20%.

The second row of Table 5E gives the percentage of the new doctoral recipients hired who are female for each of the Groups I, II, III, IV and Va. In addition, 42% of the new doctoral recipients hired in Group M, master's departments, are female; 36% of the new doctoral recipients hired in Group B, bachelor's departments, are female; and 29% of new doctoral recipients hired in business and industry are female.

The unemployment rate for female new doctoral recipients is 4.1% compared to 4.3% for males and 4.3% overall.

The percentage of female new doctoral recipients within fields of thesis ranged from 7.1% in optimization/control to 42% in statistics and 56% in mathematics education. Later sections in this First Report give more information about the female new doctoral recipients by citizenship and the female new doctoral recipients in Group IV.

Employment Information about 2001–02 New Doctoral Recipients by Citizenship and Type of Employer

Table 5F shows the pattern of employment within broad job categories broken down by citizenship status of the new doctoral recipients.

The unemployment rate for the 418 U.S. citizens is 4.8% compared to 6.4% in fall 2001. The unemployment rate for non-U.S. citizens is 3.8%. This varies by type of visa. The unemployment rate for non-U.S. citizens with a permanent visa is 5.1%, while that for non-U.S. citizens with a temporary visa is 3.8%.

Among U.S. citizens whose employment status is known, 91% are employed in the U.S. Among non-U.S. citizens with a permanent visa whose employment status is known, 90% have jobs in the U.S., while the percentage for non-U.S. citizens with a temporary visa is 75%.

Table 5G is a cross-tabulation of the 664 new doctoral recipients who have employment in the U.S. by citizenship and broad employment categories, using numbers from Table 5F. Of the 664 new doctoral recipients having jobs in the U.S., 48% are U.S. citizens. Of the 266 new doctoral recipients who took jobs in U.S. doctoral-granting departments, 44% are U.S. citizens. Of the 237 who took other academic positions, 58% are U.S. citizens. Of the 161 who took nonacademic positions, 42% are U.S. citizens.

Of the 321 U.S. citizens employed in the U.S., 36% have jobs in a doctoral-granting department, 43% are in other academic positions, and 21% are in nonacademic positions. For the 343 non-U.S. citizens employed in the U.S., the analogous percentages are 44%, 29%, and 27% respectively.
Table 7: U.S. Citizen Doctoral Recipients

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Doctorates Granted by U.S. Institutions</th>
<th>Total U.S. Citizen Doctoral Recipients</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975-76</td>
<td>965</td>
<td>722</td>
<td>75</td>
</tr>
<tr>
<td>1980-81</td>
<td>839</td>
<td>567</td>
<td>68</td>
</tr>
<tr>
<td>1985-86</td>
<td>755</td>
<td>386</td>
<td>51</td>
</tr>
<tr>
<td>1990-91</td>
<td>1061</td>
<td>461</td>
<td>43</td>
</tr>
<tr>
<td>1995-96</td>
<td>1150</td>
<td>493</td>
<td>43</td>
</tr>
<tr>
<td>1996-97</td>
<td>1158</td>
<td>516</td>
<td>45</td>
</tr>
<tr>
<td>1997-98</td>
<td>1216</td>
<td>586</td>
<td>48</td>
</tr>
<tr>
<td>1998-99*</td>
<td>1133</td>
<td>554</td>
<td>49</td>
</tr>
<tr>
<td>1999-00</td>
<td>1119</td>
<td>537</td>
<td>48</td>
</tr>
<tr>
<td>2000-01</td>
<td>1008</td>
<td>494</td>
<td>49</td>
</tr>
<tr>
<td>2001-02</td>
<td>948</td>
<td>418</td>
<td>44</td>
</tr>
</tbody>
</table>

*Prior to 1998-99, the counts include new doctoral recipients from Group Vb. In addition, prior to 1982-83, the counts include recipients from computer science departments.

Sex, Race/Ethnicity, and Citizenship Status of 2001-02 New Doctoral Recipients

Table 6 presents a breakdown of new doctoral recipients according to sex, racial/ethnic group, and citizenship status. The information reported in this table was obtained in summary form from the departments granting the degrees.

There were 418 (44%) U.S. citizens among the 948 new doctoral recipients in 2001-02. Among U.S. citizens, 18 are Asians (14 male and 4 female), 12 are Blacks or African Americans (6 male and 6 female), 8 are Hispanics or Latinos (6 male and 2 female), 370 are Whites (258 male and 112 female), and 10 are other. Among non-U.S. citizens, there are 268 Asians, 24 Hispanics or Latinos, 212 Whites, and 26 other.

Table 7 and Figure 3 give the number of new U.S. doctoral recipients and the number of U.S. citizens back to 1975-76. The 418 U.S. citizen new doctoral recipients is down by 158 (29%) since 1997-98. The percentage of U.S. citizens, which had remained steady over the last four years at 48%-49%, decreased to 44% this year, close to the all-time low of 42% in 1991-92.

Females make up 30% of the 418 U.S. citizens receiving doctoral degrees in the mathematical sciences in 2001-02. This is nearly the same as last year but down from 34% in 1998-99, the highest percentage of females among U.S. citizen new doctoral recipients ever reported by the Annual Survey. Among the 530 non-U.S. citizen new doctoral recipients, the number is down by 168 (29%) since 1997-98. The percentage of U.S. citizens, which had remained steady over the last four years at 48%-49%, decreased to 44% this year, close to the all-time low of 42% in 1991-92.

Table 8: U.S. Citizen Doctoral Recipients by Sex

<table>
<thead>
<tr>
<th>Year</th>
<th>Total U.S. Citizen Doctoral Recipients</th>
<th>Male</th>
<th>Female</th>
<th>% Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975-76</td>
<td>722</td>
<td>636</td>
<td>86</td>
<td>12</td>
</tr>
<tr>
<td>1980-81</td>
<td>567</td>
<td>465</td>
<td>102</td>
<td>18</td>
</tr>
<tr>
<td>1985-86</td>
<td>386</td>
<td>304</td>
<td>82</td>
<td>21</td>
</tr>
<tr>
<td>1990-91</td>
<td>461</td>
<td>349</td>
<td>112</td>
<td>24</td>
</tr>
<tr>
<td>1995-96</td>
<td>493</td>
<td>377</td>
<td>116</td>
<td>24</td>
</tr>
<tr>
<td>1996-97</td>
<td>516</td>
<td>368</td>
<td>148</td>
<td>29</td>
</tr>
<tr>
<td>1997-98</td>
<td>586</td>
<td>423</td>
<td>163</td>
<td>28</td>
</tr>
<tr>
<td>1998-99*</td>
<td>554</td>
<td>367</td>
<td>187</td>
<td>34</td>
</tr>
<tr>
<td>1999-00</td>
<td>537</td>
<td>379</td>
<td>158</td>
<td>29</td>
</tr>
<tr>
<td>2000-01</td>
<td>494</td>
<td>343</td>
<td>151</td>
<td>31</td>
</tr>
<tr>
<td>2001-02</td>
<td>418</td>
<td>291</td>
<td>127</td>
<td>30</td>
</tr>
</tbody>
</table>

*Prior to 1998-99, the counts include new doctoral recipients from Group Vb. In addition, prior to 1982-83, the counts include recipients from computer science departments.
recipients, 163 (31%) are female, up from last year's 27%.

Table 8 and Figure 4 give the historical record of U.S. citizen new doctoral recipients, broken down by male and female for past years, going back to 1975–76. The number of male U.S. citizen new doctoral recipients decreased by 52 from 2000–01 and is down by 132 (31%) from 1997–98. In fact, the 423 male U.S. citizen new doctoral recipients in 1997–98 is more than the total number of U.S. citizen new doctoral recipients for 2001–02. The number of female U.S. citizen new doctoral recipients is down 60 (32%) from an all-time high of 187 in 1998–99.

Table 9 gives a sex and citizenship breakdown of the new doctorates within each of the six types of doctoral-granting departments. Among all 948 new doctoral recipients, 44% of the males and 44% of the females are U.S. citizens. The percentage of the new doctoral recipients who are U.S. citizens within the groups is lowest in Group IV at 35% and highest in Group II at 55%. Group II is the only group to have more U.S. citizen than non-U.S. citizen new doctoral recipients in 2001–02.

2001–02 New Doctoral Recipients with Dissertations in Statistics/Biostatistics and Probability

Group IV contains U.S. departments (or programs) of statistics, biostatistics, and biometrics reporting a doctoral program. In the Annual Survey Reports, Group IV is referred to as the Statistics Group. In addition, other groups in the Annual Survey produce new doctoral recipients with dissertations in statistics/biostatistics and probability. The other groups produced 67 new doctoral recipients with dissertations in statistics/biostatistics and probability in 2001–02 and have averaged 83 per year over the past seven years. Information about these 67 new doctoral recipients and the 222 new doctoral recipients in Group IV is found in this section of the report.

For seven years substantial effort has gone into making Group IV an appropriate set of departments for the Annual Survey and increasing the number of Group IV departments that respond to the Annual Survey. Table 10 contains information about new doctoral recipients in Group IV as well as those with dissertations in statistics/biostatistics and probability in other groups for the past seven years. The last two rows of Table 10 give a split of the 2001–02 results between the 55 statistics departments and the 31 biostatistics and biometrics departments in Group IV. Quite a bit of the variation in numbers from year to year in this table is due to the changes made in the departments in Group IV over the seven years and to the relatively low response rate for this group. At the time of the Second Report last year, 77 of 86 (90%) of Group IV departments had responded, which is the largest percentage ever.

Group IV has 86 departments for 2001–02, 13 more than the next largest doctoral group. It contains 30% of all doctoral departments surveyed, and
the 72 Group IV departments responding to the Annual Survey reported 222 new doctoral recipients, 23% of all new doctoral recipients in 2001-02. The number of new doctoral recipients in Group IV is down 15 from the number reported at this time last year, even though the number of departments responding is up two from the number responding by this time last year.

Because of its size, the data from Group IV have a large effect on the overall results when all doctoral groups are combined. Furthermore, Group IV results are often quite different from those for Groups I (Pu), I (Pr), II, III, and Va. Group IV results can mask important changes in the other doctoral groups. In the following paragraphs some of these differences are presented.

Table 9 shows that for the Group IV new doctoral recipients, 92 of 222 (41%) are female, while 198 of 726 (27%) are female in the other doctoral groups. Among U.S. citizens, females accounted for 31 of the 77 (40%) Group IV new doctoral recipients, while for the other groups, 96 of 341 (28%) were female. Overall, 127 of 418 (30%) U.S. citizen new doctoral recipients were female.

In Group IV, 77 of 222 (35%) new doctoral recipients are U.S. citizens, while in other groups 341 of 726 (47%) are U.S. citizens.

Of the 156 new doctoral recipients from Group IV who found employment in the U.S., 56 (36%) took jobs in business or industry. From the other groups, 508 new doctoral recipients found employment in the U.S., of which 67 (13%) took jobs in business or industry.

The employment status for 184 Group IV new doctoral recipients is known, and 11 (6.0%) are unemployed. For the other groups, the employment status of 616 is known, and 23 (3.7%) are unemployed. Fifteen of 46 (33%) new doctoral recipients hired by Group IV departments were female, down from last year's 34% and down significantly from the 48% reported in 1999-2000. The other doctoral groups reported that 60 of 220 (27%) new doctoral recipients hired were female, up from last year's 23% and significantly more than the 16% reported in 1999-00.

Group IV had 221 new doctoral recipients with fields of thesis in statistics/biostatistics (215) and probability (6), and the other doctoral departments had 67 with field of thesis in statistics/biostatistics (38) and probability (29). The distribution of these 67 degrees among the various groups can be found in Table 4C. The number of new doctoral recipients with theses in statistics/biostatistics and probability (288) is larger than any other field, with algebra and number theory next with 126.

Faculty Salary Survey

The charts on the following pages display faculty salary data for Groups I (Pu), I (Pr), II, III, IV (Statistics), IV (Biostatistics), Va, M, and B: faculty salary distribution by rank, mean salaries by rank, information on quartiles by rank, and the number of returns for the group. Results reported here are summaries based on the departments who responded to this portion of the Annual Survey. This is the second year that salary information has been reported separately for statistics departments and biostatistics and biometrics departments in Group IV.

Table 11 provides the departmental response rates for the 2002 Faculty Salary Survey. Departments were asked to report for each rank the number of tenured and tenure-track faculty whose 2002-03 academic-year salaries fell within given salary intervals. Reporting salary data in this fashion eliminates some of the concerns about confidentiality but does not permit determination of actual quartiles. What can be determined is the salary interval in which the quartiles occur. The endpoints of these intervals are in thousands of dollars.

Since departments in Group I, II, and III were changed in 1995-96 (see definitions of the groups on page 253), comparisons are possible only to the last six years' data. In addition, prior to the 1998 survey Groups Va and Vb were reported together as Group V.

Table 11: Faculty Salary Response Rates

<table>
<thead>
<tr>
<th>Department</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I (Public)</td>
<td>20 of 25</td>
<td>80</td>
</tr>
<tr>
<td>Group I (Private)</td>
<td>18 of 23</td>
<td>78</td>
</tr>
<tr>
<td>Group II</td>
<td>45 of 56</td>
<td>80</td>
</tr>
<tr>
<td>Group III</td>
<td>59 of 73</td>
<td>81</td>
</tr>
<tr>
<td>Group IV (Statistics)</td>
<td>37 of 55</td>
<td>67</td>
</tr>
<tr>
<td>Group IV (Biostatistics)</td>
<td>16 of 31</td>
<td>52</td>
</tr>
<tr>
<td>Group Va</td>
<td>13 of 18*</td>
<td>72</td>
</tr>
<tr>
<td>Group M</td>
<td>101 of 192</td>
<td>53</td>
</tr>
<tr>
<td>Group B</td>
<td>348 of 1030</td>
<td>34</td>
</tr>
</tbody>
</table>

* The population for Group Va is slightly less than for the Doctorates Granted Survey, because some departments grant degrees but do not formally "house" faculty and their salaries.
### Group I (Public) Faculty Salaries

**Doctoral degree-granting departments of mathematics (25)**

20 responses (80%)

<table>
<thead>
<tr>
<th>Rank</th>
<th>No. Reported</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
<th>Mean</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistant Professor</td>
<td>110</td>
<td>&lt;55-60&gt;</td>
<td>&lt;55-60&gt;</td>
<td>&lt;60-65&gt;</td>
<td>58,688</td>
<td>56,531</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>159</td>
<td>&lt;60-65&gt;</td>
<td>&lt;65-70&gt;</td>
<td>&lt;70-75&gt;</td>
<td>66,992</td>
<td>65,461</td>
</tr>
<tr>
<td>Full Professor</td>
<td>764</td>
<td>&lt;80-85&gt;</td>
<td>&lt;90-95&gt;</td>
<td>&lt;110-120&gt;</td>
<td>100,815</td>
<td>96,380</td>
</tr>
</tbody>
</table>

2002-03 Academic-Year Salaries (in thousands of dollars)

#### Group I (Private) Faculty Salaries

**Doctoral degree-granting departments of mathematics (23)**

18 responses (78%)

<table>
<thead>
<tr>
<th>Rank</th>
<th>No. Reported</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
<th>Mean</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistant Professor</td>
<td>75</td>
<td>&lt;55-60&gt;</td>
<td>&lt;60-65&gt;</td>
<td>&lt;60-65&gt;</td>
<td>61,092</td>
<td>63,794</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>66</td>
<td>&lt;65-70&gt;</td>
<td>&lt;70-75&gt;</td>
<td>&lt;75-80&gt;</td>
<td>72,564</td>
<td>71,442</td>
</tr>
<tr>
<td>Full Professor</td>
<td>293</td>
<td>&lt;90-95&gt;</td>
<td>&lt;100-110&gt;</td>
<td>&lt;120-130&gt;</td>
<td>109,922</td>
<td>110,541</td>
</tr>
</tbody>
</table>

2002-03 Academic-Year Salaries (in thousands of dollars)
Group II Faculty Salaries
Doctoral degree-granting departments of mathematics (56)
45 responses (80%)

<table>
<thead>
<tr>
<th>Rank</th>
<th>No. Reported</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
<th>Mean</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistant Professor</td>
<td>205</td>
<td>&lt;45-50&gt;</td>
<td>&lt;50-55&gt;</td>
<td>&lt;55-60&gt;</td>
<td>52,738</td>
<td>51,701</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>402</td>
<td>&lt;55-60&gt;</td>
<td>&lt;60-65&gt;</td>
<td>&lt;65-70&gt;</td>
<td>61,342</td>
<td>59,220</td>
</tr>
<tr>
<td>Full Professor</td>
<td>941</td>
<td>&lt;65-70&gt;</td>
<td>&lt;80-85&gt;</td>
<td>&lt;90-95&gt;</td>
<td>84,663</td>
<td>82,274</td>
</tr>
</tbody>
</table>

Group III Faculty Salaries
Doctoral degree-granting departments of mathematics (73)
59 responses (81%)

<table>
<thead>
<tr>
<th>Rank</th>
<th>No. Reported</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
<th>Mean</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistant Professor</td>
<td>271</td>
<td>&lt;45-50&gt;</td>
<td>&lt;50-55&gt;</td>
<td>&lt;55-55&gt;</td>
<td>51,278</td>
<td>51,065</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>450</td>
<td>&lt;50-55&gt;</td>
<td>&lt;55-60&gt;</td>
<td>&lt;65-70&gt;</td>
<td>61,039</td>
<td>57,973</td>
</tr>
<tr>
<td>Full Professor</td>
<td>598</td>
<td>&lt;65-70&gt;</td>
<td>&lt;70-75&gt;</td>
<td>&lt;85-90&gt;</td>
<td>79,593</td>
<td>76,129</td>
</tr>
</tbody>
</table>
2002 Annual Survey of the Mathematical Sciences

Group IV (Statistics) Faculty Salaries
Doctoral degree-granting departments of statistics (55)
37 responses (67%)

<table>
<thead>
<tr>
<th>Rank</th>
<th>No. Reported</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Mean</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistant Prof.</td>
<td>101</td>
<td>&lt;55-60&gt;</td>
<td>&lt;60-65&gt;</td>
<td>&lt;60-65&gt;</td>
<td>60,934</td>
<td>57,615</td>
</tr>
<tr>
<td>Associate Prof.</td>
<td>112</td>
<td>&lt;60-65&gt;</td>
<td>&lt;65-70&gt;</td>
<td>&lt;70-75&gt;</td>
<td>69,124</td>
<td>67,031</td>
</tr>
<tr>
<td>Full Prof.</td>
<td>297</td>
<td>&lt;80-85&gt;</td>
<td>&lt;95-100&gt;</td>
<td>&lt;110-120&gt;</td>
<td>102,134</td>
<td>99,898</td>
</tr>
</tbody>
</table>

2002-03 Academic-Year Salaries (in thousands of dollars)

Group IV (Biostatistics) Faculty Salaries
Doctoral degree-granting departments of biostatistics and biometrics (31)
16 responses (52%)

<table>
<thead>
<tr>
<th>Rank</th>
<th>No. Reported</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Mean</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistant Prof.</td>
<td>52</td>
<td>&lt;55-60&gt;</td>
<td>&lt;60-65&gt;</td>
<td>&lt;65-70&gt;</td>
<td>62,568</td>
<td>59,180</td>
</tr>
<tr>
<td>Associate Prof.</td>
<td>51</td>
<td>&lt;65-70&gt;</td>
<td>&lt;70-75&gt;</td>
<td>&lt;80-85&gt;</td>
<td>77,315</td>
<td>76,877</td>
</tr>
<tr>
<td>Full Prof.</td>
<td>74</td>
<td>&lt;85-90&gt;</td>
<td>&lt;100-110&gt;</td>
<td>&lt;130-140&gt;</td>
<td>110,534</td>
<td>108,309</td>
</tr>
</tbody>
</table>

2002-03 Academic-Year Salaries (in thousands of dollars)
Group Va Faculty Salaries
Doctoral degree-granting departments of applied mathematics (18)
13 responses (72%)

<table>
<thead>
<tr>
<th>Rank</th>
<th>No. Reported</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
<th>Mean</th>
<th>2001-02 Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistant Professor</td>
<td>32</td>
<td>&lt;45-50&gt;</td>
<td>55,764</td>
<td>&lt;55-60&gt;</td>
<td>56,292</td>
<td></td>
</tr>
<tr>
<td>Associate Professor</td>
<td>40</td>
<td>&lt;50-55&gt;</td>
<td>&lt;55-60&gt;</td>
<td>&lt;60-65&gt;</td>
<td>64,380</td>
<td></td>
</tr>
<tr>
<td>Full Professor</td>
<td>95</td>
<td>&lt;70-75&gt;</td>
<td>&lt;75-80&gt;</td>
<td>&lt;80-85&gt;</td>
<td>98,228</td>
<td></td>
</tr>
</tbody>
</table>

Group M Faculty Salaries
Master's degree-granting departments of mathematics (192)
101 responses (53%)

<table>
<thead>
<tr>
<th>Rank</th>
<th>No. Reported</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
<th>Mean</th>
<th>2001-02 Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistant Professor</td>
<td>518</td>
<td>&lt;40-45&gt;</td>
<td>48,563</td>
<td>&lt;50-55&gt;</td>
<td>46,052</td>
<td></td>
</tr>
<tr>
<td>Associate Professor</td>
<td>529</td>
<td>&lt;50-55&gt;</td>
<td>&lt;55-60&gt;</td>
<td>&lt;60-65&gt;</td>
<td>58,059</td>
<td></td>
</tr>
<tr>
<td>Full Professor</td>
<td>813</td>
<td>&lt;60-65&gt;</td>
<td>&lt;70-75&gt;</td>
<td>&lt;80-85&gt;</td>
<td>74,235</td>
<td></td>
</tr>
</tbody>
</table>

2002-03 Academic-Year Salaries (in thousands of dollars)
Group B Faculty Salaries
Bachelor's degree-granting departments of mathematics (1030)
348 responses (34%)

<table>
<thead>
<tr>
<th>Rank</th>
<th>2002-03</th>
<th>2001-02</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>Median</td>
</tr>
<tr>
<td>Assistant Prof.</td>
<td>46,151</td>
<td>44,134</td>
</tr>
<tr>
<td>Associate Prof.</td>
<td>55,157</td>
<td>53,817</td>
</tr>
<tr>
<td>Full Prof.</td>
<td>70,629</td>
<td>69,091</td>
</tr>
</tbody>
</table>

Previous Annual Survey Reports
The 2001 First, Second, and Third Annual Survey Reports were published in the Notices of the AMS in the February, August, and September 2002 issues, respectively. These reports and earlier reports, as well as a wealth of other information from these surveys, are available on the AMS website at www.ams.org/employment/surveyreports.html.

Acknowledgments
The Annual Survey attempts to provide an accurate appraisal and analysis of various aspects of the academic mathematical sciences scene for the use and benefit of the community and for filling the information needs of the professional organizations. Every year, college and university departments in the United States are invited to respond. The Annual Survey relies heavily on the conscientious efforts of the dedicated staff members of these departments for the quality of its information. On behalf of the Annual Survey Data Committee and the Annual Survey Staff, we thank the many secretarial and administrative staff members in the mathematical sciences departments for their cooperation and assistance in responding to the survey questionnaires.

Other Data Sources


Definitions of the Groups

As has been the case for a number of years, much of the data in these reports is presented for departments divided into groups according to several characteristics, the principal one being the highest degree offered in the mathematical sciences. Doctoral-granting departments of mathematics are further subdivided according to their ranking of "scholarly quality of program faculty" as reported in the 1995 publication Research-Doctorate Programs in the United States: Continuity and Change. These rankings update those reported in a previous study published in 1982. Consequently, the departments which now comprise Groups I, II, and III differ significantly from those used prior to the 1996 survey.

The subdivision of the Group I institutions into Group I Public and Group I Private was new for the 1996 survey. With the increase in number of the Group I departments from 39 to 48, the Annual Survey Data Committee judged that a further subdivision of public and private would provide more meaningful reporting of the data for these departments.

Brief descriptions of the groupings are as follows:

Group I is composed of 48 departments with scores in the 3.00-5.00 range. Group I Public and Group I Private are Group I departments at public institutions and private institutions respectively.

Group II is composed of 56 departments with scores in the 2.00-2.99 range.

Group III contains the remaining U.S. departments reporting a doctoral program, including a number of departments not included in the 1995 ranking of program faculty.

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

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

Group Va is applied mathematics/applied science; Group Vb, which was no longer surveyed as of 1998–99, was operations research and management science.

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

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

Listings of the actual departments which comprise these groups are available on the AMS website at www.ams.org/employment/.

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Schramm, Agrawal Receive Clay Awards

The Clay Mathematics Institute has presented its Clay Research Awards for 2002 to ODED SCHRAMM, Microsoft Corporation, and MANINDRA AGRAWAL, Indian Institute of Technology. According to the prize citations, Schramm was selected “for his work in combining analytic power with geometric insight in the field of random walks, percolation, and probability theory in general, especially for formulating stochastic Loewner evolution.” Agrawal was chosen “for finding, jointly with two undergraduate students, an algorithm that solves a modern version of a problem going back to the ancient Chinese and Greeks: how can one determine whether a number is prime in a time that increases polynomially with the size of the number?” The awards were presented on October 30, 2002, in Cambridge, Massachusetts.

—From a Clay Institute announcement

French Academy of Sciences Elections

Nine mathematicians have been elected to the French Academy of Sciences in 2001-2002. They are: Gérard Berry, Centre de Mathématiques Appliquées at Sophia-Antipolis; JEAN-MARC FONTAINE, Institut Universitaire de France; GILLES PISIER, University of Paris and Texas A&M University; MAXIM KONTSEVICH, Institut des Hautes Études Scientifiques; LUDWIG FADDEEV, Steklov Institute of Mathematics; MASAKI KASHIWARA, University of Kyoto; SERGIU KLAINERMAN, Princeton University; JACOB PALIS, Instituto de Matemática Pura e Aplicada, Brazil; and CHRISTOPHE SOULÉ, Centre National de la Recherche Scientifique.

—From a French Academy of Sciences announcement

AAAS Fellows Elected

Seven mathematicians have been elected as Fellows of the Mathematics Section of the American Association for the Advancement of Science. The new fellows are: RONALD R. COIFMAN, Yale University; JACK D. COWAN, University of Chicago; FAN CHUNG GRAHAM, University of California, San Diego; FRANK CHARLES HOPPENSTEADT, Arizona State University; H. JEFF KIMBLE, California Institute of Technology; JEFFREY C. LAGARIAS, AT&T Shannon Laboratories; and EDWARD NELSON, Princeton University.

In addition, BART SELMAN, Cornell University, was elected a Fellow of the Information, Computing, and Communication Section.

—From an AAAS announcement

Correction

The October 2002 issue of the Notices carried a news item about the awarding of the 2002 d’Alembert Prize of the Société Mathématique de France. One of the awardees, L’Association Fermat-Lomagne, was inadvertently omitted.
Mathematics Opportunities

Collaborations in Mathematical Geosciences

The National Science Foundation sponsors the Collaborations in Mathematical Geosciences (CMG) Program. The purposes of CMG are: (A) to enable collaborative research at the intersection of mathematical sciences and geosciences, and (B) to encourage cross-disciplinary education through summer graduate training activities.

Research topics under (A) should fall within one of two broad themes: (1) mathematical and statistical modeling of large, complex geosystems; or (2) representing uncertainty in geosystems. Research projects supported under this activity should be essentially collaborative in nature. Research groups should include at least one mathematical scientist and at least one geoscientist. Projects under category (A) should be of three to four years in duration. It is not the intent of this activity to provide general support for infrastructure. Projects under category (B) are not restricted to topics (1) and (2).

The CMG program is a joint effort between the Directorate for Geosciences and the Division of Mathematical Sciences (DMS). The cognizant program officers in the DMS are: Alexandre Freire, email: afrei re@nsf.gov; Ken Shaw, email: kshaw@nsf.gov; and John Stufken, email: jstufken@nsf.gov. Further information is available on the Web at http://www.nsf.gov/cgi-bin/getpub?nsf03508. The deadline for proposals is February 20, 2003.

Request for Proposals for 2004 NSF-CBMS Regional Conferences

The National Science Foundation (NSF), with the sponsorship of the Conference Board of the Mathematical Sciences (CBMS), intends to support up to seven NSF-CBMS Regional Research Conferences in 2004.

Each five-day conference features a distinguished lecturer who delivers ten lectures on a topic of important current research in one sharply focused area of the mathematical sciences. The lecturer subsequently prepares an expository monograph based on these lectures, which, depending on the topic, is published either by the AMS, by the Society for Industrial and Applied Mathematics, or jointly by the American Statistical Association and the Institute of Mathematical Statistics. Support is provided for about thirty participants at each conference, including postdoctoral researchers and graduate students.

Colleges and universities with at least some research competence in the field of the proposal are eligible to apply. Because a major goal of these conferences is to attract new researchers into the field of the conference and to stimulate new research activity, institutions that are interested in upgrading or improving their research efforts are especially encouraged to apply.

Proposals should reach the NSF by April 8, 2003. For further information on the NSF-CBMS Regional Conferences and guidelines for preparing proposals, contact: Conference Board of the Mathematical Sciences, 1529 18th Street, NW, Washington, DC 20036-1385; telephone: 202-293-1170; fax: 202-293-3412; World Wide Web: http://www.cbmsweb.org/NSF/2004_call.htm; email: kolbe@math.georgetown.edu or rosier@math.georgetown.edu.

IAS/Park City Mathematics Institute

The Institute for Advanced Study (IAS)/Park City Mathematics Institute (PCMI) will hold its 2003 summer session from June 29-July 19, 2003, in Park City, Utah. The research topic is harmonic analysis and partial differential equations. The organizers are Michael Christ (University of California, Berkeley), Carlos Kenig (University of Chicago), and Wilhelm Schlag (California Institute of Technology). The education topic is knowledge of mathematics for teaching.
The IAS/PCMI began in 1991 at the University of Utah as a National Science Foundation Regional Geometry Institute. In 1993 the IAS assumed sponsorship of the program. Each summer the PCMI offers an integrated set of programs for researchers, postdoctorates, graduate and undergraduate students, and teachers.

Further information is available at the website http://www.admin.ias.edu/ma/.

—From an IAS/PCMI announcement

2003 NSF-CBMS Regional Conferences

With funding from the National Science Foundation (NSF), the Conference Board of the Mathematical Sciences (CBMS) will hold five NSF-CBMS Regional Research Conferences during the summer of 2003. These conferences are intended to stimulate interest and activity in mathematical research.

Each five-day conference features a distinguished lecturer who will deliver ten lectures on a topic of importance in current research. Support for about thirty participants will be provided for each conference. Established researchers, and interested newcomers, including postdoctoral fellows and graduate students, are invited to attend. The title of each conference follows, along with the names of the principal speaker, the date and location of the conference, and the names of the organizers, as well as contact information. More information about the conferences can also be found at the website http://www.cbmsweb.org/NSF/ or by contacting the Conference Board of the Mathematical Sciences, 1529 18th Street, NW, Washington, DC 20036-1385; telephone: 202-293-1170; fax: 202-293-3412; email: ko1be@math.georgetown.edu.


Fully Nonlinear Equations in Geometry, Neil Trudinger, June 23-27, University of Notre Dame. Organizers: Matthew Gursky and Qing Han. Telephone: 574-631-8848, 574-631-6834; email: gursky.1@nd.edu, qhan@nd.edu; World Wide Web: http://www.nd.edu/~cbms/.

—From a CBMS announcement

Sixth Pan-African Congress of Mathematicians

The Pan-African Congress of Mathematicians is held every four years. The next congress will take place September 1-6, 2004, at the Institut National des Sciences Appliquées et de la Technologie (INSAT) at the Université de 7 Novembre à Carthage in Tunis, Tunisia.

The theme of the congress is "Mathematical Sciences and the Development of Africa: Challenges for Building a Knowledge Society in Africa". The scientific program will include plenary lectures, invited lectures, contributed research papers, a symposium, and exhibitions.

There will be limited travel and/or subsistence support for African participants. Those interested in applying for support should submit a curriculum vitae and an abstract of their contributed papers to: J. Persens, President, African Mathematical Union, University of the Western Cape, Private Bag X17, Belville 7535, South Africa; email: jpersens@uwc.ac.za. A copy of this material should also be sent to: J.-P. Ezin, Secretary General, African Mathematical Union, Institut de Mathématiques et de Sciences Physiques, BP613, Porto Novo, Benin; email: jpezin@syfed.bj.tintu.org.

For information about the African Mathematical Union, consult the website http://www.math.buffalo.edu/mad/AMU/index.html.

—Announcement of the African Mathematical Union

News from the IMA

The Institute for Mathematics and its Applications (IMA) at the University of Minnesota is delighted to announce New Directions Visiting Professorships for 2003-2004 and the New Directions Short Course in summer 2003. These programs offer extraordinary opportunities for established mathematicians to branch into new directions and increase the impact of their research.

IMA New Directions Visiting Professorships: The IMA invites applications by established mathematicians for two Visiting Professorships for a period of 9 to 12 months, including the thematic program Probability and Statistics in Complex Systems: Genomics, Networks, and Financial Engineering, which runs from September 2003 through June 2004. Visiting Professors will enjoy an excellent research environment and stimulating scientific program with broad mathematical connections, including probability, statistics, dynamical systems, network and graph theory, optimization, control, and visualization. They are
Mathematics Opportunities

expected to be resident and active participants in the program but are not assigned formal duties. The New Directions program will supply 50 percent of faculty salary up to $45,000 maximum. Deadline: March 15, 2003.

IMA New Directions Short Courses: From June 16 to 27, 2003, the IMA will host a two-week intensive short course designed to efficiently provide mathematicians the basic knowledge prerequisite to undertaking interdisciplinary research in the burgeoning field of mathematical biology at the cellular level. The course in Cellular Physiology will be taught by James Keener, professor of mathematics and adjunct professor of bioengineering at the University of Utah and author of the award-winning text Mathematical Physiology; and Alexander Mogilner, professor and Chancellor's Fellow in the Department of Mathematics and Center for Genetics and Development at the University of California at Davis. Participants will receive full travel and lodging support during the workshop. Deadline: April 1, 2003.

For further information and application procedures, see http://www.ima.umn.edu/new-directions/.

NOTE: The IMA New Directions Program is subject to funding, which is anticipated but currently pending.

—IMA Announcement

2003 Summer Program for Women in Mathematics

The George Washington University, with funding from the National Security Agency, will hold the 2003 Summer Program for Women in Mathematics (SPWM 2003) June 28–August 2, 2003, in Washington, DC. SPWM 2003 is an intensive five-week program for mathematically talented undergraduate women who are completing their junior years and may be contemplating graduate study in the mathematical sciences. The goals of this program are to communicate an enthusiasm for mathematics, to develop research skills, to cultivate mathematical self-confidence and independence, and to promote success in graduate school. Sixteen women will be selected. Each will receive a travel allowance, campus room and board, and a stipend of $1,500. The application deadline is March 1, 2003. For further information, see the university's website, http://www.gwu.edu/~math/spwm.html, or contact the director, Murli M. Gupta (mmg@gwu.edu), Department of Mathematics, George Washington University, Washington, DC 20052; telephone: 202-994-4857; fax: 202-994-6760.

—George Washington University announcement

Cryptology Paper Competitions

The journal Cryptologia has announced two paper competitions for undergraduate students: the Annual Undergraduate Paper Competition on Cryptology and the Annual

Greg Mellen Memorial Cryptology Scholarship Prize. Papers may focus on any area of cryptology, including technical, historical, and literary subjects. Each competition offers a $300 prize and publication in Cryptologia.

Deadline for entries is December 31, 2003. Information may be obtained from Cryptologia, Department of Mathematical Sciences, United States Military Academy, West Point, NY 10996; email: Cryptologia@usma.edu; or from the website http://www.dean.usma.edu/math/pubs/cryptologia/.
For Your Information

DMS Employment Opportunities

Several of the technical staff of the Division of Mathematical Sciences (DMS) of the National Science Foundation (NSF) serve one- to two-year visiting scientist or Intergovernmental Personnel Act appointments as program directors while on leave from universities, colleges, industry, or national laboratories. Since the timing of these positions is staggered, the division continually seeks talented applicants. In 2003 the division will be seeking to make appointments in all areas. Permanent program director appointments will also be considered.

The positions involve responsibility for the planning, coordination, and management of support programs for research (including multidisciplinary projects), infrastructure, and human resource development for the mathematical sciences. Normally, this support is provided through merit-reviewed grants and contracts that are awarded to academic institutions and nonprofit, nonacademic research institutions.

Applicants should have a Ph.D. or equivalent training in a field of the mathematical sciences, a broad knowledge of one of the relevant disciplinary areas of the DMS, some administrative experience, a knowledge of the general scientific community, skill in written communications and preparation of technical reports, an ability to communicate orally, and several years of successful independent research normally expected of the academic rank of associate professor or higher. Skills in multidisciplinary research are highly desirable. Qualified women, ethnic/racial minorities, and/or persons with disabilities are strongly urged to apply. No person shall be discriminated against on the basis of race, color, religion, sex, national origin, age, or disability in hiring by the NSF.

Applicants should send a letter of interest and a vita to Deborah F. Lockhart, Acting Executive Officer, Division of Mathematical Sciences, National Science Foundation, 4201 Wilson Boulevard, Suite 1025, Arlington, Virginia 22230; telephone: 703-292-4858; fax: 703-292-9032; email: dlockhar@nsf.gov.

—NSF announcement

Mathematics Awareness Month 2003

Mathematics Awareness Month (MAM), which takes place in April each year, is a project of the Joint Policy Board for Mathematics. The purpose of MAM is to promote public awareness and appreciation of mathematics. The month provides an excellent occasion for outreach activities.

The theme for MAM 2003 is Mathematics and Art. Further information is available at the MAM website, http://www.d.umn.edu/~jgallian/art.html. The website includes links to other websites, references to resources about mathematics and art, information about MAM activities being organized on college and university campuses, and a list of speakers willing to present lectures about mathematics and art.

—Allyn Jackson
Reference and Book List

The Reference section of the Notices is intended to provide the reader with frequently sought information in an easily accessible manner. New information is printed as it becomes available and is referenced after the first printing. As soon as information is updated or otherwise changed, it will be noted in this section.

Contacting the Notices
The preferred method for contacting the Notices is electronic mail. The editor is the person to whom to send articles and letters for consideration. Articles include feature articles, memorial articles, communications, opinion pieces, and book reviews. The editor is also the person to whom to send news of unusual interest about other people's mathematics research.

The managing editor is the person to whom to send items for "Mathematics People", "Mathematics Opportunities", "For Your Information", "Reference and Book List", and "Mathematics Calendar". Requests for permissions, as well as all other inquiries, go to the managing editor.

The electronic-mail addresses are notices@math.tamu.edu in the case of the editor and notices@ams.org in the case of the managing editor. The fax numbers are 979-845-6028 for the editor and 401-331-3842 for the managing editor. Postal addresses may be found in the masthead.

Upcoming Deadlines


Where to Find It
A brief index to information that appears in this and previous issues of the Notices.

AMS Bylaws—November 2001, p. 1205
AMS Email Addresses—November 2002, p. 1275
AMS Ethical Guidelines—June/July 2002, p. 706
AMS Officers 2000 and 2001 (Council, Executive Committee, Publications Committees, Board of Trustees)—June/July 2002, p. 705
AMS Officers and Committee Members—October 2002, p. 1108
Conference Board of the Mathematical Sciences—September 2002, p. 955
Information for Notices Authors—June/July 2002, p. 697
Mathematics Research Institutes Contact Information—August 2002, p. 828
National Science Board—January 2003, p. 64
NRC Board on Mathematical Sciences and Staff—April 2002, p. 492
NRC Mathematical Sciences Education Board and Staff—May 2002, p. 583
NSF Mathematical and Physical Sciences Advisory Committee—February 2003, p. 261


March 31, 2003: Nominations for the 2003 Prize for Achievement in Information-Based Complexity. Contact Joseph Traub, traub@cs.columbia.edu.


May 15, 2003: Applications for fall semester of Math in Moscow and for AMS scholarships. See http://www.mccme.ru/mathinmoscow/, or contact Math in Moscow, P.O. Box 524, Wynnewood, PA 19096; fax +7095-291-65-01; email: mim@mccme.ru. For information about and application forms for the AMS scholarships, see http://www.ams.org/careers-edu/mimmoscow.html, or contact Math in Moscow Program, Professional Services Department, American Mathematical Society, 201 Charles Street, Providence RI 02904; email: prof-serv@ams.org.


MPS Advisory Committee
Following are the names and affiliations of the members of the Advisory Committee for Mathematical and Physical Sciences (MPS) of the National Science Foundation. The date of the expiration of each member's term is given after his or her name. The website for the MPS directorate may be found at http://www.nsf.gov/home/mps/. The postal address is Directorate for the Mathematical and Physical Sciences, National Science Foundation, 4201 Wilson Boulevard, Arlington, VA 22230.

Thomas W. Appelquist (10/04)
Department of Physics
Yale University

Shenda Baker (10/05)
Department of Chemistry
Harvey Mudd College

Roger D. Blandford (10/04)
Division of Physics, Mathematics, and Astronomy
California Institute of Technology

Jean H. Futrell (10/05)
Director
Pacific Northwest National Laboratory

S. James Gates Jr. (10/03)
Physics Department
University of Maryland

Peter F. Green (10/05)
Department of Chemical Engineering
University of Texas, Austin

Fiona Goodchild (10/03)
Materials Research Laboratory
University of California, Santa Barbara

Robert C. Hilborn (10/04)
Department of Physics
Amherst College

Lon Mathias (10/03)
Department of Polymer Science
University of Southern Mississippi

David R. Morrison (10/05)
Department of Mathematics
Duke University

Claudia Neuhauser (10/05)
Ecology, Evolution, and Behavior
University of Minnesota

Willie Pearson Jr. (CEOSE Representative)
School of History, Technology, and Society
Georgia Institute of Technology

Jeanne E. Pemberton (10/04)
Department of Chemistry
University of Arizona

Julia Phillips (10/03)
Materials Science & Technologies
Sandia National Laboratories

William R. Pulleyblank (10/04)
Mathematical Sciences and Deep Computing Institute
IBM T. J. Watson Research Center

Joseph Salah (Chair) (10/04)
Haystack Observatory
Massachusetts Institute of Technology
**Reference and Book List**

**Gary Sanders (10/05)**  
LIGO Laboratory  
California Institute of Technology

**David Siegmund (10/03)**  
Department of Statistics  
Stanford University

**Neil deGrasse Tyson (10/03)**  
 Hayden Planetarium  
American Museum of Natural History

**Book List**

The Book List highlights books that have mathematical themes and are aimed at a broad audience potentially including mathematicians, students, and the general public. When a book has been reviewed in the Notices, a reference is given to the review. Generally the list will contain only books published within the last two years, though exceptions may be made in cases where current events (e.g., the death of a prominent mathematician, coverage of a certain piece of mathematics in the news) warrant drawing readers' attention to older books. Suggestions for books to include on the list may be sent to notices-booklist@ams.org.

*Added to “Book List” since the list's last appearance.


Doctoral Degrees Conferred
2001–2002

ALABAMA

Auburn University (4)

MATHEMATICS

Leach, Charles David, Hamilton decompositions of multipartite graphs.
Walsh, Matthew Phillip, A problem of network stability.

MATHEMATICS

Baggett, Donald, Short path problems in coverings and tilings.
Hill, William C., On G-invariant norms, an extension of a result of Berezin.

University of Alabama, Birmingham (4)

MATHEMATICS

Peacock, Robert, A local Borg-Marchenko theorem for complex potentials.
Sakata, Mayumi, Generalized eigenfunction expansions.
Sims, Robert J., Localization for one-dimensional models of disordered media.
Smith, Brian R., Asymptotically flat quasi-convex Riemannian metrics of nonnegative scalar curvature and the constraint equations in general relativity.

University of Alabama, Huntsville (1)

MATHEMATICAL SCIENCES

Phillips, Ben, Colored distance and competition parameters.

University of Alabama, Tuscaloosa (4)

MATHEMATICS

Hammoud, Noureddine, A benchmark solution for phase change with convection.

MATHEMATICS

Harrison, Randall, Restricted Lie superalgebras and their universal enveloping algebras.
Monk, Barry J., A proposed theory of fuzzy random variables.
Xie, Chunping, Q_p spaces and their properties.

ARIZONA

University of Arizona (5)

APPLIED MATHEMATICS

Coombs, Daniel, Dynamics of travelling helicity fronts in bacterial flagella.

MATHEMATICS

Gallas, Brandon, Signal detection in lumpy backgrounds.

MATHEMATICS

Agrotis, Maria Andrea, Pure and applied reflections on the reduced Maxwell-Bloch system.

CALIFORNIA

California Institute of Technology (6)

APPLIED AND COMPUTATIONAL MATHEMATICS

Craciun, Bogdan, Phase boundary propagation in heterogeneous media.
Petrasek, Danny, Diffusion mediated regulation of endocrine networks.

CONTROL AND DYNAMICAL SYSTEMS

Chang, Dong-Eui, Controlled Lagrangian and Hamiltonian systems.
Fax, Alex Joseph, Optimal and cooperative control of vehicle formations.
Murphy, Todd, Control of multiple model systems.

MATHEMATICS

Vela, Luz, Time-frequency analysis based on wavelets for Hamiltonian systems.

Claremont Graduate University (3)

MATHEMATICS

Abebe, Henok, Modeling the current-voltage (I-V) characteristics of the MOSFET device with quantum mechanical effects due to thin oxide near Si/SiO2 interface using asymptotic methods.
Hayakawa, Carole Kay, Monte Carlo methods for the early detection of disease-induced transformation in tissue.
Hoang, Hue Trong, Experimental and numerical investigations of steady turbulent jets from round ribbed tools.

University of California, Berkeley (29)

BIOSTATISTICS

Henneman, Tanya, Estimating causal parameters in marginal structural models.

MATHEMATICS

Amin, Scott, Associated and attached primes over noncommutative rings.
Calef, Brandon, Optimal sampling of the discrete Fourier transform.
Calegari, Francesco, Ramification and semistable Abelian varieties.
Cameron, Christopher D., A comparative analysis of methods for sampling stationary stochastic processes.
desJardins, David L., Precise coding with noisless feedback.
Etgu, Tolga, Symplectic forms on product four-manifolds.
Goldberg, Michael J., Perturbation of the nonlinear Schrodinger equation from a linear perspective; vector-valued singular integrals from a scalar perspective.
Hadfield, Thomas Daniel, Fredholm modules over certain group C*-algebras.

The above list contains the names and thesis titles of recipients of doctoral degrees in the mathematical sciences (July 1, 2001, to June 30, 2002) reported in the 2002 Annual Survey of the Mathematical Sciences by 217 departments in 149 universities in the United States. Each entry contains the name of the recipient and the thesis title. The number in parentheses following the name of the university is the number of degrees listed for that university. A supplementary list, containing names received since compilation of this list, will appear in a summer 2003 issue of the Notices.
Israel, Joseph S., Amalgamation and unimodality.

Kempe, Julia, Universal noiseless quantum computation: Mathematical theory and applications.

Koev, Plamen, Accurate and efficient computations with structured matrices.

Lippel, David Andrew, Finitely axiomatizable omega-categorical theories.

Markiewicz, Daniel W., Completely positive semigroups and their product systems.

Matusevich, Laura F., Combinatorial aspect of hypersymmetric functions.

Radko, Olga, Some invariants of Poisson manifolds.

Reznikoff, Sarah A., Representations of the Temperley-Lieb planar algebra.

Serra, Antonio M., Twisted vertex operators, algebraic curves, and Prym varieties.

Wilkening, Jon A., Mathematical analysis and numerical simulation of electromigration.

Armstrong, Nicola, Incorporating inference in the linkage analysis of experimental crosses.

Bultotoglu, Dursun, Projection properties of Paley designs and optimal supersaturated designs.

Fridlyand, Jane, Resampling methods for variable selection and classification: Applications to Genomics.

Iontâtescu, Edward, Statistical analysis of cell motion.

Jorntzen, Becka, Data compression and its statistical implications, with an application to the analysis of microarray images.

Levina, Elizaveta, Statistical issues in texture analysis.

Yang, Yee Hwa, Statistical methods in the design and analysis of gene expression data from cDNA microarray experiments.

Zhang, Xiaoyan, Statistical topics in transportation studies.

University of California, Davis (10)

Brown, David, Stochastic spatial models of plant diseases.

Chan, Yoon-Sha, Hypersingular integral-differential equations and applications to fracture mechanics of homogeneous and functionally graded materials with strain-gradient effects.

Lorson, Brons, The continuous boundary local trigonometric transform.

Mazzag, Barbara, Mathematical models in biology.

Whitlow, Darryl, Finite volume methods for incompressible flow.

University of California, Irvine (4)

Aslam, Sajid, Robust testing procedures based on s-estimate for the dispersion parameter of univariate and multivariate normal distribution and for the two-way mixed effect models.

Facer, Mathew, Nonparametric surface estimation for quantitative bioassay, survival data, and location of extrema.

Su, Chun-Lung, Asymptotic posterior approximation with applications to generalized linear mixed models.

Wang, Wei, Proportional hazards regression with unknown link-function and applications to longitudinal time-to-event data.

University of California, San Diego (9)

Bailey, Paul L., Incremental ascent of a modular tower via branch cycle designs.

Chung, Yeojin, Global regularity and inertial manifold for Moore-Greitzer model of turbo-machinery engine and modeling of pulse propagation in optical fibers.

Nirshchik, Nick, The computation of a curve C in P^2 with the property that the fundamental group of P^2 \setminus C is a nonresidually finite group.


University of California, Los Angeles (10)

Chaffee, Lyman, Actions of the homeomorphism group of the interval.

Chang, Clement, Classification of Hermitian forms over central simple algebras with involution.

Cortez, Albert, Dynamics of diffeomorphisms of the torus.

Huckaby, David, Analysis and applications of Stewart's pivoted QLP decomposition.

Jones, Matthew, Regularity through partial elimination ideals and the canonical bundle.

Kang, Sung Ha, Mathematical approaches to color denoising and image inpainting.

Karamyan, Grant, The inverse scattering problem of fixed energy in the half space.

Tanner, Jared, Adaptive high resolution recovery of smooth data from its spectral information.

Tsai, Yen-Hsi Richard, Numerical method for Hamilton-Jacobi equations and their applications.

Watler, Brian, Finite equational bases for directed graph algebras.

University of California, Riverside (5)

Oseledets, Cyrill, Root direct limits of Lie superalgebras.

Chou, Daphne, Nonparametric estimation of the generating function of the intensity function process of a doubly stochastic Poisson process.


Dav, Steven, Estimators of long-term transition probabilities of multistate stochastic processes.

Lehr, Mark, Wavelet spectral density estimation of continuous-time stationary processes under random sampling.

University of California, Santa Barbara (10)

Bell, Jason Pierre, Affine rings of low GK dimension.

Dowka, Art, Local block bootstrap based inference for nonstationary time series.

Ellis, Robert Brian, Chip-firing games with Dirichlet eigenvalues and discrete Green's functions.

Gromoll, Hans Christian, Diffusion approximation for a processor sharing queue in heavy traffic.

Kowalski, R. Travis, Formal equivalences between real-analytic hypersurfaces.

Marcia, Roummel, Primal-dual interior-point methods for large scale optimization.

Martin, Jeremy L, Graph varieties.

Mohanty, Yana Z., Hyperbolic polyhedra: Volume and scissors congruence.

Raphael, Benjamin J., A computational investigation of spectral sets and rational dilations over multiply-connected domains.

University of California, Riverside (5)

Mathematics

Oseledets, Cyrill, Root direct limits of Lie superalgebras.

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University of California, Santa Barbara (10)

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Dowka, Art, Local block bootstrap based inference for nonstationary time series.

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Kowalski, R. Travis, Formal equivalences between real-analytic hypersurfaces.

Marcia, Roummel, Primal-dual interior-point methods for large scale optimization.

Martin, Jeremy L, Graph varieties.

Mohanty, Yana Z., Hyperbolic polyhedra: Volume and scissors congruence.

Raphael, Benjamin J., A computational investigation of spectral sets and rational dilations over multiply-connected domains.
Doctoral Degrees Conferred

Maher, Joseph, Period three actions on the three sphere.
Svensden, Anne Louise, Commuting squares and automorphisms of subfactors.

STATISTICS AND APPLIED PROBABILITY
Hsu, Chih-wen, Bayesian estimation of a covariance matrix and its application to mixed effects models.
Yang, Yuchieh, Detecting change-points and hormone pulses using partial spline models.
You, Huaxin, Classification and feature extraction methods with application to image database retrieval.

University of Southern California (6)

MATHEMATICS
Bourque, Guillaume, Algorithms for phylogenetic tree construction based on genome rearrangements.
Chu, Wensong, Optical orthogonal codes and cyclic t-designs.
Hubbell, Earl, Some combinatorial problems concerning DNA arrays.
Linchenko, Vitaly, Some properties of Hopf algebras and H-module algebras.
Wu, Jing, Statistical inference for molecular data: man, motifs and microarrays.
Yaralov, Georgi, Some problems in statistics arising in signal and image processing.

COLORADO

Colorado State University (5)

MATHEMATICS
Anderle, Markus, Resource allocating radial basis function dimension reduction networks.
Badran, Abdelhamid Elmoursi, Identification of physical properties in geology, hydrology and ecology.
Cushman, Ann Louise, Cyclotomic coset association schemes.
Erdman, Melissa Claire, Cell exclusion algorithms.
Liu, Sulhwa, Network multiple frame assignment architectures.

University of Colorado, Boulder (4)

APPLIED MATHEMATICS
Austin, Travis, Advances on a scaled least-squares method for the 3-D linear Boltzman equation.
Carter, John, Stability and existence of traveling wave solutions of the two-dimensional nonlinear Schrödinger equation and its higher-order generalizations.
Horne, Rudy, Collision induced timing jitter and four-wave mixing in wavelength division multiplexing soliton systems.

University of Colorado, Denver (3)

MATHEMATICS
Holder, LeAnn, Blocking sets of conics.
Wilson, John, Efficient solver for mixed and control-volume mixed finite element methods in three dimensions.

PREVENTIVE MEDICINE AND BIOMETRICS
Weitzenkamp, David, Heteroscedastic models for longitudinal data.

University of Northern Colorado (1)

MATHEMATICAL SCIENCES

CONNECTICUT

University of Connecticut (6)

MATHEMATICS
Horak, Jiri, Traveling waves in a nonlinear suspended beam.
Molitierno, Jason, Coefficients of ergodicity-type bounds for the algebraic connectivity of graphs.
Washington, Talitha, Mathematical model of proteins acting as on/off switches.

STATISTICS
Agarwal, Deepak, Bayesian spatial regression analysis with large datasets.
Chen, Zhen, On modeling discrete choice data.
Michaels, Athanasios, Statistical modeling and geometry of shapes.

Yale University (2)

MATHEMATICS
Muchnik, Roman, Semigroup actions of \( T^n \).
Retakh, Alexander, Associative conformal algebras and pseudoalgebras and their representations.

University of Delaware (4)

MATHEMATICAL SCIENCES
Hokston, Scott, The direct method for multicriteria problems.
Mellinger, Keith, Mixed partitions and spreads of projective spaces.
Nojumi, Hassan, An extended model of asset price dynamics.

DISTRICT OF COLUMBIA

American University (6)

MATHEMATICS AND STATISTICS
Lotze, Conrad, Online mathematics and statistics tutoring: Effectiveness and implementation issues.
Ojeda Revah, Diana, Comparative study of stable parameter estimators and regression with stably distributed errors.
Rickert-Sharkey, Charlene, Secondary school students' conceptions, factors behind achievement, and problem solving strategies with stochastic problems.
Schmidt, Lara, Estimation in the presence of fractionally integrated noise; An application to atomic time scales.
Wicks, Whiting, The impact of college students' cultural and historical awareness on their perceived mathematics self-efficacy, motivation and achievement.

George Washington University (3)

MATHEMATICS
Dimitrov, Rumen, Computably enumerable vector spaces, dependence relations and Turing degrees.
Hough, David, The genus of partitions and C-trees.
Wargan, Krzysztof, S-adic dynamical systems and Bratteli diagrams.

Howard University (5)

MATHEMATICS
Ayine, Gabriel Bong-Baane, Topics in the differential geometry of supermanifolds.
Cameron, Naomiu Tuere, Random walks, trees and extensions of Riordan group techniques.
Matthews, Lunnell Sherri, Combinatorial interpretations of Hankel matrices and further combinatorial uses of Riordan group methods.
McLeod, Jillian Elizabeth, Notions of size in adequate partial semigroups.
Mokou, Iris Gogu, The sizes of preimages of points under the natural map from \( K(bN \times N) \) to \( K(bN) \times K(bN) \).

Ou, Miao-Jung, Direct and inverse acoustic scattering problems in a class of three-dimensional waveguide.
Florida

Florida Institute of Technology (3)

Mathematical Sciences
Clary, Scott, Building a better product despite competing objectives: A characterization of product and process improvement techniques.
Hernandez, Jesus, On the Tikhonov regularization method for Fredholm integral equations of the first kind with least squares solutions in L and R.
Kim, Song Kyoo, On generalized stochastic reliability models with reserve and super-reserve machines.

Florida State University (4)

Mathematics
Pastouchenko, Nikolai, Noise from the fine scale turbulence of jets in forward flight, nonaxisymmetric jets and installed jets.
Turcic, Balsa, Self-consistent models of triaxial elliptical galaxies with central cusps.

Statistics
Leizeaux, Marc, Bayesian inference for a spatial cluster model via perfect sampling.
Whitten, Blake, Formulations of missing-data models and likelihood-based inference.

University of Florida (8)

Mathematics
Bell, Gregory, Asymptotic dimension of groups.
Lotaille, Jeffrey, The elementary divisors of incidence matrices between certain subspaces of a finite symplectic space.
Lokvancic, Mahir, Semigroup perturbations of martingales.
Mocloaca, Oana, Additive summable processes and their stochastic integral.
Sembroski, Vincent, Homeomorphisms of Knaster continua.

Statistics
Caffo, Brian, Candidate sampling schemes and some important applications.
Galin, Jones, Convergence rates and Monte Carlo standard errors for Markov chain Monte Carlo algorithms.
Jank, Wolfgang, Monte Carlo estimation methods in general hierarchical models.

University of Miami (1)

Mathematics
Browdy, Steven, Topological censorship, the topology of black holes, and the end structure of space.

Georgia

Emory University (6)

Biostatistics
Hill, Elizabeth, General saddlepoint approximations to the null distributions of Moran's I-type measures of spatial autocorrelation.
Wang, Molin, Semiparametric methods to reduce the impact of nuisance parameters.

Mathematics and Computer Science
Bailey, Dionne, Computational approaches to representation theorems for finitely generated real algebras.
Dementieva, Yulia, Equivalent conditions for hypergraph regularity.
Hunt, Jason, Forbidden triples in pancyclic graphs.
Peng, Yuejian, Counting small cliques in the 3-uniform hypergraph.

Georgia Institute of Technology (5)

Mathematics
Burer, Samuel, New algorithmic approaches for semidefinite programming with applications to combinatorial optimization.
Martin, Russell, Paths, sampling and Markov chain decomposition.
Murrali, Shobhana, Curvature, isoperimetry, and discrete spin systems.
Sutton, David, Generating random absolutely continuous distributions.
Stoyanov, Tsvetan, Isoperimetric and related constants for graphs and Markov chains.

University of Georgia (3)

Statistics
Shao, Qin, Inference for a class of periodic time series models and their applications.
Smith, D. V., Bayesian and minimum Hellinger distance approaches to inference with applications.
Wei, Xin Yu, Performance of sequential sampling schemes for some independent and dependent models.

Illinois

Illinois State University (3)

Mathematics
Fuller, Roberta, Assessing change in the beliefs, knowledge, and practices of an experienced elementary mathematics teacher.
Jaberg, Patricia, Elementary preservice teachers exploring teaching mathematics for understanding via action research.

Northern Illinois University (5)

Mathematical Sciences
Al Rawwash, Mohammed, Gaussian estimation and modeling covariance in longitudinal data analysis.
Benbourenane, Djamel, Value distribution for solutions of complex differential equations on the unit disk.
Sarkissian, Daniil, Theory and computations of partial eigenvalue and eigenstructure assignment problems in matrix second order and distributed parameter systems.
Sriraman, Bharath, Mathematical creativity: A qualitative study of 9th grade student's generalization processes.
Xu, Bangteng, Blocks with Abelian defect groups.

Northwestern University (7)

Engineering Science and Applied Mathematics
Moore, Richard, A study of optical devices with parametric gain.

Mathematics
Burslem, Elizabeth, Centralizers of partially hyperbolic diffeomorphisms.
Che, Charles, Quasi-periodic Lagrangian systems on the annulus.
Meleshuk, Vadim, Embedding templates in flows.
Pervova, Julia, Infinite-dimensional modules for infinitesimal group schemes.
Williams, Alan, Asymptotic stability of nonsymmetric neural networks by sink symmetrization.

Southern Illinois University, Carbondale (1)

Mathematics
Wang, Jianfang, Estimation of quality adjusted survival functions and mean lifetime medical cost.

University of Chicago (5)

Mathematics
Ahlin, Ashley Reiter, The large scale geometry of nilpotent-by-cyclic group.
Degni, Christopher, Positive orthogonal sets for Sp(4).
Wilson, Lawrence, Powerful groups of prime power order.
INDIANA

Indiana University, Bloomington (6)

MATHEMATICS
Cabrál, Marco, Numerical and analytical study of attractors for some Navier-Stokes related equations.
Crowley, Diarmuid, The classification of highly connected manifolds in dimensions 7 and 15.
Hill, Ellen, A Ginzburg-Landau model for Josephson junctions in a ring.
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Zhu, Jieun, Least squares estimators for the spatial regression model.

INDIANA University-Purdue University (1)

MATHEMATICAL SCIENCES
Mukhin, Dmitry, Properness and von-Neumann-Morgenstern utility functions.

Purdue University (15)

MATHEMATICS
Ghosh, Yashowanto, Limit theorems for non-negative integer-valued random walks with non-localized reflection.
Kotzev, Boris, Vanishing of the first Dolbeault cohomology group line bundles on complete intersections in infinite-dimensional projective space.
Long, Xiang, Variance reduction for numerical solutions of stochastic differential equations.
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Tamás, Csíká, Analytic rigidity of K-trivial extremal contractions of smooth threefolds.
You, Daehye, Inequalities for Schrödinger operators and laws of the iterated logarithm.
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Cahen, James, Bridge sampling with dependent random draws: Techniques and strategy.
Strahs, Andrew, Statistical problem in human genetics: Multipoint fine-scale linkage disequilibrium mapping by the decay of haplotype sharing.

University of Illinois, Urbana-Champaign (13)

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Argiris, Georgios, Counting and the ergodic averages.
Aschenbrenner, Matthias, Ideal membership in polynomial rings over the integers.
Ayaragarnchanakul, Jantana, Divergence in ergodic theory.
Bauer, Mark, Function field arithmetic and related algorithms.
Kaur, Manmohan, Ternary rings of operators and their linking C*-algebras.
Lawton, Linda, Decision problems in the lattice of IF1 classes.
Loukaki, Maria, Normal subgroups of odd order monomial pA pk-groups.
Moosa, Rahim N., Some model-theoretic results in algebraic and complex analytic geometry.
Myung, Sung, Motivic polylogarithms for the Good Willie-Lichtenbaum complex.
Ramanurthy, Radhika, Coloring problems on graphs and hypergraphs.
Richardson, Andrew, Some duality results in homological algebra.
Shin, Kwang, On some Schrödinger eigenvalue problems from mathematical physics.

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Horta, Sarah, A Bayesian framework for the unified model for assessing cognitive abilities: Blending theory with practicality.

IOWA

Iowa State University (12)

MATHEMATICS
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Choi, Ji Young, Multi-restricted numbers and powers of permutation representation.
Chryssafinos, Konstantinos, Analysis and finite element approximation of parabolic saddle-point problems and applications to optimal control.
Ju, Lih, Probabilistic and parallel algorithms for centroid Voronoi tessellations with application to meshless computing and numerical analysis on surfaces.
Lee, Jeelhyun, Optimization-based domain decomposition methods for multidisciplinary simulation.
Vojtechovsky, Petr, Finite simple Moufang loops.

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Azevedo, Karla, Using factor source estimates in latent variable analysis.
Chan, Victor, Degradation-based reliability in outdoor environments.
Fernandez, Soledad, An algorithm to sample genotypes in complex pedigrees.
Li, Xiao-Hua, Kernel smoothing for spatially correlated data.
Ryan, Kenneth, Engineering application of Bayesian statistical methods.

Sinha, Sandip, Bayesian factors for variance component testing in generalized linear mixed models.

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Chen, Wei, Pricing fixed income securities with a class of Markov regime switching processes.

Daescu, Dacian, Theoretical and practical aspects of data assimilation for air pollution models.

Forman, Sean, Torsion angle selection and emergent non-local secondary structure in protein structure prediction.

Hong, Li, Nonlinear algorithms for image resolution enhancement and image compression.

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Kolluri, Sheela, A model for longitudinal Poisson count data with informative dropout.

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Smith, Brian, A Bayesian framework for analyzing exposure data from the Iowa radon lung cancer study.

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Beaugris, Louis, A construction of the generators of cyclic codes over \( \mathbb{Z}_n \) and related results.

Li, Wei, Degenerated equations with diffusion and convection effects.

Smith, Eric, Weakly prime ideals.

Viola, Maria Grazia, Non-outer conjugates of locally symmetric groups.

Yugang, Xiao, On S-automata where the lattice of right congruences on S is semiatomic.

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Bognar, Matthew A., Bayesian estimation of a potential function in a pairwise interacting point process.

Kuo, Hsun-chih, Estimation of survival functions and multinomial parameters under order constraints.

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Logue, Mark W., Complications of an unknown genetic model in the presence of heterogeneity for linkage analysis.

KANSAS

Kansas State University (4)

Mathematics

Narayanam, Bharath, Representations of quantized function algebras for Kac-Moody algebras.

O'Brien, Timothy, A skein-theoretic construction of invariants of 3-manifolds associated to the quantum group UQ(G2).

Schroeder, W. Christopher, Cyclic coverings of regular affine maps.

Statistics

Zhang, Ying, Parameter estimation in continuous and discrete-time queuing models.

University of Kansas (3)

Mathematics

Benyi, Arpad, Bilinear singular integrals and pseudodifferential operators.

Ciuperca, Catalin, Generalized Hilbert coefficients and the S2-ification of a Rees algebra.

West, Eric, Primes associated to multigraded modules.

Wichita State University (6)

Mathematics and Statistics

Bsharat, Mohammad, On the existence of balanced arrays with two symbols.

Hervas, David, An inverse boundary value problem for a quasilinear elliptic differential equation.

Kim, Tae-Eun, Capillary surface interfaces in annular domains.

Lorenzo-Gonzalez, Edgardo, Statistical inference about some restricted classes of life distributions.

Valdivia, Nicolas, Inverse problems in scattering theory and acoustics.

Zeng, Hong-Biao, Convergence of spectra of mesoscopic system collapsing onto a graph.

Kentucky

University of Kentucky (7)

Mathematics

Davis, Anna, A relative version of the finiteness obstruction theory of Wall.

Morgan, Christopher, On univalent harmonic mappings.

Sills, Andrew, Computer assisted explorations of Rogers-Ramanujan type identities.

Sullivan, Sharon, Examples of combinatorial designs.

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Chen, Kun, Censored empirical likelihood ratio and its computation.

Diaz, Francisco, A semiparametric model to investigate growth trend of certain stochastic processes.

Pavlov, Dmitri, Identifying special disease clusters in nonhomogeneous populations.

Louisiana

Louisiana State University, Baton Rouge (5)

Mathematics

Florey, Simone, On the stabilization and regularization of rational approximation schemes for semigroups.

Guner, Cem, Artin-Schreier families and 2-D cyclic codes.

Luttamaguizzi, Jamir, A monotone follower control problem with a non-convex functional and some related problems.

Somodi, Marius, Bounding the wild set (counting the minimum number of wild primes in Hilbert symbol equivalent number fields).

Walker, Uroyoan, On k-conjugacy classes of maximal tori in semisimple algebraic groups.

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Mathematics and Statistics

Chen, Qing, Modeling and experimental verification of growth of an axisymmetric cylindrical rod by three dimensional laser induced chemical vapor deposition.

Pokorny, Kian, Fuzzy product-limit estimators: Soft computing in the presence of very small and highly censored data sets.

Tulane University (3)

Biostatistics and Epidemiology

Khader, Yousef, Factors associated with gingivitis and periodontitis in a dental teaching clinic population in northern Jordan.

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Liu, Hong, Goodness-of-fit tests for accelerated life models with right censored data.

Mactas-Diaz, Jorge, Generalizations of the Pontryagin-Hill theorems to projective modules.

University of Louisiana at Lafayette (5)

Mathematics

Arazyan, Ahvard, Inferences on the reliability of a series system.
Munoz, Humberto, Interval slopes and twin slope arithmetic in nonsmooth optimization.

Jones, Julie, Protopological groups and other generalizations of topological groups.

Tian, Haiyan, Single-point blow-up of solutions for degenerate nonlinear parabolic problems.

Thomson, Jessica, Inferential procedures for some discrete distributions.

MARYLAND

Johns Hopkins University (10)

BIOSTATISTICS

Fan, Ming-Yu, Measures of relative importance and related statistics.

Huang, Ching-Yu, Modeling and estimation for recurrent event data with dependent censoring.

Hsu, Fang-Chi, Multipoint linkage, disequilibrium mapping approaches based on the case-parent trio design.

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Pipiras, Vladas, Stable self-similar processes with stationary increments.

Brandeis University (5)

MATHEMATICS

Berger, Laurent, Limits of absolutely crystalline representations.

Milshnikov, Kirill, Maximum adjusted density estimator for structural equation models.

Tchernia, Pedro, p-fractals and Hilbert-Kunz series.


Harvard University (22)

BIOSTATISTICS

Kammann, Erin, Geostatistical models and robust mixed models.

Boston University (8)

MATHEMATICS AND STATISTICS

Dukes, Kimberly, Factor analysis: The effects of distribution type, number of factors, factor loadings, number of variables per factor and sample size.

Fortuna, Natercia, Local and global rank tests with applications to demand systems.

Khan, Amina, Comparison of tests of homogeneity in $R \times C$ contingency tables with small sample sizes.

Lee, Jennifer, Influence of floor effects on the area under the receiver operating characteristic curve.

Moreno-Rocha, Monica, Indecomposable subsets of the Julia set for unstable polynomials.

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Liang, Xiangfan, Wavelet-based multiscale window transform and energy and vorticity analysis.
Ram, Wheeler, Adaptive tree search.
Wang, Ce, Face detection and pose estimation for multimedia applications.

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Arinkin, Dmitro, Fourier transform for quantized completely integrable systems.
De Marco, Laura, Holomorphic families of rational maps: Dynamics, geometry, and potential theory.
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Libine, Matvei, A localization argument for character formula for reductive groups.
Liu, Chi-Chu (Melissa), Moduli of J-holomorphic curves with Lagrangian boundary conditions.
Mantovan, Elena, On certain unitary group Shimura varieties.
Treffkovic, Mak, On μ-invariants of elliptic curves over Q.
Yang, Huan, Hecke algebra action on Siegel modular forms.

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Bauer, Tilman, p-compact groups as framed manifolds.
Biss, Daniel, The homotopy type of the matroid Grassmannian.
Cao, Xiaodong, Ricci flow on 3-manifolds with symmetry.
Castravet, Ana-Maria, Rational families of vector bundles on curves.
Degertau, Anda, Eta-invariants and Molien series for unimodular groups.
Dunagan, John, A geometric theory of outliers and perturbation.
He, Li, Modeling and prediction of sunspot cycles.
Holm, Tara, Equivariant cohomology, homogeneous spaces and graphs.
Joseph, Benjamin, The involution principle and R-positive symmetric functions.
Liu, Xiangwu, Spectrum of some regular graphs with widely spaced modifications.
McGerty, Kevin, Affine quantum algebra, Weyl groups and constructible functions.
Poulin, Francis, The instability of time-dependent jets.
Petta, Adrian, Graph connectivity: Relaxations and algorithms.
Weatherwax, John, Mathematical modeling of shock induced martensitic phase transitions.
Wen, Tong, Support vector machine algorithms: Analysis and applications.
Yang, Xiaochun, Geometry of cone-beam reconstruction.
Yau, Donald, Localization genus of classifying spaces.
Zhang, Lizhao, Rigidity and invariance properties of certain geometric frameworks.
Zinger, Aleksey, Enumerative algebraic geometry via techniques of symplectic topology and analysis of local obstructions.

Northeastern University (1)
MATHEMATICS
Korobotnikova, Tatiana, Modeling of individual protein molecule dynamics.
Tufts University (1)
MATHEMATICS
Thomas, Christopher, Surface-realizable finite groups of outer automorphisms of finitely-generated free groups.

University of Massachusetts, Amherst (5)
MATHEMATICS AND STATISTICS
Auth, Matthew, Quaternionic Riemann-Roch theorem.
Chen, Zhixiong, Stability of traveling waves for Hamilton-Jacobi equations and mesoscopic modeling for diffusion dynamics.
Li, Zhi, Undulating coherent structures in two-dimensional turbulence: A quasi-equilibrium approach.
Stein, Benjamin, Signal formulation, segmentation, and lesion volume estimation in magnetic resonance images.
Stovall, Idris, Numerical methods for Rayleigh-Benard convection inside a Hele-Shaw cell.

MICHIGAN
Central Michigan University (5)
MATHEMATICS
Ali-Haies, Hasan, Banach-Stone theorems for nice operators on Banach function modules.
Bollman, Mark, Some Diophantine equations involving Fibonacci numbers and consecutive factorials.
Egleston, Patricia, Nonnegative matrices with prescribed spectra.
Eugene, Nicholas, A class of generalized normal distributions: Properties, estimation, and applications.
Moenk, Sr. Jeane, Subject matter preparation of pre-service elementary teachers in mathematics.

Michigan State University (13)
MATHEMATICS
Cellik, Canan, Solutions to a nonlinear heat equation with critical exponent.
Chae, Gab-Byung, Enumeration of general cubic graphs.
Ghezzi, Laura, The depth of blow-up rings of ideals.
Jabuka, Stanislav, Grafting Seiberg-Witten monopoles.
Kim, Jinwoe, Infinitely many periodic solutions of nonlinear wave equations of 5th.
Kuemmen, Eric, Three-dimensional rough surface growth: A radial continuum equation and a discrete off-lattice Eden cluster growth model.
Lee, Junho, Family Gromov-Witten invariants for Kaehler surfaces.
Lim, Hyoera, Time discretization of transition layer dynamics in viscoelastic systems.
Minut, Aurelia, Mathematical analysis of Maxwell's equation.
Sti, Wai Cheong, Hypertrees in d-uniform hypergraphs.
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Polverejan, Elena, Regression models for analysis of medical costs.

Oakland University (1)
MATHEMATICS AND STATISTICS
Roy, Amuradha, Some contributions to discrimination and classification with repeated measures data with special emphasis on biomedical applications.

University of Michigan, Ann Arbor (22)
BIOSTATISTICS
Cayetano, Shari, Nonparametric paired tests for censored survival data incorporating prognostic covariate information.
Douglas, Julie, Methods for resolving genotype and haplotype ambiguity in human genetic data.
Kaciri, Nika, Modeling nonignorable missing data for clustered longitudinal discrete outcomes: A Bayesian approach.
Lange, Ethan, Methods for mapping disease susceptibility genes using alleleshaving statistics.
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Peng, Yahong, Causal inference for discrete outcomes with missing values and non-compliance.
Tang, Gong, Pseudo likelihood selection models for nonrandomly missing data.

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Bickle, Manuel, The intersection homology D-module in finite characteristics.
Correll, William, Jr., The Smith normal form and kernel of the Varchenko matrix.
Ehsani, Dariush, The solution of the d-bar Neumann problem on non-smooth model domains.
Enescu, Florian, A study of F-rationality and F-injectivity.
Hagerty, Patrick, Radiation induced instability.
Howald, Jason, Calculations with multiplier ideals.
Li, Lang, On boundary regularity for the Stokes and Navier-Stokes equations.
Popa, Mihnea, On the structure of Bruhat order.

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Gupta, Jayanti, Bayesian inference on symmetric groups.
Kutsyy, Vadim, Modeling and inference for spatial processes with ordinal data.
Wang, Bingwu, Characterizing modality of posterior for hierarchical models.
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Zeng, Donglin, Adjusting for dependent censored using high dimensional auxiliary information.

**Wayne State University (2)**
Qin, Liu, G' interpolation of mesh curves.
Wang, Binyu, Sequential normal compactness with applications to optimization in infinite dimensions.

**Western Michigan University (3)**
Atwood, Peter, Learning to construct proofs in a first course on mathematical proofs.
Smith, Paula, Local symmetries of symmetrical Cayley maps.

**MINNESOTA**

**University of Minnesota, Minneapolis (12)**

**MATHEMATICS**
Calderhead, Kyle, Variations on the slope problem.
Chang, Won Jae, Numerical schemes for Bellman's equations with free boundary.
Chen, Kuo-Chang, Variational methods and periodic solutions of n-body problems.
Dobrinin, Natasha, Generalized distributive laws, games and a problem of von Neumann concerning measurable Borel algebras.
Dong, Xin, Topological combinatorics, Alexander duality and finite free resolutions.
Kang, Kyung Kun, On boundary regularity for the Stokes and Navier-Stokes equations.
Reading, Nathan, On the structure of Bruhat order.
Rios, Cristian, Operators with VMO coefficients and nondivergence harmonic measure.
Roh, Jaik, On the long time dynamics of an equation of Navier-Stokes class.
Urbs, Cetin, Integral representations of L-functions and Siegel-Weil-Kudla-Rallis formulas.
Wang, Jing, Design of progressive lenses—measurement analysis and numerical methods.

**STATISTICS**
Parode, Ina, A Bayesian approach to regression diagnostics.

**University of Minnesota, Twin Cities (4)**

**BIOSTATISTICS**
Han, Cong, Optimal designs for nonlinear regression models with applications to HIV dynamic studies.
Liu, Jianhong, Characterizing modality of the posterior for hierarchical models.
Wang, Faqun, Generalized common spatial factor model.
Wang, Zengli, Metameters in nonlinear random effects and frailty.

**MISSOURI**

**University of Missouri, Columbia (8)**

**MATHEMATICS**
Li, Xiaochun, Uniform bounds for the bilinear Hilbert transforms.
Rivera-Noriega, Jorge, Some remarks on certain parabolic differential operators over non-cylindrical domains.
Shen, Shih-Chi (Jerry), The inequalities of martingales.

**STATISTICS**
Chiu, Jing-er, Applications of Bayesian methods to arthritis research.
Lim, Hye-Jeong, Statistical analysis of interval-censored and truncated survival data.
Ren, Cuirong, Topics in Bayesian estimation: Frequentist risks and hierarchical models for time to pregnancy.

**University of Missouri, Rolla (2)**

**MATHEMATICS AND STATISTICS**
Atmaca, Murat, Applications of temporal logic to assembly and disassembly sequences.
Pascal, Sibel, The geometry of map equations for trochoids.

**Washington University (7)**

**MATHEMATICS**
Ho, Kwok-Pun, Anisotropic function spaces.
Johnson, Brody, Wavelets: Generalized quasi-affine and over-sampled affine frames.
Maggioli, Mauro, On the discretization of continuous wavelets and frames.

**SYSTEMS SCIENCE AND MATHEMATICS**
Dimarogonas, James, Model of the vertical vestibular-ocular reflex of the squirrel monkey.
Genc, Yvesel M. I., Hopf bifurcation related coherent oscillations in electric power systems with a clustered texture.
Kim, Sang Hyun, Adaptations of constraint programming to aircraft scheduling problems.
Nenadic, Zoran, Signal processing computation and estimation in biological neural networks.

**MONTANA**

**Montana State University (2)**

**MATHEMATICAL SCIENCES**
Bardsley, Jonathan, Constrained optimization techniques for image reconstruction.
Dumonceaux-Hamilton, Doreen, Rotation sets of flows on higher dimensional tori.

**University of Montana (3)**

**MATHEMATICAL SCIENCES**
Crip, Gregory, The effect of information on a stochastic fishery.
Lertskrai, Supawan, Asymptotic analysis of a fast reaction outside a solid sphere in a creeping flow.
Sheng, Huaiqing (Tom), Estimation in generalized linear models and time series models with nonparametric correlation coefficients.

NEBRASKA

University of Nebraska, Lincoln (3)

MATHEMATICS AND STATISTICS

Chen, Shijie, Empirical best prediction and hierarchical Bayes methods in small-area estimation.
Karr, Ryan, Optimal trading strategy for European options with transaction costs.
Katchev, Karl, Monoids, direct-sum decompositions, and elasticity of factorizations.

NEW HAMPSHIRE

Dartmouth College (2)

MATHEMATICS

Stanhope, Elizabeth A., Hearing orbifold topology.
Tomforde, Mark L., Extensions of graph C*-algebras.

NEW JERSEY

New Jersey Institute of Technology (5)

MATHEMATICAL SCIENCES

Addabbo, Raymond, The structure and stability of expanding and converging near-stochiometric flames.
Antoniou, Elaina, A new theory of premixed flames in near-stochiometric mixtures.
Kas-Danouche, Said, Nonlinear interfacial stability of co-annular film flows in the presence of surfactants.
Kunec, Stephen, Temporal synchronization of CA1 pyramidal cells by high-frequency, depressing inhibition, in the presence of intracranial noise.
Savettaseranee, Knongrat, Instability of electrified viscous films.

Princeton University (16)

APPLIED AND COMPUTATIONAL MATHEMATICS

Papavasiliou, Anastasia, Adaptive particle filters with applications.
Sales Saborit, Manuel, Analysis of credit rating equality indexes: Volatility comparison and option calibration.
Tehrunchi, Michael, Applications of infinite dimensional stochastic analysis to problems in fixed income markets.
Yilmaz, Ozgur, Mathematical properties of coarse quantization schemes in signal analysis with new applications.

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Carbery, Emma, On the existence of minimal tori in $S^3$ of arbitrary spectral genus.
Chin, Chee Whye, Independence of $L$ and monodromy groups.
Geba, Dan, A local well-posedness result for the quasilinear wave equation in $\mathbb{R}^{2+1}$. 
Ho, Alan, Optimal trading strategy for European options with transaction costs.
Jon, Bogdan, MacDonald polynomials, Demazure modules and positivity.
Johnson, Carl, Eulerian digraph immersion.
Miller, Steven, 1- and 2-level density for families of elliptic curves: Evidence for the underlying group symmetries.
Nicoara, Andrei, Global regularity of the tangential Cauchy-Riemann operator on weakly pseudo-convex CR manifolds.
Rychkov, Viatcheslav, Estimates for oscillatory integral operators.
Schenker, Jeffrey, Schrödinger evolution: Localization bounds and adiabatic theorems in the absence of a spectral gap.
Watson, Thomas, Rankin triple products and quantum cohomology.

Rutgers University, New Brunswick (8)

MATHEMATICS

Ingalls, Brian, Comparisons of stability notions for nonlinear control systems with outputs.
Milas, Antun, Correlation functions vertex operator algebras and $q$ and zeta functions.
Sakhanenko, Lyudmila, Demazure modules and positivity.
Wolverton, Robert, Classification of symplectic and Poisson structures.
Zhao, Yi, Some extreme problems and polynomial optimization.

STATISTICS

Mitra, Nandita, Analysis of censored and incomplete data using flowgraph models.

NEW MEXICO

New Mexico State University (4)

MATHEMATICAL SCIENCES

Jarrah, Abdul, Generic Cohen-Macaulay monomial ideals.
Naghashi, Hideo, A Sahlgren theorem for distributive modal logics.
Obeidat, Sofian, Wavelet techniques for the Navier-Stokes equations.
Wang, Ying, Perturbations of Gabor frames.

University of New Mexico (5)

MATHEMATICS AND STATISTICS

Panchevskaya, Dimitry, Concentration inequalities in product spaces and applications to statistical learning theory.
Robidoux, Nicolas, Number solution of the steady diffusion equation with discontinuous coefficients.
Wolpert, Robert, Shear layer stability in a two dimensional geometry.
Yau, Candice, Analysis of censored and incomplete data using flowgraph models.

NEW YORK

City University of New York, Graduate Center (6)

MATHEMATICS

Apostolakis, Nikolaos, On moves between branched coverings of the three sphere.
Cebotariu, Hulyn, Homotopic residual correction algorithms for general and structured matrices.
Janii, Jerry C., Computing normalizations using Newton polygons.
Lengyel, Florian, Recursion categories of co-algebras.
Saric, Dragomir, Complex earthquakes are holomorphic.
Zeinalian, Mahnoos, On some local combinatorial invariants of homology manifolds.

Columbia University (13)

BIOSTATISTICS

Lim, Ho-Jeong, Saddlepoint approximations to $P$-values for comparison of density estimates.
Ma, Guoguang, Measuring local sensitivity to nonignorability.
Mitra, Nandita, Analyzing data from non-randomized studies using propensity score methodology.
Doctoral Degrees Conferred

Norton, Michele R., Repeated measures analysis of continuous data: An application to assess blood pressure variability buffering effects of cardiac autonomic control during psychological and orthostatic challenge.

Paykin, Andrea, Analyzing small samples of identically treated pairs of failure time observations.

Wu, Min, Adjusting for population admixture in multipoint linkage analysis with missing parental haplotypes.

MATHEMATICS

Brendle, Tara, The Torelli group and representations of mapping class groups.

Clinger, Adrian, Heterotic string data and theta functions.

Hundley, Joseph, Siegel zeros of Eisenstein series on Gln.

Oden, Omer, Relative spherical functions on p-adic symmetric spaces (three cases).

Winkle, Nancy, The Markov theorem for transverse knots.

Xue, Hui, Central values for twisted L-functions.

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Applied Mathematics

Axtatam, Joel, Collective dynamics of the Winfree model of coupled nonlinear oscillators.

Calabrese, Peter, Stochastic microsatellite models.

Goldberg, Debra, Algorithms for the construction of comparative genome maps.

Hiebeler, David, Populations and the evolution of dispersal on spatially structured heterogeneous landscapes.

Mareno, Anita, Global continuation in higher-gradient three-dimensional nonlinear elasticity.

Porter, Mason, Quantum chaos in vibrating billiard systems.

Braun, Steven, Using spider theory to explore parameter spaces.

Nyman, Kathryn, Enumeration in geometric lattices and the symmetric group.

Spence, Sarah, Graph embeddings with applications in genomic experiments.

Hang, Fengbo, Topology of Sobolev mappings, Jacobians and Ginzburg-Landau type functions.

Jiang, Shidong, Fast evaluation of nonreflecting boundary conditions for the Schrodinger equation.

Loulakis, Michail, Einstein relation for a tagged particle in simple exclusion processes.

Petrov, Timofir, Elliptic fibrations with fixed monodromy.


Xiang, Yang, Continuum models for epithelial growth with elasticity.

Zhu, Luoding, Simulation of a flapping flexible filament in a flowing soap film by the immersed boundary method.

New York University

Statistics and Operations Research

Huang, Bu, Jiaojian, Entropy-based nonparametric tests of independence.

Rensselaer Polytechnic Institute

Mathematical Sciences

Aquino, Leslie, J. C., Modeling sediment transport using a two-phase approach.

Braun, Steven, Solving a quadratic programming problem subject to orthogonality constraints.

Geer, Pan, On cellular lines.

Jezes, Wayne, Parabolic equations for layered elastic media.

State University of New York, Albany

Mathematics and Statistics

Clark, Aaron, Solvability of equations over torsion free groups.

Kazaz, Angeliki, Generalized factorization in Hardy spaces.

Statistics and Biometry

Iasonos, Alexis, A multivariate analysis based on frequency domain decomposition and Hilbert space projection in the presence of missing data.

Lazaru-Bauer, Victoria, New methods for propensity score adjustment to selection bias for WIC prenatal effects.

Yang, Bao-Zhu, Forminability index and bias correction for measurement models.

State University of New York, Binghamton

Mathematical Sciences

Best, John David, On 3/2-transitive groups.

Forrester, Jeffrey, Efficient estimation of the regression parameter in heteroscedastic regression model where heteroscedasticity is modeled as a function of the mean response.

Haner, Matthew, Random designs in factorial experiments for estimation and searching.

Hooper, William, Efficient estimation of transformation parameters in nonparametric regression.

Peng, Xian Xiang, Efficient estimation of linear functionals of a bivariate probability with equal marginals.

Rosenthal, David, Splitting with continuous control in algebraic K-theory.

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Meng, Hongyan, Stability computation for small symmetric cycles near equilibrium in reversible systems.

Nicita, Contantin, Numerical simulation of magneto-rheological suspensions using a continuum medium approach.

Sibis, Ioana, A perturbation approach to the electron correlation cusp.

State University of New York, Stony Brook

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Choi, Yunhee, Extra-Poisson variation.

Chu, King-Wai, Optimal parallelization of simulated annealing by state mixing.

Farias, Ricardo, Efficient simulation of volumetric irregular grids data.

Guo, Wei, A parallelized point-shifted tetrahedral grid for the finite element method.


LaForest, Marc, A posteriori error estimate for front-tracking.

Lee, Chang-Ki, In air traffic management.

Magnus, Raymond, Comparison of multiple objective adaptive designs.

Otanken, Somashekar, Nonclassical shock waves in the WAG method for oil recovery.

Plohr, Yee-Sun, The linearized analysis of the Richtmyer-Meshkov instability for elastic materials.

Xiang, Xinyu, Succinct strip encoding of triangle meshes.

Zoldi, Cindy, Shock-accelerated heavy gas cylinder.

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Gony, Zsuzanna, The dimensions of escaping geodesics.

Hennes, Peter, Weierstrass representations of minimal real Kähler submanifolds.

Preston, Stephen, Eulerian and Lagrangian stability of fluid motion.

Raff, Kasra, Hyperbolic 3-manifolds and geodesics in Teichmüller space.
Seshadri, Harish, Einstein 4-manifolds with circle actions.

Song, Chanyoung, On generalizations of the scalar curvature.

Teo, Lee-Peng, Kähler geometry of moduli spaces and universal Teichmüller space.

**Syracuse University (2)**

**MATHEMATICS**

Bruce, Jennifer, Bilinski diagrams and geodesics in 1-ended planar maps.

deSilva, Rapti, Improving primary teachers’ learning and teaching of mathematics: A critical ethnography of a Sri Lankan program.

**BIOSTATISTICS**

Kost, James, Order restricted inference using dependent contrasts.

Tian, Lili, Inference procedures for the inverse Gaussian models and the Gaussian inverse Gaussian analogies.

**Mathematics and Statistics**

Kasiukov, Alexander, Higher dagger completion of linear direct systems.

**University of Rochester (3)**

**MATHEMATICS**

Kost, James, Order restricted inference using dependent contrasts.

Tian, Lili, Inference procedures for the inverse Gaussian models and the Gaussian inverse Gaussian analogies.

**BIOSTATISTICS**

Kasiukov, Alexander, Higher dagger completion of linear direct systems.

**NORTH CAROLINA**

**Duke University (3)**

**MATHEMATICS**

Ambrose, David M., Well-posedness of vortex sheets with surface tension.

Ionel, Lacramioara M., Second order families of special Lagrangian 4-folds in C^4.

**STATISTICS AND DECISION SCIENCES**

De Iorio, Maria, Markov random fields at multiple resolutions and an ANOVA model for dependent random measures.

**North Carolina State University, Raleigh (13)**

**STATISTICS**

Barber, Jarrett, Modeling and prediction of nonstationary spatial environmental processes.

Brown, George, Comparing Bayesian, maximum likelihood and classical estimates for the Jolly-Seber model.

Chen, Junliang, A Monte Carlo EM algorithm for GLMMs with flexible random effects distribution.

Chen, Pei-Yun, Estimating treatment differences in costs, effects, and cost-effectiveness ratios in observational studies with right censored data.

Chu, Tzu-Ming, Statistical nonparametric and linear mixed model analyses of oligonucleotide DNA chips data.

Dagdelen, Rukiye, Estimators for generalized linear measurement error models with interaction terms.

He, Xiaofeng, Credit cycle, credit risk, and business conditions.

Huang, Shu-Pang, Robust methods for estimating allele frequencies.

Hudson-Curtis, Buffy, Generalizations of the multivariate logistic distribution with applications to Monte Carlo importance sampling.

Kalvodyloia, Zhenyu, Frequentist and Bayesian unit root tests in stochastic volatility mode.

Kim, Hyunjung, Unit root tests in panel data: Weighted symmetric estimation and maximum likelihood estimation.

La, Kaiping, Estimation of regression coefficients in the competing risks model with missing cause of failure.

Lunceford, Jared, Estimating causal treatment effects via the propensity score and estimating survival distributions in clinical trials that follow two-stage randomization designs.

**University of North Carolina, Chapel Hill (16)**

**BIOSTATISTICS**

Demissie, Seleshi, Multilevel models with binary responses: An application to group randomized intervention trials with small number of clusters.

Henricz-Roldan, Carlos, Marginally specified conditional models for dependent binary responses.

Taylor, Doug, Mixture models for occupational exposure data with limit of detection.

Wang, Jianmin, Using probability sampling strategies with application to adolescent health studies.

**MATHEMATICS**

Bonn, James, Advective diffusion in the presence of idealized turbulence.

Duncan, David, A Wiener-Wintner double recurrence theorem.

Kneisl, Kyle, Markov partitions, Hausdorff dimension, and root finding algorithms.

Moseley, Christopher, The geometry of Engel manifolds.

Nicalaou, Katerina, Some properties of Wiener-Wintner dynamical systems.

Tertilla, John, Hypersurfaces and generalized deformations.

Young, Scott, Algebraic and spectral properties of generalized Cesaro operators.

**STATISTICS**

Bonnet, Guillaume, The Burgers superprocess.

Choi, Hyemi, Central limit theory and extremes of random fields.

Johnson, John, The association schemes of codes, fractional factorial designs, and block structures.

Lee, Kuan-Hui, Empirical evaluation and comparison of certain variance estimation methods.

Locantore, Nick, Elliptical principal component analysis.

**University of North Carolina, Charlotte (3)**

**MATHEMATICS**

Al-Hakim, Abbas, On a joint distribution for long runs and a limit theorem for approximate entropy with applications to the testing of random number generators.

Li, Jin-Liang, Numerical solutions for American options on assets with stochastic volatilities.

Yu, Yijun, Singularity treatment and high-order RWG basis functions for integral equations of electromagnetic scattering.

**NORTH DAKOTA**

**North Dakota State University (3)**

**STATISTICS**

Morel, Jeff, Analysis of count data in two-factor designs.

Madurapthy, Surekha, Interval-censored type II-plan.

Stockrahm, Jerome (Jerry), Discrete deconvolution.

**OHIO**

**Bowling Green State University (2)**

**MATHEMATICS AND STATISTICS**

Filippova, Daria, Long-term error estimates for nonlinear parabolic equations.

Rizzo Hong, Maria, A new rotation invariant goodness-of-fit test.

**Case Western Reserve University (5)**

**EPIDEMIOLOGY AND BIOSTATISTICS**

Buxbaum, Sarah, Genetics of sleep apnea.

Demko, Catherine, Determinants of sun exposure and protective behaviors among US adolescents: Results from the National Longitudinal Study of Adolescent Health.

Jean-Baptiste, Rachel, Psychosocial factors affecting end stage renal disease patient compliance with hemodialysis attendance.

Li, Jingjin, Pattern-mixture models adjusting for non-ignorable dropout with administrative censoring in longitudinal studies.

**MATHEMATICS**

Previts, William, Advances in topological groups.

**Kent State University (7)**

**MATHEMATICAL SCIENCES**

Brunkalla, Kai, Perturbation of hypercyclic and supercyclic operators.
Doctoral Degrees Conferred

Chalmers, James, A geometric approach to Boltzmann's law.
Downey, Lawrence M., Jr., Some problems in linear and multi-linear operator theory.
Feng, Bao Q., Matrix inequalities.
Kover, Janice S., Perturbation of norm attaining operators.
McVey, John Kenneth, Bounding the number of character degrees using generalized relative primeness conditions.

Ohio State University (7)
MATHEMATICS
Aydin, Nuh, New quasi-cyclic and quasi-twisted codes and an optimal family of polynomial codes.
Barbacioru, Catalin, Generalization of the Volkenborn integral.
Beli, Constantin, Integral spinor norm groups over dyadic local fields and representations of quadratic forms.
Breitenbuecher, John, Third order mock theta functions for symmetric multiple hypergeometric series.
Fiola, Nick, Some topics in combinatorial design theory and algebraic graph theory.
Jalics, Jozsi, Existence of slow waves in mutually inhibitory thalamic neuronal networks.

STATISTICS

Ohio University (1)
MATHEMATICS
Liu, Chuan, K-networks and mappings.

University of Cincinnati (5)
EPIDEMIOLOGY AND BIOSTATISTICS
Deng, Chuanqing, Statistical tests for hormesis in aquatic toxicology experiments.
Huang, Bin, Statistical assessment of the contribution of a mediator to an exposure outcome association.
Leonard, Anthony C., Hypothesis testing with the similarity index.
Pei, Huiling, Exploring bootstrap applications to linear structured equations.

MATHEMATICAL SCIENCES
Stancescu, Daniel, Bootstrap methods for the estimation of the variance of partial sums.

University of Toledo (4)
MATHEMATICS
Cao, Rongmei, Lagrangian submanifolds of 8-dimensional almost symplectic manifolds.

University of Oklahoma (1)
MATHEMATICS
Goodman, Russell, Deformations of simple representations of two generator HNN extensions.

Oklahoma State University (2)
MATHEMATICS
Tong, Simi, Complemented subspaces of $L_p$ determined by partitions and weights.

STATISTICS
Kim, Jong Min, New approaches to randomized response technique.

Oregon State University (1)
MATHEMATICAL SCIENCES
Burdon, Marcia, Embedded 2-polyhedra with regular neighborhoods which have sphere boundaries.

University of Oregon (5)
MATHEMATICS
Brandl, Katherine, Primitive and Poisson spectra of non-semisimple twists of polynomial algebras.
Brooks, Peter, Constructive recognition of the finite simple groups.
Kelm, Travis, LOT complexes and the Whitehead conjecture.
Oberbroeckling, Lisa, Generalized inverses in certain Banach algebras.
Woods, Tadg, Lorentz wave maps.

Pennsylvania State University (10)
MATHEMATICS
Dumitrascu, Constantin Dorin, A new approach to bivariant K-theory.
Emerson, Heath, An example of non-commutative Poincaré duality arising from hyperbolic dynamics.
Kim, Hee Jung, Almost complex structures arising in contact geometry.
Lemin, Vladimir, On some properties of ultrametric spaces and their applications to category theory and computer science.
Zhang, Bin, Equivariant theories and algebraic varieties.
Zhang, Sheng, A linear shell theory based on variational principles.

STATISTICS
Li, Haihong, Improving point estimation for models with many nuisance parameters.
Mao, Changxuan, Mixture models for species and population size estimation.
Mosquin, Paul, The analysis of Bayesian finite mixtures and discrete choice models.

Temple University (6)
MATHEMATICS
Al-Rasasi, Ibrahim, A mean value theorem for class numbers of quadratic extensions of function fields.
Hartenstine, David, Regularity of a class of weak solutions to the Monge-Ampere equation.
Loveridge, Clark, Measure of planes separating convex bodies in three dimensions.
Ludwick, Kurt, Survival of modularity under congruence restrictions.
Lyansky, Yan, Phase transition for the hard-core stochastic Ising model.
Xu, Jianjun, Studies of some high order finite/spectral element methods for viscous incompressible flow.

University of Pennsylvania (10)

MATHEMATICS
Atria, Matias, Two new algorithms for computational number theory.
Frye, Stephen, On the topological classification of toric varieties.
Glass, Darren, Orthogonal epsilon constants for tame actions of finite groups on surfaces.
Rajkovskaia, Natasha, Quantum field algebras.
Yan, Ning, Representation theory of the finite unipotent linear groups.

STATISTICS
Diaz-Tena, Nurra, Multiple imputation for estimation of AR(1) process parameters.
Gong, Hanfeng, Density estimation by free-knot spline functions.
Posniansky, Vladimir, Heath-Jarwood-Merton model and its application.
Zhang, Ren, Non-parametric density estimation via wavelets.

University of Pittsburgh (13)

BIOSTATISTICS
Gause, Christine, Methods for combining covariate data obtained by multiple sampling schemes in occupational cohort studies.
Li, Wei, Resampling approach for estimating prediction error and for adjusting logistic regression coefficients for covariate measurement error.
Valenta, Zdenek, Estimation of the survival function for Gray's piecewise constant time-varying coefficients model.
Yin, Yaming, Tree-structured model for interval-censored survival data.

MATHEMATICS
Buliga, Marius G., On the enumeration of colored spanning trees in a graph.
Burch, Kimberly, Matching equivalences and chemical graph theory.
Kapadia, Devendra, A class of conformally Einstein spacetimes.
Lattanzio, John, Critical colorations.
Tanriverdi, Tanfer, Boundary-value problems in ODE (the Fanno model for turbulent compressible flow, eigenfunction expansions).
Wang, Luyan, On permutation polynomials.

STATISTICS
Lee, Youngju, Assessment and improvement of neural networks.
Matas, Claudia, Statistical analysis of stereological estimators.
Sylvester, Marc, Estimation of a common mean from a series of similar interlaboratory experiments.

RHODE ISLAND Brown University (13)

APPLIED MATHEMATICS
Dance, Sarah, Particle sedimentation in viscous fluids.
Jung, Jae-Han, Multi-domain spectral penalty method for hyperbolic systems: Theory and applications.
Kubrakoff, Gershon, Approximation in an adaptive cosine basis and its application to image compression.
Lu, Conglin, Curvature-based multiscale shape analysis and stochastic shape modeling.
Lucena, Brian, Dynamic programming tree-width and computation on graphical models.
Moiser, Jamison, Stable pulse propagation in optical fibers with varying dispersion.
Pang, Tao, Stochastic control theory and its applications to financial economics.
Romeo, Monica, Stability analysis of traveling pulses composed of concatenated kinks.
Yan, Jue, Discontinuous Galerkin finite element methods for PDES with higher order derivatives.

MATHEMATICS
Bekjely, Ebru, Minimal Weierstrass equations for elliptic curves over global fields.
Hwang, Hyung Ju, On the Rayleigh-Taylor instability and regularity for the Vlasov-Poisson system in a convex domain.
Soule, Steven, Branched extensions of codimension one maps.
Vassilakis, Theodore, On a conjecture of Bando-Siu.

University of Rhode Island (2)

MATHEMATICS
McGrath, Lynn, Investigation of some difference equations.
Saad, Mary, Results on tree tolerant representations.

STATISTICS
Duralski, Valerie, The analysis of clustered matched-pair data under an equivalence design.
White, Nicole, DIVERgent Alignments (DIVA): Multiple alignment techniques for proteins with less than 20% identity.

University of South Carolina, Columbia (13)

EPIDEMIOLOGY AND BIOSTATISTICS
Gray, Brian R., Modeling nonstationary and spatially-correlated oyster infection prevalence data.
Harshaw, Charles Clinton, The tetrahedron volume scan: A tool for the detection of spatial-temporal disease clusters.
Pierce, Kristen J., Semi-parametric multiple imputation applied to stratified survival data.
Swann, R. Suzanne, Analyses of stratified longitudinal studies using generalized estimating equations with data missing at random.
Uddin, Molla A., Attributable fraction, its properties and applications.

MATHEMATICS
Allen, Martha, Generalization of the irreducibility of L. Schur.
Burton, Tamara, Domination of DOT-critical graphs.
Iwasa, Akira, Metrizability of trees.
Kumchev, Angel, Diophantine problems involving prime numbers.
Liu, Jiangguo, Efficient numerical techniques for advection dominated transport equations.

TENNESSEE University of Memphis (4)

MATHEMATICAL SCIENCES
Gao, Yuan, Mot. f-based protein structure and function prediction.
McCauley, Thomas Lee, Neutral schemas: Toward a comprehensive mechanism of mind.
Yang, Congjun, Indexes for nearest neighbor queries and related problems.
University of Tennessee (3)

MATHEMATICS
Chaios, George, On reproducing kernels and invariant subspaces of the Bergman shift.
Joshi, Hem Raj, Optimal control problems in PDE and ODE systems.
Krohn, Cynthia, An individual-based approach to population dynamics with applications to sockeye salmon and iteroparous organisms.

Vanderbilt University (5)

MATHEMATICS
Bahls, Charles Patrick, Even rigidity in Coxeter groups.
Greer, Meredith, A population model of Prion dynamics.
Lin, Amy Hsiao-Chun, The dynamics of the interactions between solid tumors and the immune system: A deterministic model.
Marotti, Miklos, The variety generated by tournaments.
Stewart, Sarah Ann, Some families of subnormal operators with finite rank self-adjoint extensions.

Southern Methodist University (1)

STATISTICAL SCIENCE
Lee, Eui Kyoo, Bayesian hierarchical spatio-temporal models with application to the modeling of Hanford Site tritium concentrations.

Texas A & M University (17)

MATHEMATICS
Bacuta, Cristina, A geometry intervention in engineering and science calculus II: Supporting the calculus reform.
Bilgin, Gulendam, Near-rings of functions.
Diao, Zijian, Quantum computing and quantum search algorithms.
Garcia, Cesar, Renormings via asymptotic uniform convexity and the approximation property on near Hilbertian spaces.
Holcomb, Trace, Contributions to a general theory of codes.
Kim, Chisup, On iteration and approximation methods or anisotropic problems.
Lowtzsch, Svenja, Approximation and interpolation employing divergence-free radial basis functions with applications.
Shafer, Stephen, Graphs with cycle lengths in a given infinite set.
Stovall, Sarah, Torsion sections of composite order on elliptic surfaces.
Tomov, Stanimire, Adaptive methods for finite volume approximations.
Zhang, Xiaofei, Wavelet sets and frame sets.

STATISTICS
Clark, Jason, Linearly constrained local polynomial regression.
Dey, Monisha, A new jackknife method for unbalanced variance component problems with applications in quantitative genetics.
Huang, Chunfeng, Topics in spline smoothing.
Kim, Hyoun Moon, Bayesian spatial data analyses and their applications.

University of Houston (3)

MATHEMATICS
Sha, Natiju, Bolstering cart and Bayesian variable selection methods for classification.
Sukashi, Amang, Goodness-of-fit tests and related diagnostics for response probability models in the analysis of complex survey data.

Texas Tech University (4)

MATHEMATICS AND STATISTICS
Cole, Leah, Applications of special function theory to complex analysis.
Keslinger, Jacob, Mathematical models for host-pathogen genetics in plant pathosystems.
Peterson, Cheryl, Asymptotic and spectral analysis of nonselfadjoint operators generated by a coupled Euler-Bernoulli/Timoshenko beam model.
Richardson, Clint, Concentration of area in half planes.

University of North Texas (4)

MATHEMATICS
Berlinkov, Artemi, Dimensions in random constructions.
Huettemmueller, Rhonda, The Pettis integral and operator theory.
Lindsay, Larry, Quantization dimension for probability distributions.
Rees, Michael, Topological uniqueness results for the special linear and other classical Lie algebras.

University of Texas, Arlington (1)

MATHEMATICS
Griffin, Byron, A study of stochastic iterative processes under random structural perturbations.

University of Texas, Austin (14)

MATHEMATICS
Browne, Lewis, Density in hyperbolic space.
Fioroni, Luis, Canonical and minimal degree liftings of curves.
Hayes, Leslie, The plus closure of an ideal.
Jiang, Jiaosheng, Bounded operators without invariant subspaces on certain Banach spaces.
Krashen, Daniel, Birational isomorphisms between Severi-Brauer varieties.
Leasure, Jason, Geodesics in the complex of curves of a surface.
Leininger, Christopher, Essential surfaces in hyperbolic three-manifolds.
Monica Torres, Razo, Plane-like minimal surfaces in periodic media with inclusions.
Socha, Katherine, Modal expansions of surface wave model equations.
Visarroga, Darrin, Heat transport models with distributed microstructure.
Yuan, Juan-Ming, Studies in recurrence and singularity formation in nonlinear dispersive wave equations.

TEXAS INSTITUTE OF COMPUTATIONAL AND APPLIED MATHEMATICS
Eaton, Frank Joseph, A multigrid preconditioner for two phase flow in porous media.
Overfelt, James, Numerical modeling of Stokesian emulsions.

University of Texas, Dallas (3)
MATHEMATICAL SCIENCES
Gill, Ryan Scott, Introduction to generalized broken-line regression.
Johnson, Joel, Tensor algebras, displacement structure and some classes of stochastic processes.
Nita, Bogdan, Pure gravitational radiation with twisting rays.

UTAH

University of Utah (5)

MATHEMATICS
Cytrynbaum, Eric, Using low dimensional models to understand cardiac arrhythmias.
Dereaux, Martin, Complex surfaces of negative curvature.
Dumett, Miguel, A numerical method for solving anisotropic elliptic boundary value problems on irregular domains in two and three dimensions.
Hohn, Michael, On the solution of mixed boundary value problems in elasticity.
Kucuk, Ismail, Variational approach to optimization of elastic structures.

VERMONT

University of Vermont (2)

MATHEMATICS AND STATISTICS
Riccari, Karen L, Optimal groundwater remediation design subject to uncertainty.
Yaw Aido, Anthony, Studies on a prototype channel geometry for acetylcholine receptor channel.

VIRGINIA

College of William and Mary (1)

MATHEMATICS
Evans, Diane, Algorithms for operations on probability distributions in a computer algebra system.

Old Dominion University (1)
MATHEMATICS AND STATISTICS
McKaig, Iain, Mathematical models of quiescent solar prominences.

University of Virginia (4)

MATHEMATICS
Fulgham, Bernard, The scalar center for quadratic Jordan algebras.
Hag, Aaron, Free closures of projective remoteness configurations.
Li, Weiping, Algebraic groups and support varieties.

STATISTICS
Chattopadhyay, Somesh, Simultaneous hormone pulse time and secretion/elimination estimation: An alternating metropolis and diffusion scheme.

Virginia Commonwealth University (3)

BIOSTATISTICS
Massie, Tammy, Testing genetic hypothesis on bivariate dose using repeated measures logistic regression.
Massey, Tristan, Variance estimation and influence functions for threshold models.
Shih, Margaret, Titrating and evaluating multiple drug regimens with subjects.

Virginia Polytechnic Institute and State University (9)

MATHEMATICS
Drumright-Clarke, Mary Ann, Numerical simulations that characterize the effects of surfactant on droplets in shear flow.
Hartman, Gregory, Graphs and noncommutative Koszul algebras.
Massey, Thomas Christopher, Development of a flexible Galerkin finite element method for hyperbolic PDE’s and a posteriori discontinuous finite element error estimation for two-dimensional hyperbolic problems.

STATISTICS
Clark, Seth, Model robust regression based on generalized estimating equations.
Dorat-Raj, Sundaradas, First- and second-order properties of spatiotemporal point processes in the space-time and frequency domains.
Liang, Hong, Adaptive Fourier analysis for unequally-spaced time series data.
Lipkovich, Ilya, Bayesian model averaging and variable selection in multivariate ecological models.
Waterman, Megan, Linear mixed model robust regression.
Wilcock, Samuel, A new nonparametric procedure for the k-sample problem.

WASHINGTON

University of Washington (20)

APPLIED MATHEMATICS
Bale, Derek, Wave propagation algorithms on curved manifolds with applications to relativistic hydrodynamics.
Dolven, Eric, Seakeep waves-standing wave dynamics with Faraday excitation and radiative loss.
Fogarty, Tieren, Finite volume methods for acoustics and elasticity with support transport in a heterogeneous media.
Lee, Long, Immersed interface methods for incompressible flow with moving interfaces.
Mudavanhu, Blessing, Renormalization approach for solving weakly nonlinear differential equations.
Rasmann, James, A wave propagation method with constrained transport for ideal and shallow water magnetohydrodynamics.

BIOSTATISTICS
Dodd, Lori, Regression methods of areas and partial areas under the receiver-operating characteristic curve.
Hu, Chengcheng, Semiparametric failure-time regression with mismeasured or missing covariates.
Meler, Amalia, Discrete proportional hazards models for uncertain outcomes.
Nan, Bin, Information bounds and efficient estimates for two-phase designs with lifetime data.

MATHEMATICS
Cokus, Shawn, Qualitative linear algebra and computational complexity.
Garfield, Peter, The bigraded Rumin complex.
Hampton, Marshall, Concave central configurations of the four body problem.
Mihalisin, James, Polytope graphs and digraphs.
Doctoral Degrees Conferred

Packer, Asa, On certain optimal containment problems involving convex sets.
Tamasan, Alexandru, A two dimensional inverse boundary value problem in radiation transport.
Williams, Gordon, Petrie schemes.

STATISTICS

Bates, Samantha C., Bayesian inference for deterministic simulation models for environmental assessment.
Song, Shuguang, Estimation with bivariate interval-censored data.

WASHINGTON STATE UNIVERSITY (2)

MATHEMATICS

Hagerty, Gary, Finding a few eigenvalues of large sparse non-symmetric matrices.

WEST VIRGINIA

West Virginia University (6)

MATHEMATICS

Espinoza, Benjamin, Whitney preserving maps.
Li, Xiangwen, Cycle cover, group coloring with related problems.
Li, Xuechao, Chords of longest circuits of graphs.
Luo, Rong, Edge coloring of simple graphs and edge-face coloring of simple plane graphs.
Montgomery, Bruce, Dynamic coloring of graphs.
Plotka, Krzysztof, Set-theoretic and algebraic properties of certain families of real functions.

WISCONSIN

Medical College of Wisconsin (1)

BIOSTATISTICS

Shu, Youyi, Multistate survival models: Theory and applications.

University of Wisconsin, Madison (24)

MATHEMATICS

Baker, Joni, Some topological results on ultrafilters.
Bloss, Matthew, Partition algebras and permutation representations of wreath products.
Christlieb, Andrew, Computational methods for long mean free path environments.
Hamblin, James, On solvable groups satisfying the two-prime hypothesis.

Hsieh, Liang-Yu, On minimum rank matrices having prescribed graph.
Li, Xiantao, Computation of the semiclassical limits of the Schrödinger equation and related problems.
Mazaheri, Mohsen, Valuation and robustness in stochastic volatility environments.
Poddar, Mainak, Orbifold Hodge numbers for Calabi-Yau hypersurfaces.
Uribe, Bernardo, Twisted K-theory and orbifold cohomology of the symmetric product.
Vovkivsky, Taras, Groups acting on trees and algebraic K-theory.
Wiles, Peter, Coordinating mathematical and pedagogical content in preservice teacher education.

STATISTICS

Brumback, Lyndia, Flexible random time transformations for functional data.
Buhr, Kevin, A Brownian particle system with local time interaction.
Cho, Hyungjun, Tree-structured regression modeling for censored data.
Huang, Li-Fei, Confidence regions for the ratio of percentiles.
Huang, Yufen, Transformations, regression geometry and R².
Lin, Pet Sheng, Analysis of cross-classified spatial data with autocorrelation.
Park, Soomin, Analysis of longitudinal data with informative missingness.
Shen, Lei, Analysis of longitudinal data: Measurement error, confounding and model misspecification.
Shi, Yuanjun, Monte Carlo techniques for design and analysis of group sequential clinical trials with multiple primary endpoints.
Wang, Chen, Joint analysis of quality of life and survival.
Wang, Hansheng, Two-way contingency table with marginally and conditionally imputed non-respondents.
Wang, Jin, Testing hypothesis and estimation in the presence of omitted confounders.
Yang, Yueyun Jessie, Two-level factorial and fractional factorial designs in blocks of size two.

BIOSTATISTICS

Shu, Youyi, Multistate survival models: Theory and applications.

University of Wisconsin, Milwaukee (3)

MATHEMATICAL SCIENCES

Ilicasu, Fatma Olcay, High order methods for singular perturbation problems.
Radcliffe, David, Unique presentation of Coxeter groups and related groups.
Solecki, Tatiana, Wavelet based computerized tomography.
From the AMS

2002 Election Results

In the elections of 2002 the Society elected a vice president, a trustee, five members at large of the Council, two members of the Editorial Boards Committee, and three members of the Nominating Committee. Terms for these positions are three years beginning on 1 February 2003 and ending on 31 January 2006, except for the trustee, whose term is for five years ending on 31 January 2008. Members elected to the Nominating Committee begin serving immediately, and their terms end on 31 December 2005.

Vice President
Elected as the new vice president is Karen Vogtmann from Cornell University.

Trustee
Elected as the new trustee is Jean E. Taylor from Rutgers University.

Members at Large of the Council
Elected as new members at large of the Council are
- Susan E. Hermiller from the University of Nebraska-Lincoln
- Brian H. Marcus from the University of British Columbia
- John E. McCarthy from Washington University, St. Louis
- Paul J. Sally Jr. from the University of Chicago
- Paul Zorn from St. Olaf College

Editorial Boards Committee
Elected as new members of the Editorial Boards Committee are
- Richard A. Brualdi from the University of Wisconsin-Madison
- Leonard L. Scott Jr. from the University of Virginia

Nominating Committee
Elected as new members of the Nominating Committee are
- Nathaniel Dean from Rice University
- Richard M. Hain from Duke University
- Krystyna Kuperberg from Auburn University

Suggestions for elections to be held in the fall of 2003 are solicited by the 2003 Nominating Committee. Positions to be filled in the 2003 election are: vice president, trustee, and five members at large of the Council. Suggestions should be sent to the secretary.

Suggestions for nominations for two positions on the Editorial Boards Committee and three positions on the 2003 Nominating Committee can also be sent to the secretary:

Robert J. Daverman, Secretary
American Mathematical Society
312D Ayres Hall
University of Tennessee
Knoxville, TN 37996-1330
secretary@ams.org

The deadline for suggestions is 28 February 2003.
There will be a number of contested seats in the 2003 AMS Elections. Your suggestions are wanted by:

The Nominating Committee for vice president, trustee, and five members at large of the Council

and by

The President for three Nominating Committee members and two Editorial Boards Committee members.

In addition

The Editorial Boards Committee requests suggestions for appointments to various editorial boards of Society publications.

Send your suggestions for any of the above to:

Robert J. Daverman, Secretary
American Mathematical Society
312D Ayres Hall
University of Tennessee
Knoxville, TN 37996-1330
e-mail: secretary@ams.org

The deadline for suggestions is 28 February 2003.
Vice President or Member at Large

One position of vice president and member of the Council ex officio for a term of three years is to be filled in the election of 2003. The Council intends to nominate at least two candidates, among whom may be candidates nominated by petition as described in the rules and procedures.

Five positions of member at large of the Council for a term of three years are to be filled in the same election. The Council intends to nominate at least ten candidates, among whom may be candidates nominated by petition in the manner described in the rules and procedures.

Petitions are presented to the Council, which, according to Section 2 of Article VII of the bylaws, makes the nominations. The Council of 23 January 1979 stated the intent of the Council of nominating all persons on whose behalf there were valid petitions.

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

Editorial Boards Committee

Two places on the Editorial Boards Committee will be filled by election. There will be four continuing members of the Editorial Boards Committee.

The President will name at least four candidates for these two places, among whom may be candidates nominated by petition in the manner described in the rules and procedures.

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

Nominating Committee

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

The President will name at least six candidates for these three places, among whom may be candidates nominated by petition in the manner described in the rules and procedures.

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

Rules and Procedures

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

1. To be considered, petitions must be addressed to Robert J. Daverman, Secretary, American Mathematical Society, 312 D Ayres Hall, University of Tennessee, Knoxville, TN 37996-1330, and must arrive by 28 February 2003.

2. The name of the candidate must be given as it appears in the Combined Membership List (www.ams.org/cm1). If the name does not appear in the list, as in the case of a new member or by error, it must be as it appears in the mailing lists, for example on the mailing label of the Notices. If the name does not identify the candidate uniquely, append the member code, which may be obtained from the candidate's mailing label or the Providence office.

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

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

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

6. The signature may be in the style chosen by the signer. However, the printed name and address will be checked against the Combined Membership List and the mailing lists. No attempt will be made to match variants of names with the form of name in the CML. A name neither in the CML nor on the mailing lists is not that of a member. (Example: The name Robert J. Daverman is that of a member. The name R. Daverman appears not to be.)

7. When a petition meeting these various requirements appears, the secretary will ask the candidate to indicate willingness to be included on the ballot. Petitioners can facilitate the procedure by accompanying the petitions with a signed statement from the candidate giving consent.
Nomination Petition for 2003 Election

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

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

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


Name and address (printed or typed)

Signature

Signature

Signature

Signature

Signature

Signature

Signature
The selection committee for these prizes requests nominations for consideration for the 2004 awards. Further information about the prizes can be found in the November 2001 Notices, pp. 1211-1223 (also available at http://www.ams.org/prizes-awards).

Three Leroy P. Steele Prizes are awarded each year in the following categories: (1) the Steele Prize for Lifetime Achievement: for the cumulative influence of the total mathematical work of the recipient, high level of research over a period of time, particular influence on the development of a field, and influence on mathematics through Ph.D. students; (2) the Steele Prize for Mathematical Exposition: for a book or substantial survey or expository-research paper; and (3) the Steele Prize for Seminal Contribution to Research: for a paper, whether recent or not, that has proved to be of fundamental or lasting importance in its field, or a model of important research. In 2004 the prize for Seminal Contribution to Research will be awarded for a paper in Analysis.

Nominations with supporting information should be submitted to the Secretary, Robert J. Daverman, American Mathematical Society, 312D Ayres Hall, University of Tennessee, Knoxville, TN 37996-1330. Include a short description on the work that is the basis of the nomination, including complete bibliographic citations. A curriculum vitae should be included. The nominations will be forwarded by the Secretary to the prize selection committee, which will, as in the past, make final decisions on the awarding of prizes.

Deadline for nominations is March 31, 2003.
Add this Cover Sheet to all of your Academic Job Applications

**How to use this form**

1. Using the facing page or a photocopy, (or visit the AMS web site for a choice of electronic versions at [www.ams.org/cover_sheet](http://www.ams.org/cover_sheet)), fill in the answers which apply to all of your academic applications. Make photocopies.

2. As you mail each application, fill in the remaining questions neatly on one cover sheet and include it on top of your application materials.

The purpose of the cover form is to aid department staff in tracking and responding to each application for employment. Mathematics departments in Bachelor's-, Master’s-, and Doctorate-granting institutions are expecting to receive the form from each applicant, along with the other application materials they require.

The AMS suggests that applicants and employers visit the Job Application Database for Mathematicians ([www.mathjobs.org](http://www.mathjobs.org)), a new electronic resource being offered by the AMS (in partnership with Duke University) for the second year in 2002-03. The system provides a way for applicants to produce printed coversheet forms, apply for jobs, or publicize themselves in the “Job Wanted” list. Employers can post a job listing, and once applications are made, search and sort among their applicants. Note-taking, rating, e-mail, data downloading and customizable EOE functions are available to employers. Also, reference writers can submit their letters online. A paperless application process is possible with this system, however; employers can choose to use any portion of the service. There will be annual employer fees beginning this year. This system was developed at the Duke University Department of Mathematics.

Please direct all questions and comments to: emp-info@ams.org.
Academic Employment in Mathematics  

AMS STANDARD COVER SHEET

Last Name ___________________________  
First Name ___________________________  
Middle Names ___________________________

Address through next June ———— Home Phone ————

———— e-mail Address ————

Current Institutional Affiliation ———— Work Phone ————

Highest Degree Held or Expected ———— Date (optional) ————

Granting Institution ————
Ph.D. Advisor ————
Ph.D. Thesis Title (optional) ————

Indicate the mathematical subject area(s) in which you have done research using the Mathematics Subject Classification printed on the back of this form or on the AMS website. Use the two-digit classification which best fits your interests in the Primary Interest line and additional two-digit numbers in the Secondary Interest line.

Primary Interest [ ]
Secondary Interests optional [ ] [ ]

Give a brief synopsis of your current research interests (e.g. finite group actions on four-manifolds). Avoid special mathematical symbols and please do not write outside of the boxed area.

Most recent, if any, position held post Ph.D.

University or Company ————
Position Title ————

Indicate the position for which you are applying and position posting code, if applicable

If unsuccessful for this position, would you like to be considered for a temporary position?
[ ] Yes  [ ] No  If yes, please check the appropriate boxes.

[ ] Postdoctoral Position  [ ] 2+ Year Position  [ ] 1 Year Position

List the names, affiliations, and e-mail addresses of up to four individuals who will provide letters of recommendation if asked. Mark the box provided for each individual whom you have already asked to send a letter.

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A First Course in Complex Analysis with Applications
Dennis Zill & Patrick D. Shanahan — Loyola Marymount University
Cloth, 512 pages, ©2003

A First Course in Complex Analysis with Applications limits theoretical coverage to only what is necessary, and conveys it in a student-friendly style. Its aim is to introduce the basic principles and applications of complex analysis to junior-level undergraduate students who are majoring in math, physics, computer science, and electrical engineering, and have no prior knowledge of this subject. The textbook offers a breadth approach by including complex number system, complex functions and sequences, real integrals, concepts of calculus, and the functions of a complex variable.

Exploring Numerical Methods: An Introduction to Scientific Computing
Peter Linz, University of California, Davis & Richard L. drag, Prentice Hall, Inc.
ISBN: 0-7381-1440-1
Cloth, 384 pages, © 2003

Exploring Numerical Methods: An Introduction to Scientific Computing stresses insight and hands-on experience as it provides students in mathematics, engineering, computer science, and the physical sciences a well-crafted introduction to traditional numerical analysis topics. The text includes an exploration section with problems that deal with the practical issues of software evaluation, selection, modification, and solutions to not-entirely-open-ended problems. Designed to accommodate the needs of beginner and more experienced students, the text encourages active learning, and uses MATLAB to implement the methods and algorithms that it discusses.

Complex Analysis for Mathematics and Engineering, Fourth Edition
John H. Mathews, California State University, Fullerton
& Russell W. Howell, Westmont College
ISBN: 0-7637-1425-9
Cloth, 596 pages, © 2001

Complex Analysis for Mathematics and Engineering strikes a balance between the pure and applied aspects of complex analysis, and presents concepts using a clear writing style. Believing that mathematicians, engineers, and scientists should be exposed to a careful presentation of mathematics, attention to topics such as ensuring required assumptions are met before the use of a theorem or algebraic operations are applied.

Request your complementary copy for your next course.
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Mathematics Calendar

The most comprehensive and up-to-date Mathematics Calendar information is available on e-MATH at http://www.ams.org/mathcal/.

February 2003

*10-14 Workshop on Neural Coding, Mathematical Biosciences Institute (MBI), The Ohio State University, Columbus, Ohio.

Information: http://www.newton.cam.ac.uk/programmes/CED/
Isaac Newton Institute for Mathematical Sciences, 20 Clarkson Road, Cambridge, CB3 0EH or CB3 0EH; tel: +44 (0) 1223 335999; fax: +44 (0) 1223 330508; email: info@newton.cam.ac.uk.

*17-28 Area Concentration on Functional Analysis of Nervous Systems: From Tasks to Implementation, Mathematical Biosciences Institute (MBI), The Ohio State University, Columbus, Ohio.

March 2003

*3-7 Computational Aspects of algebraic curves, and cryptography, Gainesville, Florida.
Topic: Interactions between modern computational tools questions and the theory of algebraic curves.
Information and Support: Graduate students and recent PhD's will be given priority for support for participation in the mini-courses. We especially encourage women and minorities to apply. The workshop is supported by NSA, NSF and the University of Florida. For further information and for information for financial support contact: email: helmut@math.ufl.edu or visit http://www.math.ufl.edu/~helmut/compaalg.html.

*3-7 Mini-courses in cryptography, Gainesville, Florida.
Topics: We plan to offer 4 mini-courses introducing mathematical tools of increasing sophistication. The first course gives a basic introduction to public-key cryptography, describing the cryptographic encryption schemes currently in use. It is accessible to advanced undergraduates. The second course shows how elliptic curve cryptography generalizes to hyperelliptic curve cryptography, and discusses the possible advantages. This requires tools from the classical theory of algebraic curves.
Information and Support: Graduate students and recent PhD's will be given priority for financial support. The workshop is supported by NSA, NSF and the University of Florida. Deadline for applications: January 31, 2003 For further information and for applications contact email: helmut@math.ufl.edu or visit http://www.math.ufl.edu/~helmut/compaalg.html.

Information: email: sci@com.thanh.nctu.ac.vn.

*17-19 DIMACS Workshop on Network Information Theory, DIMACS Center, Rutgers University, Piscataway, New Jersey.
Description: The DIMACS Workshop on Network Information Theory will focus on the area of efficient and reliable communication in multi-terminal settings. This field has recently attracted renewed attention because of key developments that have spawned a rich set of challenging research problems. Applications such as wireless cellular and LAN data services, ad hoc networks and sensor networks will be given priority for financial support.

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 and symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. A complete list of meetings of the Society can be found on the last page of each issue.

An announcement will be published in the Notices if it contains a call for papers and specifies the place, date, subject (when applicable), and the speakers; a second 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 every third 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 the 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 the Notices in care of the American Mathematical Society in Providence or electronically to notices@ams.org or mathcal@ams.org.

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 the 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.

The complete listing of the Mathematics Calendar will be published only in the September issue of the Notices. The March, June, and December issues will include, along with new announcements, references to any previously announced meetings and conferences occurring within the twelve-month period following the month of those issues. New information about meetings and conferences that will occur later than the twelve-month period will be announced once in full and will not be repeated until the date of the conference or meeting falls within the twelve-month period.

The Mathematics Calendar, as well as Meetings and Conferences of the AMS, is now available electronically through the AMS website on the World Wide Web. To access the AMS website, use the URL: http://www.ams.org/.
should benefit from these developments. The aim of the workshop is to achieve a better understanding of the underlying information theoretic problems and their solutions. The workshop topics will include, but are not limited to, the following areas: large communication networks analysis, design, asymptotics; multi-terminal capacity/coding relays, multi-access, random access; multi-terminal source coding distributed sources, multiple descriptions; network coding efficiency and reliability. The workshop will consist of 45-minute invited presentations and ample time for discussion.

**Sponsor:** DIMACS Center.

**Organizers/Contacts:** P. Gupta, Bell Laboratories, pgupta@research.bell-labs.com; G. Kramer, Bell Laboratories, gkr@research.bell-labs.com; A.J. van Wijngaarden, Bell Laboratories, alw@research.bell-labs.com.

**Local Arrangements:** J. Herold, DIMACS Center, jherold@dimacs.rutgers.edu, 732-445-4581.

**Deadlines:** Talks by invitation only. Preregistration deadline is March 10, 2003.

**Information:** See http://dimacs.rutgers.edu/Workshops/NetworkInformation/.

*21-23 Fourth International Conference on Intelligent Data Engineering and Automated Learning (IDEAL’03), Hong Kong Convention and Exhibition Centre, Hong Kong, P.R. China.

**Information:** http://www.comp.hkbu.edu.hk/IDEAL2003/.


**Languages:** Russian and English.

**Deadline:** For submitting completed registration forms and abstracts is February 1, 2003.

**Information:** Mailing address of the Organizing Committee: 117198, Russia, Moscow, Mikhlevo-Maldar str., 6, room 240a; email: cao@mail.rudn.ru.

*31-April 2 Tutorial on Olfaction, Audition, and the Sensory System, Mathematical Biosciences Institute (MBI), The Ohio State University, Columbus, Ohio.

**Information:** phone: (614) 292-3648; http://mbi.osu.edu/.

*5-9 Théorie des Nombres et Applications, Université Hassan II de Casablanca and Université de Marrakech, Morocco.

**Aim:** The meeting plans to bring together number theorists in all areas of number theory and to let them interact with (in particular) Moroccan mathematicians, to initiate new collaborations, and to develop new interests in applications of number theory (like cryptography).

**Organizers:** S. El Morchid (U. Hassan II Ain Chok, Casablanca) and C. Levesque (CICMA, Univ. Laval, Quebec, Canada).

Call for Papers: Mathematicians are invited to attend this conference. Those interested in giving a lecture are invited to send an abstract of their planned lectures to one of the organizers, who will send an official invitation upon acceptance of the lecture project. Some proceedings are planned.

Information: email: elmorchid@yahoo.fr or elmor@univ-laval.ca.

5-9 Workshop on the Auditory System, Mathematical Biosciences Institute (MBI), The Ohio State University, Columbus, Ohio.


Information: http://www.newton.cam.ac.uk/programmes/CPD/.

19-24 The V International Conference “Algebra and Number Theory: Modern Problems and Applications”, Tula State Pedagogical University, Tula, Russia.


Deadlines: The deadline for submission of abstracts is February 1, 2003. The entrance fee will be $100. Hotel rate is about $10-20 a day; guest house about $4 per day. You have to send a copy of a passport two months before the conference to receive a visa.

Information: Fax: 7-0872-354060; email: dobrovol@tspu.tula.ru, pikhlikov@tula.net.

23-26 International Conference on Numerical Analysis & Computational Mathematics (NACoM-2003), Anglia Polytechnic University (APU), Cambridge, United Kingdom.

Description: The multidisciplinary field of numerical analysis and computational mathematics is long suffering from major delays in the publication of original papers. In most cases it takes at least 2 to 3 years for a paper to be accepted, and the situation seems to get worse by the year. NACoM-2003 will address this serious problem as follows: (1) The NACoM conference will serve as the medium for the official launch of a new Wiley journal, Applied Numerical Analysis and Computational Mathematics (ANACM) (editor-in-chief, T. E. Simos). The journal will provide colleagues with a new, really efficient medium for refereed publications. Generally, in ANACM it is expected that the time between a paper submission and its acceptance for publication will be around 6 months. ANACM will be registered with the ISI Citation Index without delay. (2) The NACoM-2003 conference is expected to attract very high-quality papers, and a refereed selection of them will be published in two special issues of the new journal. (3) This will be an excellent opportunity for colleagues from the international numerical and computational mathematics community to meet with members of the ANACM editorial board. Furthermore, high-ranking representatives from Wiley-Europe will be present and will address the participants.

General Chair & Organizer: G. Psihoyios, Anglia Pol. Univ., Cambridge, UK.

Plenary Speakers (to be finalized): J. R. Cash (Imperial College, London, UK), A. Cuyt (Univ. of Antwerp, Belgium), M. Hochbruck (Univ. of Duesseldorf, Germany), W. F. Mitchell (Nat. Inst. of Standards & Technology, USA), G. Vanden Bergh (Univ. of Gent, Belgium), G. A. Watson (Univ. of Dundee, UK).

Call for Papers & Expression of Interest: Submission of original papers is invited for the NACoM-2003 conference. Please initially submit an abstract of up to four A4 pages to the general chair (g.y.psihoyios@apu.ac.uk) by February 28, 2003. Please send a standard LaTeX article style abstract without page numbers. Send the LATeX and the PostScript files. If you do not plan to present a paper but are seriously thinking of participating, please send a short email to indicate your intention to participate. This will greatly assist in making appropriate plans according to the expected number of participants.

Deadlines: Submission of abstract (on or before February 28, 2003).

Abstracts refereed selection (by March 20, 2003). Submission of full-length papers (to be announced).

Information: Further information with regard to parallel-sessions/mimi-symposia, poster sessions, deadlines, etc., will be announced in due course and through the website http://www.apu.ac.uk/npacm/nacom-2003/.

24-30 Conference in Number Theory in Honour of Professor H. C. Williams, The Banff Center, Banff, Alberta, Canada.

Information: See http://www.fields.utoronto.ca/programs/scientific/02-03/numtheory/.

30-June 1 Annual Meeting of the Canadian Society for History and Philosophy of Mathematics (CSHPM), Dalhousie University, Halifax, Nova Scotia, Canada.

Description: The CSHPM is dedicated to scholarship in the history and philosophy of mathematics and in bringing that scholarship to bear on teaching and research in mathematics. It is associated with the journals Historia Mathematica and Philosophia Mathematica. The meeting includes a Special Session (invited speaker to be announced) on Maritime Mathematics, broadly understood. Talks, in French or English, are solicited both for Contributed Paper Sessions and the Special Session.

Call for Papers: Please submit title and abstract by February 15, 2003.

Special Session: tom.archibald@acadiau.ca.

Contributed Paper Sessions: balintus@oaugeo. edu.

Registration and Lodging: Through the Congress of the Social Sciences and Humanities: http://www.hssfc.ca/.

Information: http://www.cshtm.org/.

June 2003

9-13 Workshop on the Sensory Motor System, Mathematical Biosciences Institute (MBI), The Ohio State University, Columbus, Ohio.


10-14 Fifth Dublin Differential Equations Conference, Dublin City University, Dublin, Ireland.

Information: See http://www.deconf.dcu.ie/.

10-14 Groups and Group Rings X, Wisla, Poland.

Description: The conference is intended to extend knowledge of algebraists (not only experts) on groups and group rings and to stimulate research contacts of mathematicians in East, West, and Central Europe. In addition to one-hour lectures given by main speakers, we plan afternoon seminars with short talks (15-30 min.). The abstract (1-2 pages in LATeX) should be sent by email or regular mail before April 30. Ph.D. students and postgraduate students interested in groups and rings are warmly invited to participate in the conference.

Organizing Committee: J. Galuszka, Glawicz; W. Holubowski, Glawicz; J. Kurempe, Warsaw; O. Macedonska, Glawicz; V. Sushchanski,

Information:
Gliwice.
Program Committee: R. Bryant, Manchester; O. Kegel, Freiburg; J. Krempa, Warsaw; O. Mchedl, Gliwice; V. Sushchanski, Gliwice.
Main Speakers (preliminary): C. Baginski, Białystok, Poland; R. M. Bryant, Manchester, UK; F. de Giovanni, Naples, Italy; E. Jespers, Brussels, Belgium; O. H. Kegel, Freiburg, Germany; V. Mikhailean, Yerevan, Armenia; L. Novedski, Wrocław, Poland; G. Rosenberger, Dortmund, Germany; R. Schmidt, Kiel, Germany; N. Vavilov, St. Petersburg, Russia; J. S. Wilson, Birmingham, UK; A. Zuki, Lyon, France.


Short Description: Most lectures will be delivered by invited speakers who will each give a survey of one of the many fields that Furstenberg has made an impact on.
Contact: D. Berend, email: berend@math.bgu.ac.il.

Information: http://www.newton.cam.ac.uk/programmes/CPD/.
Isaac Newton Institute for Mathematical Sciences, 20 Clarkson Road, Cambridge, CB3 0EH or CB3 0EH; tel: +44 (0) 1223 335999; fax: +44 (0) 1223 330508; email: info@newton.cam.ac.uk.

*23-29 Symmetry in Nonlinear Mathematical Physics, Institute of Mathematics, Kiev, Ukraine.
Conference Topics: Classical, Nonclassical, Conditional, Approximate and Other Symmetries of Equations of Mathematical Physics; Symmetry in Quantum Mechanics, Quantum Field Theory, Gravity, Fluid Mechanics, Mathematical Biology, Mathematical Economics; Symbolic Computations in Symmetry Analysis; Supersymmetry and Its Generalizations; Representation Theory; q-Algebras and Quantum Groups; Dynamical Systems, Solitons and Integrability; Superintegrability and Separation of Variables.
Information: A. Nikitin, Inst. of Math., Nat. Acad. of Sci. of Ukraine, 3 Treschkovichska Street, Kyiv 4, 01060 Ukraine; email: apmath@imath.kiev.ua; fax:+38044 2352010; phone:+38044 2346322 (office); +38044 2500966 (home). Further information is available on our website: http://www.imath.kiev.ua/~apmath/conf.html or mirror http://www.bgu.ac.il/~alexzh/apmath/conf.html.

July 2003

*1-5 EuroConference VBAC 2003: Dedicated to Andrei Tyurin, Porto, Portugal.
Topics: The meeting will cover a range of topics in the area of vector bundles on algebraic curves with special emphasis on moduli spaces and topology.
Funding: Will be available for accommodation, registration fee and possibly travel expenses for young researchers (up to 35) from the EU and associated states (at the moment Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia, Iceland, Liechtenstein, Norway and Israel), with priority given to those from less favoured regions and to women researchers. Limited support may be available for young researchers from other countries.
Deadlines: If you wish to give a talk and/or apply for financial support, please register before March 1, 2003. Otherwise, please register before April 15, 2003 (after this date we may not be able to guarantee availability of accommodation).


*7-18 Discrete Dynamical Systems and Their Applications to Population Dynamics, University of Wyoming, Laramie, Wyoming.
Program: The course will cover the basic theory of semidynamical systems as defined by difference equations (or maps) and their application to population dynamics and ecology. Main topics will be stability and bifurcation theory. A significant part of the course will be devoted to case studies in which difference equations have played a fundamental role in recent experimental projects designed to study nonlinear phenomena in population dynamics. Included will be a detailed discussion of the experiment that provided the first demonstration of chaos in a real biological population.
Speakers: J. M. Cushing, Univ. of Arizona; S. Henson, Andrews Univ.
Sponsors: Rocky Mountain Mathematics Consortium and the Univ. of Wyoming.
Information: B. L. Shader, Math. Dept., Univ. of Wyoming, Laramie, WY 82071; email: bashader@uwoy.edu; http://math.uwoy.edu/

*21-25 Infinite Dimensional Algebras and Quantum Integrable Systems, Faro, Portugal.
Description: This is a satellite workshop of the XIV International Congress on Mathematical Physics, Lisbon, July 28-August 2, 2003, and is intended to focus on recent developments in infinite dimensional algebras and their applications to quantum integrable systems. The workshop will be held at the University of Algarve, Faro, southern Portugal. There will be invited lectures and contributed talks from the participants.

Program: There will be invited talks by main speakers as well as contributed talks.
Main Speakers: The confirmed main speakers to date are: J. Baez, Univ. California at Riverside (on categorification of Yang-Mills theory); L. Breen (Univ. Paris 13) (on non-Abelian gerbes); Louis Crane, Kansas State Univ. (to be announced); Mikhail Khovanskii, Univ. California at Davis (on categorification of the Jones polynomial); Stephan Stolz, Univ. Notre Dame (on elliptic objects).
Organizers: M. Mackaay, mmackaay@ualg.pt; R. Picken, rpicken@math.ist.utl.pt.
Deadlines: People interested in giving a contributed talk should contact the organisers as soon as possible to register their interest and should send a title and abstract before January 31, 2003. The list of accepted talks will be announced before April 1.
Information: This workshop is a satellite event of the International Conference on Mathematical Physics, July 28th-August 2, 2003, Lisbon, Portugal (http://icomp2003.net/). Due to the limitations of the budget, it is unlikely that financial support will be available except for the main speakers and perhaps some local students. Further information will be provided on the conference homepage: http://www.math.ist.utl.pt/~rpicken/CHBO2003.

*23-26 The Joint Meeting of ISAMA 2003 and the 6th Annual BRIDGES Conference, University of Granada, Spain.
Conference Topics: Mathematical Visualization, Mathematics and Music, Computer Generated Art, Symmetry Structures, Origami,
Mathematics and Architecture, Tessellations and Tilings, Aesthetic Connections between Mathematics and Humanities, Geometric Art in Two and Three Dimensions, Geometries in Quilting.

Description: The conference will feature presentations of regular, plenary, and short papers. These will all be selected from the pool of submitted papers. Regular and plenary presentations require a paper of about 8 pages; short presentations require a 1–2 page extended abstract. The regular presentations will be given between a 30-minute time slot. The best papers or the ones that promise to appeal to the largest part of the audience will be selected for plenary presentations in a 45-minute time slot. Short presentations will be given a 20-minute slot.

The conference plans to offer a few hands-on workshops as in its past conferences, as well as a visit to the Alhambra, and possibly yet another tour of nearby towns or villages.

The conference plans to publish refereed proceedings, to be distributed at the conference. There is a tight and firm schedule.


Organizers: Registration and Reservations: J. Barralio, Univ. of the Basque Country ETS Arquitectura, Plaza Onati, 20018 San Sebastian, Spain; email: maapbaca@etsa.ehu.es. Logisitics, Scheduling and Exhibit: N. Friedman, Dept of Math and Stat., Univ. at Albany, State Univ of New York, Albany, NY 12222; email: artmathe@math.albany.edu. Space Management: J.A. Maldonado and J. Martinez, Univ. of Granada, Spain. Conference Proceedings: R. Sarhangi, Math. Dept., Towson Univ., 8000 York Road, Towson, MD 21252; (410) 704-4922; email: r.sarhang@towson.edu. Papers & Presentations: C. Sequin, EECs, Comput. Sci. Division, Soda Hall #1077, Univ. of California, Berkeley, CA 94720-1776; email: sequin@cs.berkeley.edu

*24–26 First Joint ISBA-IMS Meeting, Intercontinental Hotel, Isla Verde, San Juan, Puerto Rico.
Information: Please visit http://www.cmet.clu.edu/math/IMS-ISBA-PR2003/.

*29–August 1 Tenth Workshop on Logic, Language, Information and Computation (WoLLIC’2003), Ouro Preto, Minas Gerais, Brazil.
Sponsor: An ASL-sponsored meeting.
Description: This is the tenth in a series of workshops intended to foster interdisciplinary research in pure and applied logic.
Deadlines: The deadline for submission of papers is March 1, 2003.
Financial Aid: Graduate students and recent Ph.D.’s in logic may apply for modest grants to attend the workshop; the deadline for applications is March 1, 2003.

*29–August 2 IMS New Researchers Conference, University of California, Davis, California.
Information: http://www-rohan.sdsu.edu/~ralevine/MRC/.

August 2003

Organizer: Charles Univ. Prague, Faculty of Math. and Physics (M. Feistauer); Inst. of Chem. Tech., Dept. of Math. (A. Klíč).
Scientific Committee: O. Axelsson (Netherlands), C. Bernardi (France), C. Canuto (Italy), M. Griebel (Germany), R. Hoppe (Germany), G. Kobelkov (Russia), M. Křížek (Czech Republic), P. Neittaanmäki (Finland), O. Pironneau (France), A. Quarteroni (Italy/Switzerland), C. Schwab (Switzerland), E. Süli (Great Britain), W. Wendland (Germany).
Program Committee: F. Brezzi (Italy), M. Feistauer (Czech Republic), R. Glowinski (France/USA), R. Jeltsch (Switzerland), Yu. Kuznetsov (Russia/USA), J. Periaux (France), R. Rannacher (Germany).
Invited Plenary Speakers: A. Bermudez (Spain), R. Blaheta (Czech Republic), T. Gallouët (France), J. Haslinger (Czech Republic), R. Hiptmair (Germany), T. J. R. Hughes (USA), J. Rappaz (Switzerland), A. Russo (Italy), V. Schulz (Germany), A. Tveito (Norway).
Call for Papers: The program of the conference will include invited 50-minute lectures and 25-minute communications. A limited number of minisymposia (2 hours or, exceptionally, 4 hours) will be organized. Abstracts of communications and proposals of minisymposia should be sent to the contact address by February 28, 2003.
Information: email: enumath@karlin.mff.cuni.cz or http://www.karlin.mff.cuni.cz/~enumath/.

*28–30 International Conference on Computability and Complexity in Analysis, University of Cincinnati, Cincinnati, Ohio.
Description: The conference is concerned with the theory of computability and complexity over real-valued data.
Sponsor: An ASL-sponsored meeting.
Organizers: The chair of the scientific program committee is K. Weihrauch, and the chair of the local organizing committee is N. Zhong.
Deadlines: The deadline for submission of papers is June 2, 2003. Limited funds are available to conference participants, in particular to young researchers and Ph.D. students.
Information: http://www.informatik.fh.uni-hagen.de/cca/cca2003/.

September 2003

*12–16 International Conference of Computational Methods in Sciences and Engineering (ICCMSE 2003), Kastoria, Greece.
Description: In the past decades many significant insights have been made in several areas of computational methods in sciences and engineering. New problems and methodologies have appeared. There is permanently a need in these fields for the advancement of information exchange. The aim of the conference is to bring together computational scientists and engineers from several disciplines in order to share methods, methodologies, and ideas.
Topics: The topics to be covered include (but are not limited to): Computational mathematics, computational physics, computational chemistry, computational engineering, computational mechanics, computational finance, computational medicine, computational biology, computational economics, high-performance computing, mathematical methods in sciences and engineering, industrial mathematics, etc.
Contact Information: Secretary ICCMSE, email: iccmse@uop.gr; 26 Menelaou Street, Amfithea Paleon Faliron, GR-175 64, Athens, Greece; fax: +30210 94 20 091.
28-31 Fourteenth International Symposium on Methodologies for Intelligent Systems, Maebashi TERRSA, Maebashi City, Japan. Description: This symposium is intended to attract individuals who are actively engaged both in theoretical and practical aspects of intelligent systems. The goal is to provide a platform for a useful exchange between theoreticians and practitioners, and to foster the cross-fertilization of ideas in the following areas: active media human-computer interaction, automatic and evolutionary computation, intelligent agent technology, intelligent information retrieval, intelligent information systems, knowledge representation and integration, knowledge discovery and data mining, logic for artificial intelligence, soft computing, web intelligence. In addition, we solicit papers dealing with applications of intelligent systems in complex/novel domains, e.g., human genome, global change, manufacturing, health care, etc. Authors are invited to submit their manuscript in the LNCS/LNAI style (maximum 10 pages). All paper submissions will be handled electronically. Detailed instructions are provided on the conference homepage at http://www.wi-lab.com/ismis03/.


Call for Papers: ISMIS 2003.

Information: For additional information contact: Z. W. Ras (ISMIS 2003), Univ. of North Carolina, Dept. of Computer Science, Charlotte, NC 28226; Fax: 704-547-3518; email: ras@anncs. unc.edu. N. Zhong (ISMIS 2003), Department of Information Engineering, Maebashi Institute of Technology, 460-1, Kamisadori-Cho, Maebashi-City, 371-0816, Japan; telephone & fax: +81-27-265-7366; email: zhong@maebashi-it.ac.jp.

The following new announcements will not be repeated until the criteria in the next to the last paragraph at the bottom of the first page of this section are met.

July 2004

24-28 European Congress on Computational Methods in Applied Sciences and Engineering, Jyvaskyla, Finland. Scientific Programme: The scientific programme of the Congress consists of invited keynote lectures by leading experts, minisymposiums, special technological sessions, contributed papers, and poster presentations. Further details will be given in the Third Announcement (May 2003).

Congress Topics: Computational fluid mechanics, Computational solid and structural mechanics, Computational acoustics, Computational electromagnetics, Computational chemistry, Computational mathematics and numerical methods, Inverse problems, Optimization and control, Computational methods in life sciences, Industrial applications.

Call for Papers: Prospective authors are kindly invited to visit the Congress website in order to submit their two-page abstracts on topics related to the themes of the Congress by November 15, 2003.

Further Information: The congress website http://www.mit.jyu.fi/eccomas2004/ or ECCOMAS Chairman, Prof. Pekka Neittaanmaki, Univ. of Jyvaskyla, Dept. of Math. Inform. Tech., P.O. Box 35 FIN-40014 Univ. of Jyvaskyla, Finland; fax: +358 14 260 2771; email: pn@mit.jyu.fi; ECCOMAS 2004 Congress Secretariat, Ms. Pirjo-Leena Pitkanen, Jyvaskyla Congresses, P.O. Box 212 FIN-40101, Jyvaskyla, Finland; fax: +358 14 339 8159; email: pirjo-leena.pitkanen@jyvaskylaam.com.
New Publications Offered by the AMS

Algebra and Algebraic Geometry

**Geometry of Toric Varieties**
Laurent Bonavero and Michel Brion, Institut Fourier, Saint-Martin d'Hères, France, Editors
*A publication of the Société Mathématique de France.*

Toric varieties form a beautiful class of algebraic varieties, which are often used as a testing ground for verifying general conjectures in algebraic geometry, for example, in Hilbert schemes, singularity theory, Mori theory, and so on.

This volume gathers expanded versions of lectures presented during the summer school of "Geometry of Toric Varieties" in Grenoble (France). These lectures were given during the second and third weeks of the school. (The first week was devoted to introductory material.) The paper by D. Cox is an overview of recent work in toric varieties and its applications, putting the other contributions of the volume into perspective.

Distributed by the AMS in North America. Orders from other countries should be sent to the SMF, Maison de la SMF, B.P. 67, 13274 Marseille cedex 09, France, or to Institut Henri Poincaré, 11 rue Pierre et Marie Curie, 75231 Paris cedex 05, France. Members of the SMF receive a 30% discount from list.

Contents: D. A. Cox, Update on toric geometry; W. Bruns and J. Gubeladze, Semigroup algebras and discrete geometry; A. Craw and M. Reid, How to calculate A-Hilb C^2; D. I. Dais, Resolving 3-dimensional toric singularities; D. I. Dais, Crepant resolutions of Gorenstein toric singularities and upper bound theorem; J. Hausen, Producing good quotients by embedding into toric varieties; Y. Ito, Special McKay correspondence; Y. Tschinkel, Lectures on height zeta functions of toric varieties; J. A. Wiśniewski, Toric Mori theory and Fano manifolds.

Séminaires et Congrès, Number 6

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Hecke Algebras with Unequal Parameters
G. Lusztig, Massachusetts Institute of Technology, Cambridge

Hecke algebras arise in representation theory as endomorphism algebras of induced representations. One of the most important classes of Hecke algebras is related to representations of reductive algebraic groups over p-adic or finite fields. In 1979, in the simplest (equal parameter) case of such Hecke algebras, Kazhdan and Lusztig discovered a particular basis (the KL-basis) in a Hecke algebra, which is very important in studying relations between representation theory and geometry of the corresponding flag varieties. It turned out that the elements of the KL-basis also possess very interesting combinatorial properties.

In the present book, the author extends the theory of the KL-basis to a more general class of Hecke algebras, the so-called algebras with unequal parameters. In particular, he formulates conjectures describing the properties of Hecke algebras with unequal parameters and presents examples verifying these conjectures in particular cases.

Written in the author's precise style, the book gives researchers and graduate students working in the theory of algebraic groups and their representations an invaluable insight and a wealth of new and useful information.

Contents: Coxeter groups; Partial order on W; The algebra H; The bar operator; The elements c_w; Left or right multiplication by c_w; Dihedral groups; Cells; Cosets of parabolic subgroups; Inversion; The longest element for a finite W; Examples of elements D_w; The function a; Conjectures; Example: The split case; Example: The quasisplit case; Example: The infinite dihedral case; The ring J; Algebras with trace form; The function a; Study of a left cell; Constructible representations; Twisted cells; Virtual cells; Relative Coxeter groups; Representations; A new realization of Hecke algebras; Bibliography; Other titles in this series.

CRM Monograph Series, Volume 18
Cohomology of Siegel Varieties

A. Mokrane, P. Polo and J. Tilouine, CNRS, Université de Paris XIII, Villetaneuse, France

A publication of the Société Mathématique de France.

This volume deals with the properties of cohomology of Siegel varieties with coefficients in $\mathbb{Z}_p$ or in a certain local system of flat $\mathbb{Z}_p$-modules. The main result of the book establishes the absence of $p$-torsion in certain localizations of this cohomology. Two arithmetic applications are presented: One concerns Hida families of Hecke eigensystems, and the other is a step towards the existence of certain Taylor-Wiles systems for symplectic groups.

Distributed by the AMS in North America. Orders from other countries should be sent to the SMF, Maison de la SMF, B.P. 67, 13274 Marseille cedex 9, France, or to Institut Henri Poincaré, 11 rue Pierre et Marie Curie, 75231 Paris cedex 05, France. Members of the SMF receive a 30% discount from list.

Contents: A. Mokrane and J. Tilouine, Cohomology of Siegel varieties with $p$-adic integral coefficients and applications; P. Polo and J. Tilouine, Bernstein-Gelfand-Gelfand complexes and cohomology of nilpotent groups over $\mathbb{Z}_p(n)$ for representations with $p$-small weights.

Astérisque, Number 280


Algebraic Geometry 2000, Azumino

Sampei Usui, Osaka Univ., Toyonaka, Japan; Mark Green, University of California, Los Angeles, Lue Illusie, Université de Paris-Sud, Orsay, France; Kazuya Kato, Kyoto University, Japan; Eduard Looijenga, University of Utrecht,

Netherlands, Siegeru Mukai, RIMS, Kyoto University, Japan, and Shuji Saito, Nagoya University, Japan, Editors

A publication of the Mathematical Society of Japan.

This conference proceedings volume contains survey and research articles on topics of current interest written by leading international experts. The topic of the symposium was “Interactions of Algebraic Geometry, Hodge Theory, and Logarithmic Geometry from the Viewpoint of Degenerations”.


The volume is intended for researchers interested in algebraic geometry, particularly in the study of families of algebraic varieties and Hodge structures.

Published for the Mathematical Society of Japan by Kinokuniya, Tokyo, and distributed worldwide, except in Japan, by the AMS.


Advanced Studies in Pure Mathematics, Volume 36

October 2002, 442 pages, Hardcover, ISBN 4-931469-20-5, 2000 Mathematics Subject Classification: 11S20; 14D05, List $104^*$, Order code ASPM/36N

Differential Equations

Lie Groups, Geometric Structures and Differential Equations—One Hundred Years After Sophus Lie

Tohru Morimoto, Nara Women's University, Japan, Hajime Sato, Science University of Tokyo, Japan, and Keizo Yamaguchi, Hokkaido University, Sapporo, Japan, Editors

A publication of the Mathematical Society of Japan.

The blending of algebra, geometry, and differential equations has a long and distinguished history, dating back to the work of Sophus Lie and Élie Cartan. Overviewing the depth of their influence over the past 100 years presents a formidable challenge. A conference was held on the centennial of Lie's death to reflect upon and celebrate his pursuits, later developments, and what the future may hold. This volume showcases the contents, atmosphere, and results of that conference.

Of particular importance are two survey articles: Morimoto develops a synthetic study of Lie groups, geometric structures, and differential equations from a unified viewpoint of nilpotent geometry; Yamaguchi and Yatsui discuss the geometry of higher order differential equations of finite type. Contributed
research articles cover a wide range of disciplines, from geometry of differential equations, CR-geometry, and differential geometry to topics in mathematical physics.

This volume is intended for graduate students studying differential geometry and analysis and advanced graduate students and researchers interested in an overview of the most recent progress in these fields.

This item will also be of interest to those working in geometry and topology.

Published for the Mathematical Society of Japan by Kinokuniya, Tokyo, and distributed worldwide, except in Japan, by the AMS.


Advanced Studies in Pure Mathematics, Volume 37

General and Interdisciplinary

Mathematical Sciences Professional Directory, 2003
This annual directory provides a handy reference to various organizations in the mathematical sciences community. Listed in the directory are the following: officers of over thirty professional mathematical organizations; addresses of selected government agencies; academic departments in the mathematical sciences; and alphabetic listings of colleges and universities.


New Publications Offered by the AMS

Geometry and Topology

Symplectic and Contact Topology: Interactions and Perspectives
Yakov Eliashberg, Stanford University, CA, Boris Khesin, University of Toronto, ON, Canada, and François Lalonde, University of Québec at Montréal, Canada, Editors

The papers presented in this volume are written by participants of the "Symplectic and Contact Topology, Quantum Cohomology, and Symplectic Field Theory" symposium. The workshop was part of a semester-long joint venture of The Fields Institute in Toronto and the Centre de Recherches Mathématiques in Montréal.

The twelve papers cover the following topics: Symplectic Topology, the interaction between symplectic and other geometric structures, and Differential Geometry and Topology.

The Proceeding concludes with two papers that have a more algebraic character. One is related to the program of Homological Mirror Symmetry: the author defines a category of extended complex manifolds and studies its properties. The subject of the final paper is Non-commutative Symplectic Geometry, in particular the structure of the symplectomorphism group of a non-commutative complex plane.

The in-depth articles make this book a useful reference for graduate students as well as research mathematicians.

Contents: M. Abreu, Kähler geometry of toric manifolds in symplectic coordinates; V. Apostolov and T. Drăghici, The curvature and the integrability of almost-Kähler manifolds: A survey; F. Bourgeois, A Morse-Bott approach to contact homology; J. Chen, Deforming surfaces in four dimensional manifolds; A. Dancer and M. Y. Wang, Integrability and the Einstein equations; J. Epstein and D. Fuchs, On the invariants of Legendrian torus links; R. Ibáñez, Yu. Rudyak, A. Tralle, and L. Ugarte, Symplectically harmonic cohomology of nilmanifolds; D. Kotschick, Godbillon-Vey invariants for families of foliations; S. A. Merkulov, A note on extended complex manifolds and studies its properties. The proceed concludes with two papers that have a more algebraic character. One is related to the program of Homological Mirror Symmetry: the author defines a category of extended complex manifolds and studies its properties. The subject of the final paper is Non-commutative Symplectic Geometry, in particular the structure of the symplectomorphism group of a non-commutative complex plane.

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The in-depth articles make this book a useful reference for graduate students as well as research mathematicians.
Logic and Foundations

Computable Functions
A. Shen, Independent
University of Moscow, Russia,
and N. K. Vereshchagin,
Moscow State Lomonosov
University, Russia

In 1936, before the development of modern computers, Alan Turing proposed the concept of a machine that would embody the interaction of mind, machine, and logical instruction. The idea of a “universal machine” inspired the notion of programs stored in a computer’s memory. Nowadays, the study of computable functions is a core topic taught to mathematics and computer science undergraduates.

Based on the lectures for undergraduates at Moscow State University, this book presents a lively and concise introduction to the central facts and basic notions of the general theory of computation. It begins with the definition of a computable function and an algorithm, and discusses decidability, enumerability, universal functions, numberings and their properties, m-completeness, the fixed point theorem, arithmetical hierarchy, oracle computations, and degrees of unsolvability. The authors complement the main text with over 150 problems. They also cover specific computational models, such as Turing machines and recursive functions.

The intended audience includes undergraduate students majoring in mathematics or computer science, and all mathematicians and computer scientists that would like to learn basics of the general theory of computation. The book is also an ideal reference source for designing a course.

Contents: Computable functions, decidable and enumerable sets; Universal functions and undecidability; Numberings and operations; Properties of Gödel numberings; Fixed point theorem; m-reducibility and properties of enumerable sets; Oracle computations; Arithmetical hierarchy; Turing machines; Arithmetical hierarchy of computable functions; Recursive functions; Bibliography; Glossary; Index.

Student Mathematical Library, Volume 19


Mathematical Physics

Mirror Symmetry IV
Eric D’Hoker, University of California, Los Angeles,
Duong Phong, Columbia
University, New York, and
Shing-Tung Yau, Harvard
University, Cambridge, MA, Editors

This book presents contributions of participants of a workshop held at the Centre de Recherches Mathématiques (CRM), University of Montréal. It can be viewed as a sequel to Mirror Symmetry I (1998), Mirror Symmetry II (1996), and Mirror Symmetry III (1999), copublished by the AMS and International Press.

The volume presents a broad survey of many of the noteworthy developments that have taken place in string theory, geometry, and duality since the mid 1990s. Some of the topics emphasized include the following: Integrable models and supersymmetric gauge theories; theory of M- and D-branes and noncommutative geometry; duality between strings and gauge theories; and elliptic genera and automorphic forms. Several introductory articles present an overview of the geometric and physical aspects of mirror symmetry and of corresponding developments in symplectic geometry. The book provides an efficient way for a very broad audience of mathematicians and physicists to explore the frontiers of research into this rapidly expanding area.

This book is copublished by the AMS, International Press, and CRM.

New Publications Offered by the AMS

dence; M. Porrati and A. Starinets, Holographic duals of 4D field theories; D. Kabat, G. Lifschytz, and D. A. Lowe, Black hole thermodynamics from calculations in strongly-coupled gauge theory; O. Lunin and S. D. Mathur, Correlation functions for orbifolds of the type $M^N/S^N$; Elliptic genera and automorphic forms: L. A. Borisov and A. Libgober, Elliptic genera of singular varieties, orbifold elliptic genus and chiral de Rham complex; K. Liu and X. Ma, On family rigidity theorems for Spin$^c$ manifolds; J. Jorgenson and A. Todorov, Aample divisors, automorphic forms and Shafarevich's conjecture.

AMS/IP Studies in Advanced Mathematics, Volume 33
March 2003, 381 pages, Hardcover, ISBN 0-8218-3335-9, LC 2002038580, 2000 Mathematics Subject Classification: 14-XX, 32-XX, 81-XX, List $69^*$, Order code AMSIP/33N

*Discounted pricing is available to AMS members. Call 1-800-321-4AMS (4267), in the U.S. and Canada, or 1-401-455-4000 (worldwide); fax: 1-401-455-4046; email: cust-serv@ams.org. American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294, USA
Classified Advertisements

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ARKANSAS

SOUTHERN ARKANSAS UNIVERSITY
Department of Mathematics and Computer Science

Assistant professor of mathematics, nine-month, tenure-track position. The successful candidate must have a doctorate in mathematics, experience teaching undergraduate mathematics courses, and experience using scientific software such as LAPACK, MATLAB, EISPACK and/or MATHEMATICA. Specialization in computation (e.g., LAPACK, MATLAB, EISPACK and/or MATH) is desirable. Further, willingness to teach all undergraduate mathematics courses, including intermediate and college algebra. Duties: Teaching load of at least 12 hours each semester, student advising, scholarly contribution, serving on university committees. Interested parties should send letter of application, curriculum vitae, unofficial transcripts, and the names and telephone numbers of three references to: Office of Personnel, Southern Arkansas University, P.O. Box 9288, Magnolia, AR 71754-9288. For full consideration application must be received by February 20, 2003. AA/EOE.

MASSACHUSETTS

WILLIAMS COLLEGE
Department of Mathematics and Statistics

The department invites applications for two positions in mathematics and one position in statistics, beginning fall 2003, all at the rank of assistant professor (in exceptional cases, more advanced appointments may be considered). We are seeking highly qualified candidates who have demonstrated excellence in teaching and research and who will have a Ph.D. by the time of appointment.

Williams College is a private, residential, highly selective liberal arts college with an undergraduate enrollment of approximately 2,000 students. The teaching load is two courses per 12-week semester and a winter-term course every other January. In addition to excellence in teaching, an active and successful research program is expected.

To apply, please send vita and three letters of recommendation on teaching and research to the Hiring Committee, Department of Mathematics and Statistics, Williams College, Williamstown, MA 01267. Teaching and research statements are also welcome. Evaluations of applications will begin on or after November 25 and will continue until the positions are filled. Williams College is dedicated to providing a welcoming intellectual environment for all of its faculty, staff, and students; as an EEO/AA Employer, Williams especially encourages applications from women and underrepresented minorities. For more information on the Department of Mathematics and Statistics, visit http://www.williams.edu/Mathematics/.

MICHIGAN

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NORTHERN MICHIGAN UNIVERSITY
Department of Mathematics

The Department of Mathematics and Computer Science invites applications for two tenure-track positions in mathematics at the rank of assistant professor beginning with the 2003-2004 academic year. Successful candidates must have a Ph.D. in an area of the mathematical sciences by August 2003. For more information, visit our website at http://math.nmu.edu/career/position.html. EEO/AA.

UNIVERSITY OF MICHIGAN
Department of Mathematics
Ann Arbor, MI

The department expects to have a position beginning September 2003 at the advanced assistant professor or tenured level for a specialist in mathematics education. Duties will include teaching a range of courses for students seeking a teaching certificate in either elementary
or secondary mathematics education, providing counseling for these students, and working with the mathematics specialists in the School of Education to develop and maintain this joint program. Outreach to schools is strongly encouraged. Applications should address the candidate’s teaching experience and capabilities. To: Personnel Committee, University of Michigan, Department of Mathematics, 2074 East Hall, Ann Arbor, MI 48109-1109. Applications are considered on a continuing basis, but candidates are urged to apply by December 15, 2002. Women and minorities are encouraged to apply; the university is responsive to the needs of dual-career couples. Inquiries may be made by email to: math-fac-searchumich.edu. More detailed information regarding the department may be found on our webpage: http://www.math.lsa.umich.edu/. The University of Michigan is an Equal Opportunity/Affirmative Action Employer.

MONTANA

ROCKY MOUNTAIN COLLEGE
Department of Mathematics

The Department of Mathematics at Rocky Mountain College invites applications for a tenure-track position beginning fall 2003. The successful candidate will need a strong background in analysis and must demonstrate obvious enthusiasm and talent for undergraduate teaching both at the introductory and upper levels. Classes taught will include, but are not limited to, differential equations, vector analysis, advanced calculus, complex variables and topology. The candidate will also be expected to teach part of the traditional four-semester calculus sequence. The successful candidate must be committed to undergraduate teaching, with a demonstrated ability to teach effectively to students of varied interests and backgrounds. A Ph.D. or ABD in mathematics is required, and the successful candidate will play a large role in shaping the future direction of the program. In their applications, applicants should address their interests in teaching in an undergraduate, liberal arts environment that emphasizes close faculty-student interaction. Applications will be screened beginning February 15, 2003. Send letter of application, statement of teaching philosophy, curriculum vitae, and three letters of recommendation which address the candidate’s interest in and commitment to excellent teaching to: Bob Robertson, Director of Personnel, Rocky Mountain College, 1511 Poly Drive, Billings, MT 59102. Email inquiries to wiens@rocky.edu, AA/EOE.

NEW YORK

LEHMAN COLLEGE
The City University of New York
Department of Mathematics and Computer Science

Tenure-track position(s) available starting September 1, 2003, for assistant/associate/full professor in mathematics or computer science. Positions require an earned doctorate, outstanding research record or potential, and commitment to excellence in teaching and service. Also possibly available is a position of Distinguished Lecturer (nontenure-track) for an individual with significant experience in the computer industry. Appointment rank and salary commensurate with qualifications and experience.

Application procedure: Send curriculum vitae along with a cover letter and at least three letters of recommendation to: Prof. Robert Feinerman, Chair, Department of Mathematics and Computer Science, Lehman College, 250 Bedford Park Boulevard West, Bronx, NY 10468. Review of applications will begin on February 3, 2003, and will continue until positions are filled. Use of the AMS Cover Sheet for Academic Employment is encouraged. Additional information is available at: http://www.lehman.cuny.edu/, AA/EOE/ADA Employer.

CANADA

PACIFIC INSTITUTE FOR THE MATHEMATICAL SCIENCES
Director

Applications are invited for the post of director of the Pacific Institute for the Mathematical Sciences. The Pacific Institute is a consortium of mathematical scientists at Simon Fraser University and the Universities of Alberta, British Columbia, Calgary, Victoria, and Washington and is supported by these schools, the federal government of Canada through NSERC, and the provincial governments of Alberta and British Columbia. The appointee will have a distinguished record of scholarship in the mathematical sciences and will possess superior leadership and management skills. The director will provide leadership at all PIMS sites for all components of the institute’s mandate, including: * promotion of research in the mathematical sciences; * support of education, training, and communication in the mathematical sciences; * creation of links and partnerships between mathematical scientists in the academic community and the private and government sectors; * enhancement and creation of mathematical partnerships within Canada and with groups in the U.S. and the nations of the Pacific Rim.

As chair of the Executive Committee of the Banff International Research Station (BIRS) and a member of the Steering Committee of the MITACS Network of Centres of Excellence, the director will play a critical role in helping oversee the activities of these two large national initiatives. The director will also ensure continued good relations with the federal and provincial governments and their appropriate agencies and will explore new opportunities for growth with these and other agencies. The director will hold a faculty appointment, which is to be negotiated at one of the five founding Western Canadian Universities. The date of appointment will be between July 1, 2003, and July 1, 2004, and the term will be from 4 to 5 years. Other conditions of service are to be negotiated with the candidate.

Comprehensive information on PIMS may be found at: http://www.pims.math.ca/.

For information on BIRS and MITACS see: http://www.pims.math.ca/birs/ and http://www.mitacs.math.ca/.

Enquiries and applications should be addressed to the Search Committee (M. Boorman (U. Calgary); K. Foxcroft (TD Securities); A. Gupta (SFU, MITACS); R. Moody (U. Alberta, BIRS); H. Morris, chair (Elorado Gold); E. Perkins (UBC); and M. Taylor (U. Victoria)) at: Director Search Committee The Pacific Institute for the Mathematical Sciences Room 200, 1933 West Mall University of British Columbia Vancouver BC V6T 1Z2, Canada tel: 604-822-3922 email: pims@pims.math.ca and should be received no later than February 25, 2003. The Universities of Alberta, British Columbia, Calgary, and Victoria, and Simon Fraser University hire on the basis of merit and are committed to employment equity. We encourage all qualified persons to apply; however, Canadian citizens and permanent residents will be given priority.

HONG KONG

CITY UNIVERSITY OF HONG KONG
Liu Bie Ju Centre for Mathematical Sciences
Postdoctoral Fellowships/Research
Fellowships [Ref. A/R/471/49]

Applications are invited for three Research Fellows in the areas of industrial mathematics, partial differential equations and applications, and mathematical finance, respectively. Applicants should have a Ph.D. degree plus appropriate experience or outstanding research performance.

Starting rank and salary will depend on qualifications and experience. Starting salary is HK$26,805 (exchange rate: US$1 = HK$7.8 approximately) per month. Fringe benefits include medical and dental schemes and annual leave. Initial employment is for one year and the position is renewable, subject to funding and performance.

Please send your application letter with an updated curriculum vitae to: Director, Liu Bie Ju Centre for Mathematical Sciences, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong; or by fax: (852) 2788-7446; email: mclbj@cityu.edu.hk, by April 30, 2003. For information please visit http://www.cityu.edu.hk/.

PUERTO RICO

UNIVERSITY OF PUERTO RICO
AT MAYAGUEZ
Department of Mathematics

We anticipate filling three to four positions in August 2003; at least two would be tenure track. We would prefer one in mathematics education and one in computer science/computational mathematics. Other position(s) could be any specialty. Doctorate in mathematics and computer science or related area is required. Fluency in Spanish would be an advantage but is not required. Send applications, official transcripts, and three references to: Personnel Committee, Department of Mathematics, University of Puerto Rico at Mayaguez, P.O. Box 9018, Mayaguez, PR 00681. M/F/V/H.

TURKEY

BILKENT UNIVERSITY
Department of Mathematics

Tenure-track visiting assistant professor positions. The Department of Mathematics needs to fill visiting assistant professor positions. Employment begins in September 2003 and is renewable or can be made permanent at the end of the first year by mutual consent. Candidates are expected to have demonstrated excellence in both teaching and research after the Ph.D. in mathematics in an area related to the existing interests in the department, i.e., algebra, algebraic geometry, applied mathematics (nonlinear integrable systems and general relativity), complex analysis, functional analysis, number theory and topology. Successful applicants will be expected to teach across the undergraduate and graduate mathematics curriculum, including service courses; to supervise graduate and undergraduate students; as well as to carry on an active research program. The teaching load is two courses per semester. Free, furnished, on-campus housing is available.

Applicants should send a curriculum vitae and arrange to have sent three letters of recommendation addressing both their research and teaching to: Prof. Mefharet Kocatepe, Department of Mathematics, Bilkent University, TR-06533, Bilkent, Ankara, Turkey; email: kocatepe@fen.bilkent.edu.tr. More information about the position and the department can be found at the department's homepage: http://www.fen.bilkent.edu.tr/~cvmath/.
Applications are invited for one or more tenure-track positions in applied mathematics, to begin in August 2003. Applicants are expected to possess an outstanding record in research and a strong interest and ability in teaching. We invite candidates with a commitment to applied mathematics and interdisciplinary research. We are especially interested in candidates whose work involves mathematically based ideas for extracting information from data (data-mining, imaging, optimization, bioinformatics, geoinformatics, etc.), inverse problems, and scientific computation. Applicants should submit a letter of application, a curriculum vitae, a description of research interests, and arrange to have three letters of recommendations sent directly to: Donald Drew, Professor, Mathematical Sciences, School of Science, Rensselaer Polytechnic Institute, 110 8th Street, Troy, NY 12180. E-mail: drewd@rpi.edu

Evaluation of applications will begin immediately, and will continue until a candidate is selected.

Rensselaer is an equal opportunity/affirmative action employer and strongly encourages applications from women and underrepresented minorities.
Members of the Society who move or change positions are urged to notify the Providence Office as soon as possible.

Journal mailing lists must be printed four to six weeks before the issue date. Therefore, in order to avoid disruption of service, members are requested to provide the required notice well in advance.

Besides mailing addresses for members, the Society's records contain information about members' positions and their employers (for publication in the Combined Membership List). In addition, the AMS maintains records of members' honors, awards, and information on Society service.

When changing their addresses, members are urged to cooperate by supplying the requested information. The Society's records are of value only to the extent that they are current and accurate.

If your address has changed or will change within the next two or three months, please fill out this form, supply any other information appropriate for the AMS records, and mail it to:

**Customer Services**  
AMS  
P.O. Box 6248  
Providence, RI  
02940-6248 USA

or send the information on the form by e-mail to:  
amsmem@ams.org or  
cust-serv@ams.org

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New position

If mailing address is not that of your employer, please supply the following information:

New employer

Location of employer (city, state, zip code, country)

Telephone/home: office:

Fax:

e-mail

Recent honors and awards
Meetings & Conferences of the AMS

IMPORTANT INFORMATION REGARDING MEETINGS PROGRAMS: AMS Sectional Meeting programs do not appear in the print version of the Notices. However, comprehensive and continually updated meeting and program information with links to the abstract for each talk can be found on the AMS website. See http://www.ams.org/meetings/. Programs and abstracts will continue to be displayed on the AMS website in the Meetings and Conferences section until about three weeks after the meeting is over. Final programs for Sectional Meetings will be archived on the AMS website in an electronic issue of the Notices as noted below for each meeting.

Baton Rouge, Louisiana
Louisiana State University
March 14–16, 2003
Meeting #984
Southeastern Section
Associate secretary: John L. Bryant
Announcement issue of Notices: January 2003
Program first available on AMS website: January 30, 2003
Program issue of electronic Notices: March 2003
Issue of Abstracts: Volume 24, Issue 2

Deadlines
For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: January 22, 2003

Invited Addresses
Bruce K. Driver, University of California San Diego, Heat equations on loop groups.
Gunter Lumer, University of Mons-Hainaut, Stability analysis, Paley-Wiener criteria, and related problems in material science/ecology.
Barry M. McCoy, SUNY at Stony Brook, Title to be announced.
Stephen C. Milne, Ohio State University, A new look at sums of squares, Jacobi elliptic functions, and Ramanujan's tau function.

Special Sessions
Arrangements in Topology and Algebraic Geometry (Code: AMS SS C1), Daniel C. Cohen, Louisiana State University, and Alexander I. Suciu, Northeastern University.
Asymptotic Analysis, Stability, and Generalized Functions. (Code: AMS SS M1), Ricardo Estrada and Frank Neubrander, Louisiana State University, and Gunter Lumer, University of Mons-Hainaut.
Commutative Ring Theory (Code: AMS SS D1), James B. Coykendall, North Dakota State University, and Bernadette Mullins, Birmingham State College.
Frames, Wavelets, and Tomography (Code: AMS SS E1), Gestur Olafsson, Louisiana State University.
Graphs and Matroids (Code: AMS SS F1), Bogdan S. Oporowski and James G. Oxley, Louisiana State University.
Low Dimensional Topology (Code: AMS SS H1), Oliver T. Dasbach, Patrick M. Gilmer, and Richard A. Litherland, Louisiana State University.
Mathematical Techniques in Musical Analysis (Code: AMS SS J1), Judith L. Baxter, University of Illinois at Chicago, and Robert Peck, Louisiana State University.
Q-Series in Number Theory and Combinatorics (Code: AMS SS N1), Mourad E. H. Ismail, University of South Florida, and Stephen C. Milne, The Ohio State University.
The Role of Mathematics Departments in Secondary Education (Code: AMS SS P1), James J. Madden and Frank Neubrander, Louisiana State University.
Stochastics, Quantization, and Segal-Bargmann Analysis (Code: AMS SS L1), Bruce K. Driver, University of California San Diego, Brian C. Hall, University of Notre Dame, and Jeffrey J. Mitchell, Baylor University.

Bloomington, Indiana
Indiana University
April 4–6, 2003
Meeting #985
Central Section
Associate secretary: Susan J. Friedlander
Announcement issue of Notices: February 2003
Program first available on AMS website: February 20, 2003
Program issue of electronic Notices: April 2003
Issue of Abstracts: Volume 24, Issue 2

Deadlines
For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: February 11, 2003

Invited Addresses
Daniel J. Allcock, University of Texas, Title to be announced.
Brian D. Conrad, University of Michigan, Title to be announced.
Robin A. Pemantle, Ohio State University, Title to be announced.
Sijue Wu, University of Maryland, Title to be announced.

Special Sessions
Algebraic Topology (Code: AMS SS W1), Randy McCarthy, University of Illinois at Urbana-Champaign, and Ayelet Lindenstrauss, Indiana University.
Applications of Teichmüller Theory to Dynamics and Geometry (Code: AMS SS K1), Christopher M. Judge and Matthias Weber, Indiana University.
Codimension One Splittings of Manifolds (Code: AMS SS U1), James F. Davis, Indiana University, and Andrew A. Ranicki, University of Edinburgh.
Cryptography and Computational and Algorithmic Number Theory (Code: AMS SS S1), Joshua Holden and John Rickert, Rose-Hulman Institute of Technology, Jonathan Sorenson, Butler University, and Andreas Stein, University of Illinois at Urbana-Champaign.
Differential Geometry (Code: AMS SS L1), Jiri Dadok, Bruce Solomon, and Ji-Ping Sha, Indiana University.
Ergodic Theory and Dynamical Systems (Code: AMS SS A1), Roger L. Jones and Ayse A. Sahin, DePaul University.
Extremal Combinatorics (Code: AMS SS R1), Dhruv Mubayi, University of Illinois at Chicago, and Jozef Skokan, University of Illinois at Urbana-Champaign.
Graph and Design Theory (Code: AMS SS N1), Atif A. Abueida, University of Dayton, and Mike Daven, Mount Saint Mary College.
Graph Theory (Code: AMS SS Q1), Tao Jiang, Zevi Miller, and Dan Pritikin, Miami University.
Harmonic Analysis in the 21st Century (Code: AMS SS E1), Winston C. Ou and Alberto Torchinsky, Indiana University.
Mathematical and Computational Problems in Fluid Dynamics and Geophysical Fluid Dynamics (Code: AMS SS H1), Roger Temam and Shouhong Wang, Indiana University.
Operator Algebras and Free Probability (Code: AMS SS J1), Hari Bercovici, Indiana University, and Marius Dadarlat, Purdue University.
Operator Algebras and Their Applications (Code: AMS SS T1), Jerry Kaminker and Ronghui Ji, Indiana University-Purdue University Indianapolis.
Particle Models and Their Fluid Limits (Code: AMS SS F1), Robert T. Glassey and David C. Hoff, Indiana University.
Probability (Code: AMS SS G1), Russell D. Lyons, Indiana University, and Robin A. Pemantle, Ohio State University.
Recent Trend in the Analysis and Computations of Functional Differential Equations (Code: AMS SS M1), Paul W. Eloe and Qin Sheng, University of Dayton.
Representations of Infinite Dimensional Lie Algebras and Mathematical Physics (Code: AMS SS P1), Katrina Deane Barron, University of Notre Dame, and Rinat Kedem, University of Illinois at Urbana-Champaign.
Stochastic Analysis with Applications (Code: AMS SS V1), Jin Ma and Frederi Viens, Purdue University.
Weak Dependence in Probability and Statistics (Code: AMS SS C1), Richard C. Bradley and Lanh T. Tran, Indiana University.

Accommodations
Participants should make their own arrangements directly with the property listed below: Special rates for the meeting are available at this property for the period April 3–6. The AMS is not responsible for rate changes or for the quality of the accommodations.
A block of sleeping rooms has been reserved in the Indiana Memorial Union (IMU) Hotel. The IMU Hotel is located at 900 East Seventh Street, Bloomington, IN 47405.
The hotel is a completely modern facility located in the center of the Indiana University campus. To make your reservation, please telephone 800-209-8145. When you call please indicate that you are attending the American Mathematical Society Sectional Meeting so that your reservation will be made within the block of rooms reserved for the meeting. Rates range from $68–$95 for single occupancy and $76–$103 for double occupancy, plus tax. We encourage you to make your reservation by Friday, March 21, 2003; after that date any unreserved rooms will be released for sale to the general public. The IMU Hotel accepts all major credit cards.

Food Service
The Indiana Memorial Union provides a variety of food service options, including six eateries and three snack shops. Food service outlets range from fast food type service to the elegant Tudor Room for a relaxing buffet lunch.

For a city of its size, Bloomington, Indiana, has a delightful selection of ethnic restaurants. In the area immediately west of campus, you will find a unique blend of ethnic restaurants, including Moroccan, Indian, Japanese, Italian, Korean, in addition to several casual pubs. All are within easy walking distance of the Indiana Memorial Union.

Local Information
The following webpages will prove useful as you plan your travel to Indiana University and the Bloomington community:

- Indiana University Bloomington
  http://www.iub.edu/
- Indiana Memorial Union
  http://www.imu.indiana.edu/
- Bloomington Community
  http://www.visitbloomington.com/
- Bloomington Shuttle Service
  http://www.bloomingtonshuttle.com/

Indiana University is often cited as one of the most beautiful college campuses in the nation. The 1,930-acre woodland setting is a harmonious blend of natural landscape and campus buildings constructed predominately of native limestone. More than a hundred years ago the board of trustees selected this woodland site to become the home of the university. The university has actively worked to preserve portions of the original woods and maintain them in their natural state. As late as the 1980s the university designated a large central campus area for the development of an arboretum. Your visit in early April will be just as spring is beginning.

Other Activities
Book Sales: Examine the newest titles from the AMS! Many of the AMS books will be available at a special 50% discount available only at the meeting. Complimentary coffee will be served courtesy of AMS Membership Services.

AMS Editorial Activity: An acquisitions editor from the AMS book program will be present to speak with prospective authors. If you have a book project that you would like to discuss with the AMS, please stop by the book exhibit.

Parking
Parking is available in two lots adjacent to the Indiana Memorial Union: one immediately to the east of the IMU and a second just across Seventh Street to the north. Both of these lots are complimentary for IMU Hotel guests. The daily charge for non-IMU Hotel guests is currently a maximum of $6.50/day.

Registration and Meeting Information
The meeting will be held in the Indiana Memorial Union, situated in the heart of the woodland campus of Indiana University-Bloomington. The IMU is the world's largest student union.

The registration desk will be located in the Conference Lounge on the mezzanine level of the Indiana Memorial Union. The desk will be open Friday, April 4, from noon until 4:00 p.m., and Saturday, April 5, from 8:00 a.m. until 4:00 p.m. Fees are $40 for AMS or CMS members, $60 for nonmembers, and $5 for students/unemployed/emeritus, payable on site by cash, check, or credit card.

Transportation
The nearest major commercial airport is the Indianapolis International Airport. The Indianapolis Airport is located approximately 45 miles from Indiana University. Travel time to the Indianapolis Airport is about one hour to one hour and fifteen minutes. All major auto rental agencies are represented at the Indianapolis Airport.

Shuttle service from the Indianapolis Airport to the Indiana Memorial Union is conveniently provided via Bloomington Shuttle Service. Bloomington Shuttle Service operates on a fixed schedule, arriving and departing the IMU nine times each day. The shuttle departs from the Ground Transportation Center, located on the baggage claim level of the Indianapolis Airport. To make your reservation, please telephone 800-589-6004. The current charge is $20 one way and $35 round trip. Travel time from the airport is approximately one hour and fifteen minutes.

To view a complete schedule and to make your reservation online, please visit the Bloomington Shuttle Service webpage at http://www.bloomingtonshuttle.com/.

If your travel schedule does not permit the use of the Bloomington Shuttle Service, you may arrange door-to-door service through Signature Limousine Service. This service is also operated by Bloomington Shuttle Service at the number listed above.

Car Rental: Special rates have been negotiated with Avis Rent A Car for the period March 28 to April 13, 2003, beginning at $23.99/day for a subcompact car at the weekend rate (the weekend rate is available from noon Thursday until midnight Monday). All rates include unlimited free mileage. Rates do not include state or local surcharges, tax, optional coverages, or gas refueling charges. Renter must meet Avis's age, driver, and credit requirements, and return to the same renting location. Make reservations by calling 800-331-1600 or online at http://www.
Driving to Indiana University

From the South: The best route is from Louisville, Kentucky. Take I-65, the four-lane interstate, north from Louisville to Columbus, Indiana (approximately one-hour drive).

From Columbus, take Indiana Highway 46 west to Bloomington. (State highway is two lanes and winds through the hills.) Travel east approximately one hour to Bloomington. Upon entering the commercial and residential district, Highway 46 becomes East Third Street. Continue heading west on Third Street through the stoplights at K-Mart/Marsh Supermarket, College Mall Road (Shell Station/Red Lobster), Eastland Plaza, High Street, Jordan Avenue. (Third Street becomes one-way street heading west between the High Street and Jordan Avenue stoplights.) Turn right (north) at Indiana Avenue, the next stoplight. Indiana is a one-way street going north. Go three blocks to the second stop sign (3-way stop), which is intersection of Seventh and Indiana. Turn right (east) on Seventh. Turn right at the second stop sign into the Indiana Memorial Union circle drive/parking lot.

From the West: From St. Louis and points west, take Interstate 70 east to Terre Haute.

From Terre Haute, take Indiana Highway 46 east to Bloomington. (State highway is two lanes and winds through the hills.) Travel east approximately one hour to Bloomington. Westbury Village will be on the left (north) of the road as it crosses over Highway 37 and leads into Bloomington. Highway 46 becomes 17th Street at this point. Once you have entered Bloomington, continue to the second stoplight (College Avenue). College is one-way going south. Turn right on College and continue to 7th Street. Turn left (east) on 7th Street. Continue through the 4-way and 3-way stops (approximately eight blocks) to the Indiana Memorial Union.

From Evansville, IN, take Highway 41 north to Terre Haute. See directions above.

From the North: From Chicago, take Interstate 65 to Indianapolis. Take 465 bypass southwest to Highway 37.

From Detroit/Lansing areas, take Highway 69 to Indianapolis. Take 465 bypass southeast to Highway 37.

From Indianapolis, take Indiana Highway 37 (four-lane state highway with many series of stoplights) south. Travel south for approximately one hour to the first Bloomington exit (College Avenue/Business 37 exit). Continue south on College as it becomes one-way. Turn left (east) on 7th Street. Follow directions listed above in Terre Haute entry.

From the East: From Columbus, OH, take Interstate 70 to Indianapolis. Take 465 bypass south to Highway 37.

From Cincinnati, OH, take Interstate 74 to Indianapolis. Take 1-65, the four-lane interstate, north from Louisville to Columbus, Indiana (approximately one-hour drive).

From Columbus, take Indiana Highway 46 west to Bloomington. (State highway is two lanes and winds through the hills.) Travel east approximately one hour to Bloomington. Upon entering the commercial and residential district, Highway 46 becomes East Third Street. Continue heading west on Third Street through the stoplights at K-Mart/Marsh Supermarket, College Mall Road (Shell Station/Red Lobster), Eastland Plaza, High Street, Jordan Avenue. (Third Street becomes one-way street heading west between the High Street and Jordan Avenue stoplights.) Turn right (north) at Indiana Avenue, the next stoplight. Indiana is a one-way street going north. Go three blocks to the second stop sign (3-way stop), which is intersection of Seventh and Indiana. Turn right (east) on Seventh. Turn right at the second stop sign into the Indiana Memorial Union circle drive/parking lot.

Weather

Early April temperatures normally range from a daily high of 63°F to a low of 42°F. Spring also tends to be a rainy time of year, so be sure to bring an umbrella or raincoat.

New York, New York

Courant Institute

April 12–13, 2003

Meeting #986

Eastern Section

Associate secretary: Lesley M. Sibner

Announcement issue of Notices: February 2003

Program first available on AMS website: February 27, 2003

Program issue of electronic Notices: April 2003

Issue of Abstracts: Volume 24, Issue 3

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions: Expired

For abstracts: February 18, 2003

Invited Addresses

Matthias Aschenbrenner, University of California Berkeley, Title to be announced.

John Etnyre, University of Pennsylvania, Legendrian knots.

Hans Foellmer, Humboldt University Berlin, Title to be announced.

Wilfrid Gangbo, Georgia Institute of Technology, Title to be announced.

Special Sessions

Algebraic and Topological Combinatorics (Code: AMS SS E1), Eva-Maria Feichtner, ETH, Zurich, Switzerland, and Dmitry N. Kozlov, University of Bern, Switzerland, and KTH, Stockholm, Sweden.

Algebraic Geometry, Integrable Systems, and Gauge Theory (Code: AMS SS C1), Marcos Jardim and Eyal Markman, University of Massachusetts, Amherst.

Algebraic Geometry, Integrable Systems, and Gauge Theory (Code: AMS SS E1), Alexander P. Stone, University of New Mexico, and Peter A. McCoy, U. S. Naval Academy.

Combinatorial and Statistical Group Theory (Code: AMS SS B1), Alexei Myasnikov and Vladimir Shpilrain, City College, New York.

Contact and Symplectic Geometry (Code: AMS SS K1), John B. Etnyre and Joshua M. Sabloff, University of Pennsylvania.


The History of Mathematics (Code: AMS SS D1), Patricia R. Allaie, Queensborough Community College, CUNY, and Robert E. Bradley, Adelphi University.

Hopf Algebras and Quantum Groups (Code: AMS SS A1), M. Susan Montgomery, University of Southern California, Earl J. Taft, Rutgers University, and Sarah J. Witherspoon, Amherst College.
Low-Dimensional Topology (Code: AMS SS M1), James Conant, Cornell University, Slava Krushkal, University of Virginia, and Rob Schneiderman, NYU-Courant Institute.


Topological Aspects of Complex Singularities (Code: AMS SS H1), Sylvain E. Cappell, NYU-Courant Institute, and Walter D. Neumann and Agnes Szilard, Barnard College, Columbia University.

Accommodations

Participants should make their own arrangements directly with a hotel of their choice. Special rates for the meeting are available at the property shown below for the nights of Friday, and Saturday, April 11 and 12. Room rates do not include the tax of 14%. Please cite the group name or booking number as indicated when making a reservation. Hotels have varying cancellation or early checkout penalties; be sure to ask for details when making your reservation. The AMS is not responsible for rate changes or for the quality of the accommodations.

Washington Square Hotel, 13 Waverly Place at Washington Square West, New York, NY 10011-9194, 212-777-9515; 212-979-8373 (fax); $165 for one full/queen bedded room for one or two persons; includes complimentary continental breakfast, exercise room, restaurant and lounge; about three blocks from the meeting site. The number of rooms is very limited; deadline for reservations is February 24, 2003. Please cite group number 0412 when making a reservation.

Please watch http://www.ams.org/amsmtgs/sectional.html for additional information on hotel availability for the meeting.

Food Service

There are a variety of restaurants within walking distance of the sessions.

Local Information

The Courant Institute homepage is located at http://www.cims.nyu.edu; New York University's homepage is http://www.nyu.edu. There is an excellent downloadable campus map at http://www.nyu.edu/v40extras/nyumap.pdf; visitor's information is at http://www.nyu.edu/visitors.nyu.

Other Activities

Book Sales: Examine the newest titles from the AMS! Many of the AMS books will be available at a special 50% at the meeting. Complimentary coffee will be served courtesy of AMS Membership Services.

AMS Editorial Activity: An acquisitions editor from the AMS Book program will be present to speak with prospective authors. If you have a book project that you would like to discuss with the AMS, please stop by the book exhibit.

Parking

The closest available off-street parking (about three or four blocks) is at the Hillary Gardens Garage, 300 Mercer St. between 8th St. and Waverly Pl. (212-473-8752), rates are $19/day or $24/overnight; and the Thompson Street Garage, 221 Thompson between 3rd St. and Bleecker St. (212-677-8741), rates are $14/day or $28/overnight.

Registration and Meeting Information

The meeting is at the Courant Institute of Mathematical Sciences, Warren Weaver Hall, 251 Mercer St. between 3rd and 4th Streets. Sessions will take place in here and in other buildings; Invited Addresses will be in Warren Weaver Hall.

The registration desk will be in Warren Weaver Hall and will be open 7:30 a.m.-4:00 p.m. on Saturday, April 12, and 8:00 a.m.-noon on Sunday, April 13. Fees are $40 for AMS or CMS members, $60 for nonmembers; and $5 for students/unemployed/emeritus, payable on site by cash, check or credit card.

Travel

From La Guardia International Airport, Kennedy International Airport, or Newark International Airport, take the airport shuttle bus to Port Authority Bus Terminal or Grand Central Station.

From Port Authority, take the A or E subway downtown to West Fourth Street-Washington Square Station, or from Grand Central, take the Lexington Avenue subway (No. 6 train) downtown to Astor Place Station. Cabs and car services are available at the airport and, even though they cost more, they are more convenient if you have a lot of luggage. Plan on spending at least $25 to $40 depending on the airport and time of day.

Once in the city you can take one of these subway routes: Take the Lexington Avenue subway (No. 6 train) to Astor Place Station. Go west on Astor Place to Broadway. Walk south on Broadway to Waverly Place. Walk westward on Waverly Place until you reach Washington Square.

Take the Broadway subway (N or R train) to Eighth Street Station. At Broadway walk south to Waverly Place. Walk westward on Waverly Place until you reach Washington Square.

Take the Sixth Avenue subway to West Fourth Street-Washington Square Station (A, C, E, F, V, or S train). Walk east on West Fourth Street until you reach Washington Square.

Take the Seventh Avenue subway to Christopher Street­Sheridan Square Station (1 or 2). Walk east on Christopher Street to West Fourth Street. Continue east to Washington Square.

Weather

Weather conditions in mid April in New York City are usually pleasant. Temperatures are between 45 and 60 degrees, and the average rainfall is four inches for the month. For up to the minute forecasts see http://asp.usatoday.
San Francisco, California
San Francisco State University
May 3–4, 2003

Meeting #987
Western Section

Associate secretary: Michel L. Lapidus
Announcement issue of Notices: March 2003
Program first available on AMS website: March 20, 2003
Program issue of electronic Notices: May 2003
Issue of Abstracts: Volume 24, Issue 3

Deadlines
For organizers: Expired
For consideration of contributed papers in Special Sessions: January 14, 2003
For abstracts: March 11, 2003

Invited Addresses
Joe P. Buhler, Reed College, A problem in symmetric functions arising from phase determination in crystallography.
Raymond C. Heitmann, University of Texas at Austin, Title to be announced.
Alexei Y. Kitaev, California Institute of Technology, Title to be announced.
Arkady Vaintrob, University of Oregon, Title to be announced.

Special Sessions
Beyond Classical Boundaries of Computability (Code: AMS SS E1), Mark Burgin, University of California Los Angeles, and Peter Wegner, Brown University.
Combinatorial Commutative Algebra and Algebraic Geometry (Code: AMS SS C1), Serkan Hosten, San Francisco State University, and Ezra Miller, Mathematical Sciences Research Institute.
Commutative Algebra (Code: AMS SS L1), Raymond C. Heitmann, University of Texas at Austin, and Irena Swanson, New Mexico State University.
Efficient Arrangements of Convex Bodies (Code: AMS SS H1), Dan P. Ismailescu, Hofstra University, and Wlodzimierz Kuperberg, Auburn University.
Geometry and Arithmetic over Finite Fields (Code: AMS SS G1), Bjorn Poonen, University of California Berkeley, and Joe P. Buhler, Reed College.
Gromov-Witten Theory of Spin Curves and Orbifolds (Code: AMS SS M1), Tyler Jarvis, Brigham Young University, and Arkady Vaintrob, University of Oregon.
The History of Nineteenth and Twentieth Century Mathematics (Code: AMS SS A1), Shawnee McMurran, California State University, San Bernardino, and James A. Tattersall, Providence College.
Numerical Methods, Calculations and Simulations in Knot Theory and Its Applications (Code: AMS SS J1), Jorge Alberto Calvo, North Dakota State University, Kenneth C. Millett, University of California Santa Barbara, and Eric J. Rawdon, Duquesne University.
PDEs and Applications in Geometry (Code: AMS SS K1), Qifeng Zhang, University of California, Riverside.
Q-Series and Partitions (Code: AMS SS B1), Neville Robbins, San Francisco State University.
Qualitative Properties and Applications of Functional Equations (Code: AMS SS F1), Theodore A. Burton, Southern Illinois University at Carbondale.
Topological Quantum Computation (Code: AMS SS D1), Alexei Kitaev, California Institute of Technology, and Samuel J. Lomonaco, University of Maryland, Baltimore County.

Seville, Spain
June 18–21, 2003

Meeting #988
First Joint International Meeting between the AMS and the Real Sociedad Matematica Espanola (RSME).

Associate secretary: Susan J. Friedlander
Announcement issue of Notices: To be announced
Program first available on AMS website: Not applicable
Program issue of electronic Notices: Not applicable
Issue of Abstracts: Not applicable

Deadlines
For organizers: Expired
For consideration of contributed papers in Special Sessions: February 10, 2003
For abstracts: February 10, 2003

Invited Addresses
Xavier Cabre, Universidad Politècnica de Cataluña, Barcelona, Title to be announced.
Charles Fefferman, Princeton University, Title to be announced.
Michael Hopkins, Massachusetts Institute of Technology, Title to be announced.
Ignacio Sols, Universidad Complutense, Madrid, Title to be announced.
Luis Vega, Universidad del Pais Vasco, Bilbao, Title to be announced.
Efim Zelmanov, Yale University, Title to be announced.
Special Sessions

Affine Algebraic Geometry, Jaime Gutierrez, University of Cantabria, Vladimir Shpilrain, City College of New York, and Jie-Tai Yu, University of Hong Kong.

Algebraic Geometry, Felix Delgado, Universidad de Valladolid, and Andrey N. Todorov, University of California Santa Cruz.

Algebraic Topology, Alejandro Adem, University of Wisconsin, J. Aguade, Universitat Autònoma de Barcelona, and Eric M. Friedlander, Northwestern University.

Banach Spaces of Analytic Functions, Daniel Girela, University of Malaga, and Michael Stessin, SUNY at Albany.

Biomolecular Mathematics, Thomas J. Head and Fernando Guzman, SUNY at Binghamton, Mario Perez, University de Sevilla, and Carlos Martin-Vide, Rovira i Virgili University.

Classical and Harmonic Analysis, Nets Katz, Washington University, Carlos Perez, Universidad de Sevilla, and Ana Vargas, Universidad Autónoma de Madrid.

Combinatorics, Joseph E. Bonin, George Washington University, and Marc Noy, Universitat Politécnica de Catalunya.

Commutative Algebra: Geometric, Homological, Combinatorial, and Computational Aspects, Alberto Corso, University of Kentucky, Philippe Gimenez, Universidad de Valladolid, and Santiago Zarzuela, Universitat de Barcelona.

Computational Methods in Algebra and Analysis, Eduardo Cattani, University of Massachusetts, Amherst, and Francisco Jesus Castro-Jimenez, Universidad de Sevilla.

Constructive Approximation Theory, Antonio Duran, Universidad de Sevilla, and Edward B. Saff, Vanderbilt University.

Control and Geometric Mechanics, Manuel de Leon, Instituto de Matemáticas y Física Fundamental, Alberto Ibort, Universidad Carlos III, and Francesco Bullo, University of Illinois at Urbana-Champaign.

Differential Galois Theory, Teresa Crespo and Zbigniew Hajto, Universitat de Barcelona, and Andy R. Magid, University of Oklahoma.

Differential Structures and Homological Methods in Commutative Algebra and Algebraic Geometry, Jennifer Cattani, University of Minnesota, and Luis Narvaez-Macarro, Universidad de Sevilla.

Discrete and Computational Geometry, Ferran Hertado, Universitat Politècnica de Catalunya, and William Steiger, Rutgers University.

Dynamical Systems, George Haller, Massachusetts Institute of Technology, Zbigniew H. Nitecki, Tufts University, Enrique Ponce, Universidade de Sevilla, Tere M. Seara, Universitat Politècnica de Catalunya, and Xavier Jarque, Universitat Autònoma de Barcelona.

Effective Analytic Geometry over Complete Fields, Luis-Miguel Pardos, Universidad de Cantabria, and J. Maurice Rojas, Texas A&M University.

Geometric Methods in Group Theory, José Burillo, Universitat Politècnica de Catalunya, Jennifer Tayback, University of Albany, and Enric Ventura, Universitat Politècnica de Catalunya.

History of Modern Mathematics—Gauss to Wiles, Jose Ferreira, Universidad de Sevilla, and David Rowe, Universitat Mainz.

Homological Methods in Banach Space Theory, Jesus M. F. Castillo, Universidad de Extremadura, and N. J. Kalton, University of Missouri.

Homotopy Algebras, Pedro Real, Universidad de Sevilla, Thomas J. Lada, North Carolina State University, and James Stasheff, University of North Carolina.

Interpolation Theory, Function Spaces and Applications, Fernando Cobos, Universidad Complutense de Madrid, and Pencho Petrushev, University of South Carolina.

Lorentzian Geometry and Mathematical Relativity, Luis J. Alias, Universidad de Murcia, and Gregory James Galloway, University of Miami.

Mathematical Aspects of Semiconductor Modeling and Nanotechnology, Irene Martinez Gamba, University of Texas, Austin, and Jose Antonio Carrillo, Universidad de Granada.

Mathematical Fluid Dynamics, Diego Cordoba, CSIC, Madrid, and Princeton University, Susan Friedlander, University of Illinois at Chicago, and Marcos Antonio Fontelos, Universidad Rey Juan Carlos.

Mathematical Methods in Finance and Risk Management, Santiago Carrillo Menendez, Universidad Autónoma de Madrid, Antonio Falcó Montesinos, Universidad Cardenal Herrera CEU, Antonio Sanchez-Calle, Universidad Autónoma de Madrid, and Luis A. Seco, University of Toronto at Mississauga.

The Mathematics of Electronmicroscopic Imaging, Jose-Maria Carazo, Centro Nacional de Biotecnología-CSIC, and Gabor T. Herman, City University of New York.

Moduli Spaces in Geometry and Physics, Steven B. Bradlow, University of Illinois at Urbana-Champaign, and Oscar Garcia-Prada, Universidad Autónoma de Madrid.

Nonassociative Algebras and Their Applications, Efim I. Zelmanov, Yale University, Santos Gonzalez, Universidad de Oviedo, and Alberto Elduque, Universidad de Zaragoza.

Nonlinear Dispersive Equations, Gustavo Ponce, University of California Santa Barbara, and Luis Vega, Universidad del Pais Vascos.

Numerical Linear Algebra, Lothar Reichel, Kent State University, and Francisco Marcellan, University Carlos III de Madrid.


PDE Methods in Continuum Mechanics, Juan L. Vazquez, Universidad Autónoma de Madrid, and J. W. Neuberger, University of North Texas.

Polynomials and Multilinear Analysis in Infinite Dimensions, Richard M. Aron, Kent State University, J. A. Jaramillo
Meetings & Conferences

and José G. Llavona, Universidad Complutense de Madrid, and Andrew M. Tonge, Kent State University.

Quantitative Results in Real Algebra and Geometry, Carlos Andradas and Antonio Diaz-Cano, Universidad Complutense, Victoria Powers, Emory University, and Frank Sottile, University of Massachusetts, Amherst.

Recent Developments in the Mathematical Theory of Inverse Problems, Russell Brown, University of Kentucky, Alberto Ruiz, Universidad Autónoma de Madrid, and Gunther Uhlmann, University of Washington.

Riemannian Foliations, Jesús Antonio Alvarez Lopez, Universidade de Santiago de Compostela, and Efton L. Park, Texas Christian University.

Ring Theory and Related Topics, José Gomez-Torrecillas, University of Granada, Pedro Antonio Guíl Asensio, University of Murcia, Sergio R. López-Permouth, Ohio University, and Blas Torrecillas, University of Almeria.

Variational Problems for Submanifolds, Frank Morgan, Williams College, and Antonio Ros, Universidad de Granada.

Meeting Website

The First Joint International Meeting between the American Mathematical Society (AMS) and the Real Sociedad Matemática Española (RSME) will be held in Seville (Spain) on June 18–21, 2003. The following information is taken from the website for the meeting maintained by RSME. For more details see their website at http://www.us.es/rsme-ams/english/english.htm (English version). The meeting will take place in the Escuela Técnica Superior de Ingenieros Industriales (http://www.esi.us.es) of the Universidad de Sevilla (http://www.us.es). Sessions begin on Wednesday, June 18, and conclude on Saturday, June 21, with a closing ceremony at 1:30 p.m. The plenary talks will be given in the Salón de Actos, located on the first floor. The Special Sessions will take place in rooms (aulas) on floors P1 and E2 (click on the map http://www.esi.us.es/TMG_ESC/sen_plaza_americ_97/distrib.html for details). The exact room for each session will be announced later.

Abstract Submission

The deadline for submission of all abstracts is February 10. All speakers in Special Sessions should submit their abstracts using the electronic submission process at the website maintained by the RSME. All abstracts must be sent according to the instructions listed on the meeting website.

Accommodations

Blocks of rooms have been reserved in two-, three-, four- and five-star hotels. Current prices range from about 67 to 155 euros/single and from 81 to 175 euros/double. You should make a preliminary request for the type of room you prefer as soon as possible from the meeting website.

Registration

All registration fees will be collected in euros. Advance registration fees until March 31 are 120 euros/AMS, RSME, SCM, SEEIO, SEEMA, and SPM members; and 180 euros/nonmembers; fees after April 1 will increase by 50%. Payment in advance is accepted by credit card. Please fill out the form on the meeting website maintained by the RSME.

Since Wednesday and Thursday have morning and afternoon activities and there are no restaurants close to the building, lunch will be catered both days. Registration includes these two lunches as well as provisions for the morning and afternoon coffee breaks. The conference banquet on Friday will be paid for separately, as indicated on the registration form. For the other meals on Friday and Saturday, we recommend trying the delicious local cuisine.

Travel

Seville Airport is conveniently located 7 kilometres from central Seville. There are few scheduled international flights. Cheap charter flights to Seville are scarce. For more economical flights, flying into Jerez de la Frontera or Málaga and taking the bus to Seville is another option.

Seville has good rail links to Barcelona, Cádiz, Córdoba, Jaén, Jerez de la Frontera, Granada, Huelva, Madrid, Málaga, Ronda, and Valencia. The fast-track AVE railway line provides a 2 hour and 30 min. connection to Madrid every hour.

More information is available on the meeting website maintained by the RSME.

Boulder, Colorado

University of Colorado

October 2–4, 2003

Meeting #989

Joint Central/Western Sections

Associate secretaries: Susan J. Friedlander and Michel L. Lapidus

Announcement issue of Notices: August 2003

Program first available on AMS website: August 21, 2003

Program issue of electronic Notices: October 2003

Issue of Abstracts: Volume 24, Issue 4

Deadlines

For organizers: March 3, 2003
For consideration of contributed papers in Special Sessions: June 6, 2003
For abstracts: August 12, 2003

Invited Addresses

J. Brian Conrey, American Institute of Mathematics, Title to be announced.

Giovanni Forni, Northwestern University, Title to be announced.

Juha M. Heinonen, University of Michigan, Title to be announced.
Meetings & Conferences

Joseph D. Lakey, New Mexico State University, Title to be announced.
Albert Schwarz, University of California Davis, Title to be announced.
Avi Wigderson, Institute for Advanced Study, Title to be announced (Erdős Memorial Lecture).

Special Sessions
Algebras, Lattices and Varieties (Code: AMS SS A1), Keith A. Kearnes, University of Colorado, Boulder, Agnes Szendrei, Bolyai Institute, and Walter Taylor, University of Colorado, Boulder.
Applications of Number Theory and Algebraic Geometry to Coding (Code: AMS SS B1), David R. Grant, University of Colorado, Boulder, Jose Felipe Voloch, University of Texas, Austin, and Judy Leavitt Walker, University of Nebraska, Lincoln.
Groupoids in Analysis and Geometry (Code: AMS SS D1), Lawrence Baggett, University of Colorado, Boulder, Jerry Kaminker, Indiana University-Purdue University Indianapolis, and Judith Packer, University of Colorado, Boulder.
Noncommutative Geometry and Geometric Analysis (Code: AMS SS E1), Carla Farsi, Alexander Gorokhovsky, and Siye Wu, University of Colorado.

Binghamton, New York
Binghamton University
October 11–12, 2003

Meeting #990
Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of Notices: August 2003
Program first available on AMS website: August 28, 2003
Program issue of electronic Notices: October 2003
Issue of Abstracts: Volume 24, Issue 4

Deadlines
For organizers: March 10, 2003
For consideration of contributed papers in Special Sessions: June 24, 2003
For abstracts: August 19, 2003

Invited Addresses
Peter Kuchment, Texas A&M University, Title to be announced.
Zlil Sela, Einstein Institute of Mathematics, Title to be announced.
Zoltan Szabo, Princeton University, Title to be announced.
Jeb F. Willenbring, Yale University, Title to be announced.

Special Sessions
Biomolecular Mathematics (Code: AMS SS A1), Thomas J. Head and Dennis G. Pixton, Binghamton University, Mitsunori Ogihara, University of Rochester, and Carlos Martin-Vide, Universitat Rovira i Virgili.
Boundary Value Problems on Singular Domains (Code: AMS SS C1), Juan B. Gil, Temple University, and Paul A. Loya, SUNY at Binghamton.
Infinite Groups and Group Rings (Code: AMS SS D1), Luise-Charlotte Kappe, Binghamton University, and Derek J. S. Robinson, University of Illinois at Urbana-Champaign.
Lie Algebras, Conformal field Theory, and Related Topics (Code: AMS SS E1), Chongying Dong, University of California Santa Cruz, and Alex J. Feingold, Binghamton University.

Chapel Hill, North Carolina
University of North Carolina at Chapel Hill
October 24–25, 2003

Meeting #991
Southeastern Section
Associate secretary: John L. Bryant
Announcement issue of Notices: August 2003
Program first available on AMS website: September 11, 2003
Program issue of electronic Notices: October 2003
Issue of Abstracts: Volume 24, Issue 4

Deadlines
For organizers: March 24, 2003
For consideration of contributed papers in Special Sessions: July 19, 2003
For abstracts: September 3, 2003

Bangalore, India
India Institute of Science
December 17–20, 2003

Meeting #992
First Joint AMS-India Mathematics Meeting
Associate secretary: Susan J. Friedlander
Announcement issue of Notices: To be announced
Program first available on AMS website: Not applicable
Program issue of electronic Notices: Not applicable
Issue of Abstracts: Not applicable
Meetings & Conferences

Deadlines
For organizers: To be announced
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Invited Addresses
George C. Papanicolaou, Stanford University, Title to be announced.
Peter Sarnak, Princeton University and New York University-Courant Institute, Title to be announced.
Vladimir Voevodsky, Institute for Advanced Study, Title to be announced.

Special Sessions
Algebraic and Geometric Topology (Code: AMS SS E1), Parameswaren Sankaran, Institute of Mathematical Sciences, and P. B. Shalen, University of Illinois.
Commutative Algebra and Algebraic Geometry (Code: AMS SS B1), Sudhir Ghorpade, Indian Institute of Technology, Hema Srinivasan, University of Missouri, and Jugal K. Verma, Indian Institute of Technology.
Cycles, $K$-Theory, and Motives (Code: AMS SS D1), Eric M. Friedlander, Northwestern University, Steven Lichtenbaum, Brown University, Kapil Paranjape, Institute of Mathematical Sciences, and Vasudevan Srinivas, Tata Institute of Fundamental Research.
PDE and Application (Code: AMS SS F1), Susan B. Friedlander, University of Illinois, and P. N. Srikanth, Tata Institute of Fundamental Research.

Phoenix, Arizona
Phoenix Civic Plaza
January 7-10, 2004

Meeting #993
Joint Mathematics Meetings, including the 110th Annual Meeting of the AMS, 87th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).

Associate secretary: Michel L. Lapidus
Announcement issue of Notices: October 2003
Program first available on AMS website: To be announced

Tallahassee, Florida
Florida State University
March 12-13, 2004

Meeting #994
Southeastern Section
Associate secretary: John L. Bryant
Announcement issue of Notices: To be announced
Program first available on AMS website: To be announced
Program issue of electronic Notices: To be announced
Issue of Abstracts: To be announced

Deadlines
For organizers: August 13, 2003
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
Athens, Ohio
Ohio University
March 26–27, 2004
Meeting #995
Central Section
Associate secretary: Susan J. Friedlander
Announcement issue of Notices: To be announced
Program first available on AMS website: To be announced
Program issue of electronic Notices: To be announced
Issue of Abstracts: To be announced

Deadlines
For organizers: August 26, 2003
For consideration of contributed papers in Special Sessions:
To be announced
For abstracts: To be announced

Los Angeles, California
University of Southern California
April 3–4, 2004
Meeting #996
Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of Notices: To be announced
Program first available on AMS website: To be announced
Program issue of electronic Notices: To be announced
Issue of Abstracts: To be announced

Deadlines
For organizers: To be announced
For consideration of contributed papers in Special Sessions:
To be announced
For abstracts: To be announced

Special Sessions
Contact and Symplectic Geometry (Code: AMS SS A1),
Dragomir Dragnev, Ko Honda, and Sang Seon Kim, University of Southern California.

Lawrenceville, New Jersey
Rider University
April 17–18, 2004
Meeting #997
Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of Notices: To be announced
Program first available on AMS website: To be announced
Program issue of electronic Notices: To be announced
Issue of Abstracts: To be announced

Deadlines
For organizers: September 17, 2003
For consideration of contributed papers in Special Sessions:
To be announced
For abstracts: To be announced

Houston, Texas
University of Houston
May 13–15, 2004
Sixth International Joint Meeting of the AMS and the Sociedad Matematica Mexicana (SMM),
Associate secretary: John L. Bryant
Announcement issue of Notices: To be announced
Program first available on AMS website: To be announced
Program issue of electronic Notices: To be announced
Issue of Abstracts: To be announced

Deadlines
For organizers: To be announced
For consideration of contributed papers in Special Sessions:
To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

Pittsburgh, Pennsylvania
University of Pittsburgh
November 6–7, 2004
Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of Notices: To be announced
Program first available on AMS website: To be announced
Program issue of electronic Notices: To be announced
Issue of Abstracts: To be announced
Meetings & Conferences

Deadlines
For organizers: April 7, 2004
For consideration of contributed papers in Special Sessions:
To be announced
For abstracts: To be announced

Atlanta, Georgia
Atlanta Marriott Marquis and Hyatt Regency Atlanta

January 5-8, 2005
Joint Mathematics Meetings, including the 111th Annual Meeting of the AMS, 88th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL).
Associate secretary: Lesley M. Sibner
Announcement issue of Notices: October 2004
Program first available on AMS website: To be announced
Program issue of electronic Notices: January 2005
Issue of Abstracts: To be announced

Deadlines
For organizers: April 5, 2004
For consideration of contributed papers in Special Sessions:
To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

Mainz, Germany
Deutsche Mathematiker-Vereinigung (DMV) and the Österreichische Mathematische Gesellschaft (OMG)

June 16-19, 2005
Second Joint AMS-Deutsche Mathematiker-Vereinigung (DMV) Meeting
Associate secretary: Susan J. Friedlander
Announcement issue of Notices: To be announced
Program first available on AMS website: To be announced
Program issue of electronic Notices: To be announced
Issue of Abstracts: To be announced

Deadlines
For organizers: To be announced
For consideration of contributed papers in Special Sessions:
To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

San Antonio, Texas
Henry B. Gonzalez Convention Center

January 12-15, 2006
Joint Mathematics Meetings, including the 112th Annual Meeting of the AMS, 89th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL).
Associate secretary: John L. Bryant
Announcement issue of Notices: October 2005
Program first available on AMS website: To be announced
Program issue of electronic Notices: January 2006
Issue of Abstracts: To be announced

Deadlines
For organizers: April 12, 2005
For consideration of contributed papers in Special Sessions:
To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

New Orleans, Louisiana
New Orleans Marriott and Sheraton New Orleans Hotel

January 4-7, 2007
Joint Mathematics Meetings, including the 113th Annual meeting of the AMS, 90th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL).
Associate secretary: Susan J. Friedlander
Announcement issue of Notices: October 2006
Program first available on AMS website: To be announced
Program issue of electronic Notices: January 2007
Issue of Abstracts: To be announced

Deadlines
For organizers: April 4, 2006
For consideration of contributed papers in Special Sessions:
To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced
NEW & NOTEWORTHY from Birkhäuser

2002 Ferran Sunyer i Balaguer Prize Winner
Automorphic Pseudodifferential Analysis and Higher-Level Weyl Calculus
A. Unterberger, Université de Reims, France

The main subject of this monograph is the study of automorphic distributions and of the operators associated with such distributions under the Weyl rule of symbolic calculus. The concept of quantization pervades the book: an entirely new approach to composition formulas is presented, and the main lines of a new program in this direction are indicated.

2003 APPROX. 280 PP./HARDCOVER/$98.00 (TENT)
ISBN 3-7643-6909-4
PROGRESS IN MATHEMATICS, VOLUME 209

2002 Ferran Sunyer i Balaguer Prize Winner
Subgroup Growth
A. Iuoritz&i, Hebrew University, Jerusalem, Israel; and D. Segal, All Souls College, Oxford, UK

Subgroup growth is a subject in group theory that has developed into one of the most active areas of research in infinite group theory; this book is a systematic and comprehensive account of the substantial theory that has emerged. A wide range of mathematical disciplines play a significant role in the book: infinite group theory, finite simple groups and permutation groups, profinite groups, arithmetic groups and Strong Approximation, algebraic and analytic number theory, probability, and p-adic model theory. Relevant aspects of such topics are explained in self-contained "windows," making the book accessible to a broad mathematical readership. A list of over sixty challenging open problems is included to stimulate further research in this rapidly growing field.

2003 APPROX. 500 PP./HARDCOVER/$198.00 (TENT)
ISBN 3-7643-6911-6
PROGRESS IN MATHEMATICS, VOLUME 208

Forthcoming!
Torsions of 3-Dimensional Manifolds
V. Turaev, Université Louis Pasteur, Strasbourg, France

This book is concerned with one of the most interesting and important topological invariants of 3-dimensional manifolds based on an original idea of Kurt Reidemeister (1935). This invariant, called the maximal abelian torsion, was introduced by the author in 1976. The book offers a systematic exposition of the theory of maximal abelian torsions of 3-manifolds. Apart from publication in scientific journals, many results are recent and appear here for the first time.

2003 APPROX. 288 PP./HARDCOVER/$79.95 (TENT)
ISBN 3-7643-6911-6
PROGRESS IN MATHEMATICS, VOLUME 208

2001 Ferran Sunyer i Balaguer Prize Winner
The Symmetry Perspective
From Equilibrium to Chaos in Phase Space and Physical Space
M. Golubitsky, University of Houston, TX; and I. Stewart, University of Warwick, UK

The symmetries of a system of nonlinear ordinary or partial differential equations can be used to analyze, predict, and understand general mechanisms of pattern formation. This book applies symmetry methods to increasingly complex kinds of dynamic behavior: equilibria, periodic-doubling, time-periodic states, homoclinic and heteroclinic orbits, and chaos. Examples are drawn from both ODEs and PDEs. In each case the type of dynamical behavior being studied is motivated through applications, drawn from a wide variety of scientific disciplines ranging from theoretical physics to evolutionary biology. An extensive bibliography is provided.

2002/334 PP., 182 ILLUS./HARDCOVER/$99.95
ISBN 3-7643-6609-5
PROGRESS IN MATHEMATICS, VOLUME 200

Homotopy Theoretic Methods in Group Cohomology
W.G. Dwyer, University of Notre Dame, IN; and H.-W. Henn, Université Louis Pasteur, Strasbourg, France

This book studies group cohomology using tools from homotopy theory. The exposition leads the reader from introductory material to the frontiers of current research. The book should also be interesting to anyone who wishes to learn some of the machinery of homotopy theory (simplicial sets, homotopy colimits, Lannes' T-functor, the theory of unstable modules over the Steenrod algebra) by seeing how it is used in a practical setting.

2002/112 PP./SOFTCOVER/$39.95
ISBN 3-7643-6465-2
ADVANCED COURSES IN MATHEMATICS

2002 Ferran Sunyer i Balaguer Prize Winner
Lectures on Algebraic Quantum Groups
K.A. Brown, University of Glasgow, UK; and K.R. Goodearl, University of California, Santa Barbara, CA

This book consists of an expanded set of lectures on algebraic aspects of quantum groups, concentrating on quantized coordinate rings of algebraic groups and spaces, and quantized enveloping algebras of semisimple Lie algebras. The approach, a mixture of introductory textbook, lecture notes, and overview survey, is accessible to a broad audience of graduate students and researchers.

2003/560 PP./SOFTCOVER/$44.95
ISBN 3-7643-6441-9
ADVANCED COURSES IN MATHEMATICS

Fibonacci Numbers
N.N. Vorobiev, (dec.)
Translated by M. Martín, Baker University, Baldwin City, KS

Since their discovery hundreds of years ago, the wondrous properties of Fibonacci numbers have been of great interest. A certain acquaintance with elementary operations and a readiness for mathematical thought are enough to follow the presentation of this work to remarkable mathematical depths. The book is suitable for undergraduate courses on this subject, touching on several mathematical areas along the way. Fibonacci numbers create a fascinating and beautiful world of original problems that many amateurs and professionals find exciting to explore. The book is an invitation to this world.

2003/176 PP./SOFTCOVER/$32.95 (TENT)
ISBN 3-7643-6135-2

Forthcoming!
The Kepler Problem
Group Theoretical Aspects, Regularization and Quantization, with Application to the Study of Perturbation
B. Cordani, Universita degli Studi di Milano, Italy

This book contains a comprehensive treatment of the Kepler problem, i.e., the two-body problem. The first part gives elementary arguments, and the properties of the problem are recovered in a computational way for undergraduate students. In the second part a unifying point of view, originally due to the author, is presented which centers around the intrinsic group-geometric aspects. This part requires more mathematical background, in particular, the basic tools of differential geometry and analytical mechanics used in the book. Later chapters give a geometric description of the perturbation theory of the Kepler problem.

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The Meetings and Conferences section of the Notices gives information on all AMS meetings and conferences approved by press time for this issue. Please refer to the page numbers cited in the table of contents on this page for more detailed information on each event. Invited Speakers and Special Sessions are listed as soon as they are approved by the cognizant program committee; the codes listed are needed for electronic abstract submission. For some meetings the list may be incomplete. Information in this issue may be dated.

Up-to-date meeting and conference information at www.ams.org/meetings/.

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Important Information regarding AMS Meetings

Potential organizers, speakers, and hosts should refer to page 108 in the January 2003 issue of the Notices for general information regarding participation in AMS meetings and conferences.

Abstracts

Several options are available for speakers submitting abstracts, including an easy-to-use interactive Web form. No knowledge of \LaTeX{} is necessary to submit an electronic form, although those who use \LaTeX{} may submit abstracts with such coding, and all math displays and similarly coded material (such as accent marks in text) must be typeset in \LaTeX{}.

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Paper abstract forms may be sent to Meetings & Conferences Department, AMS, P.O. Box 6887, Providence, RI 02940. There is a $20 processing fee for each paper abstract. There is no charge for electronic abstracts. Note that all abstract deadlines are strictly enforced. Close attention should be paid to specified deadlines in this issue. Unfortunately, late abstracts cannot be accommodated.

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J.L. NAZareth, Washington State University, Pullman, WA

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