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Notices

of the American Mathematical Society

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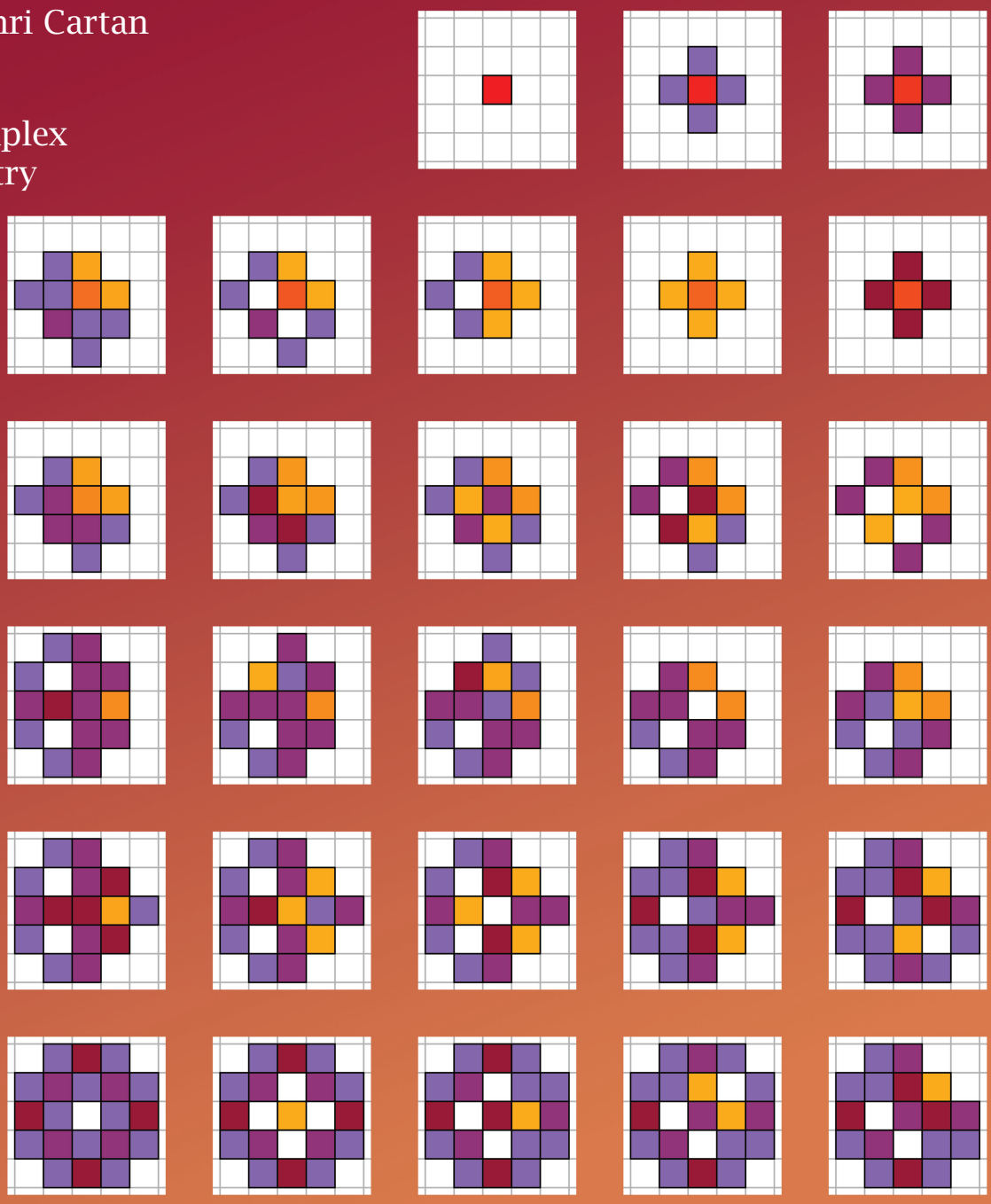

About the Cover: Sandpile
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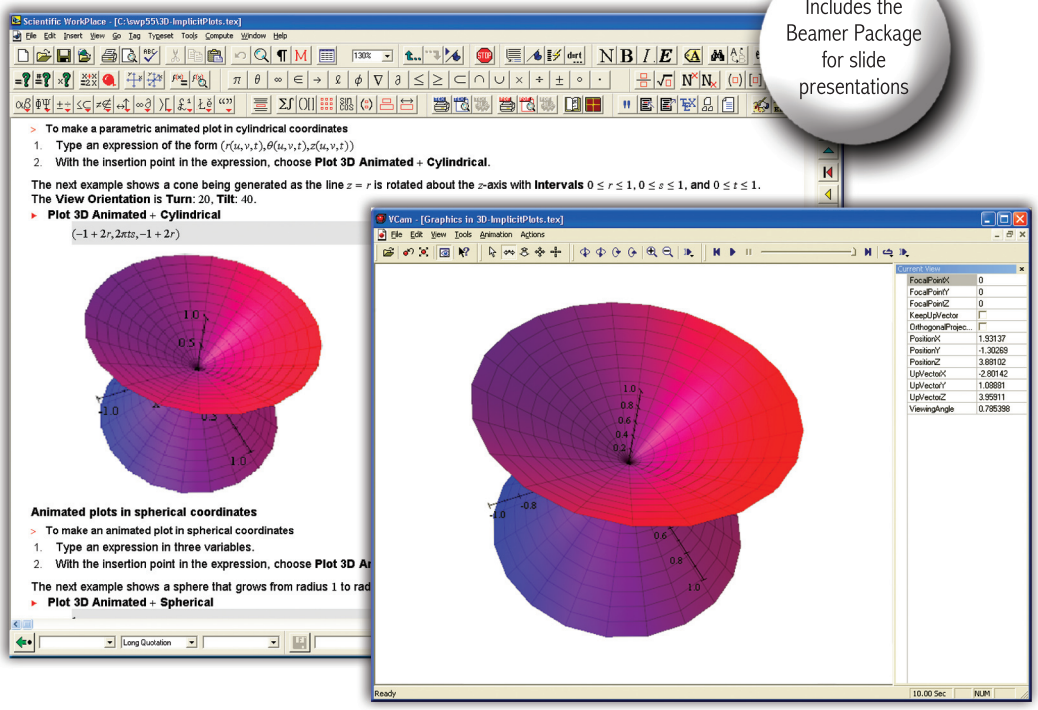

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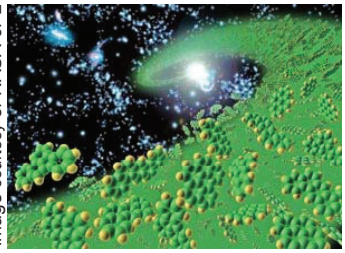

image courtesy of NASA-JPL

INSTITUTE FOR PURE AND APPLIED MATHEMATICS

Los Angeles, California

Navigating Chemical Compound Space for Materials and Bio Design

March 14 – June 17, 2011

ORGANIZING COMMITTEE: Jean-Loup Faulon (Université d'Évry-Val d'Essonne), **William Hart** (Sandia National Labs), **Kendall Houk** (UCLA), **Peter Jones** (Yale), **Steven Lustig** (DuPont), **Tamar Seideman** (Northwestern), **Mark Tuckerman** (NYU), **Anatole von Lilienfeld** (Sandia National Labs)

Scientific Overview

Chemical compound space (CCS) is the combinatorial set which encompasses all chemical compounds. It can be viewed as the high dimensional space spanned by all the possible stoichiometries and configurations of electrons and atomic nuclei which form molecular or condensed matter. Due to the combinatorial nature of CCS, systematic screening for interesting properties or even simple enumeration is beyond any computational capacity. But CCS provides a natural framework in which to construct rigorous mathematical tools for the development of direct and inverse quantitative structure-property relationships, which can be applied to challenges in Materials and Bio design. Diverse scientific areas are involved, which benefit from historically grown experimental insights as well as advances made in theoretical and computational sciences. They include statistical mechanics, liquid and solid state physics, quantum chemistry, graph theory, molecular physics, condensed matter physics, optimization algorithms, data mining, statistical analysis, and others.

Workshop Schedule

- Chemical Compound Space Tutorials, March 15-18, 2011
- Workshop 1: Design of Drugs and Chemicals that Influence Biology, April 4-8, 2011
- Workshop 2: Optimization, Search and Graph-Theoretical Algorithms for Chemical Compound Space, April 11-15, 2011
- Workshop 3: Materials Design in Chemical Compound Space, May 2-6, 2011
- Workshop 4: Physical Frameworks for Sampling Chemical Compound Space, May 16-20, 2011
- Culminating Workshop at Lake Arrowhead Conference Center, June 12-17, 2011

Participation

This long program will bring together senior as well as junior researchers of diverse scientific communities, which are involved in addressing the question of how to best navigate CCS, such that they can discuss current bottlenecks with each other and, in particular, with the applied mathematics community. It is expected lead to fruitful collaborations where all participants benefit largely from mathematical insights on their specific optimization and design problems.

Full and partial support for long-term participants is available. We are especially interested in applicants who intend to participate in the entire program, but will consider applications for shorter periods. Funding is available to participants at all academic levels, though recent PhDs, graduate students, and researchers in the early stages of their careers are especially encouraged to apply. Encouraging the careers of women and minority mathematicians and scientists is an important component of IPAM's mission and we welcome their applications. More information and a link to an application are available online.

www.ipam.ucla.edu/programs/ccs2011

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New and Forthcoming

BIRKHÄUSER

Classical Mechanics

Theory and Mathematical Modeling

E. DiBenedetto, Vanderbilt University, Nashville, TN, USA

This textbook covers standard topics of a mechanics course, namely, the mechanics of rigid bodies, Lagrangian and Hamiltonian formalism, stability and small oscillations, an introduction to celestial mechanics, and Hamilton – Jacobi theory. Using a pedagogical approach, the author covers many topics that are gradually developed and motivated by classical examples. Beautiful illustrations, unique examples, and useful remarks are key features throughout the text. Prerequisites include a working knowledge of linear algebra, multivariate calculus, the basic theory of ordinary differential equations, and elementary physics.

HARDCOVER
2010. XX, 350 P. 63 ILLUS.
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ISBN: 978-0-8176-4526-7
CORNERSTONES

Distributions

Theory and Applications

J.J. Duistermaat, J.A.C. Kolk,
Mathematical Institute, Utrecht University, The Netherlands

This textbook is an application-oriented introduction to the theory of distributions, a powerful tool used in mathematical analysis. The treatment emphasizes applications that relate distributions to linear partial differential equations and Fourier analysis problems found in mechanics, optics, quantum mechanics, quantum field theory, and signal analysis. The book is motivated by many exercises, hints, and solutions that guide the reader along a path requiring only a minimal mathematical background.

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2010. XVI, 446 P. 41 ILLUS.,
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CORNERSTONES

Ramsey Theory

Yesterday, Today, and Tomorrow

A. Soifer, University of Colorado, Colorado Springs, CO, USA (Ed.)

This book explores the theory's history, recent developments, and some promising future directions through invited surveys written by prominent researchers in the field. The first three surveys provide historical background on the subject; the last three address Euclidean Ramsey theory and related coloring problems. In addition, open problems posed throughout the volume and in the concluding open problem chapter will appeal to graduate students and mathematicians alike.

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PROGRESS IN MATHEMATICS, VOLUME 285

A Basis Theory Primer

Expanded Edition

C. Heil, Georgia Institute of Technology, Atlanta, GA, USA

This textbook is a self-contained introduction to the abstract theory of bases and redundant frame expansions and their use in both applied and classical harmonic analysis. The four parts of the text take the reader from classical functional analysis and basis theory to modern time-frequency and wavelet theory.
Extensive exercises complement the text and provide opportunities for learning-by-doing, making the text suitable for graduate-level courses. The self-contained presentation with clear proofs is accessible to graduate students, pure and applied mathematicians, and engineers interested in the mathematical underpinnings of applications.

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APPLIED AND NUMERICAL HARMONIC ANALYSIS

A Modern Approach to Functional Integration

J. R. Klauder, University of Florida, Gainesville, FL, USA

This text takes advantage of recent developments in the theory of path integration and attempts to make a major paradigm shift in how the art of functional integration is practiced. The techniques developed will prove valuable to graduate students and researchers in physics, chemistry, mathematical physics, and applied mathematics who find it necessary to deal with solutions to wave equations, both quantum and beyond. **A Modern Approach to Functional Integration** offers insight into contemporary research topics, which may lead to improved methods and results that cannot be found elsewhere. Exercises are included in most chapters, making the book suitable for a one-semester graduate course on functional integration.

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Lattice Theory: Foundation

G. Grätzer, University of Manitoba, Winnipeg, Canada

Based on three previous publications on the subject, this updated new edition covers the key concepts and results in the field. The main topics are distributivity, congruences, constructions, modularity and semimodularity, varieties, and free products.

Review of the Previous Edition

"….Grätzer's 'General Lattice Theory' has become the lattice theorist's bible. Now… we have the second edition, in which the old testament is augmented by a new testament…. The new testament gospel is provided by leading and acknowledged experts in their fields…. This is an excellent and engaging second edition that will long remain a standard reference."

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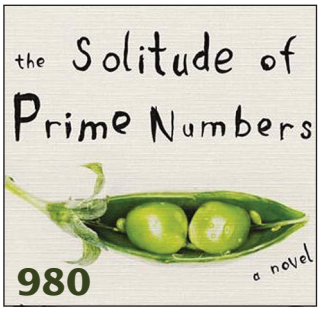

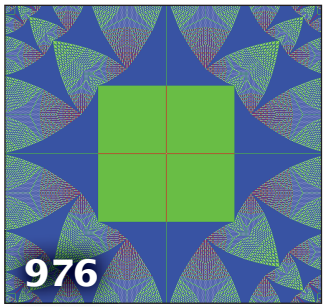

Features

A Tribute to Henri Cartan

Luc Illusie and Pierre Cartier, Coordinating Editors

Henri Cartan was a towering figure in twentieth-century mathematics. The son of distinguished mathematician Élie Cartan, Henri Cartan charted his own course in several complex variables and complex geometry. He was also a great humanitarian and a powerful force in the lives of those around him. He lived to be well over one hundred years old—a long and impressive life. He will certainly be missed.

—Steven G. Krantz
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Notices

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I thank Randi D. Ruden for her splendid editorial work, and for helping to assemble this issue. She is essential to everything that I do.

—Steven G. Krantz
Editor

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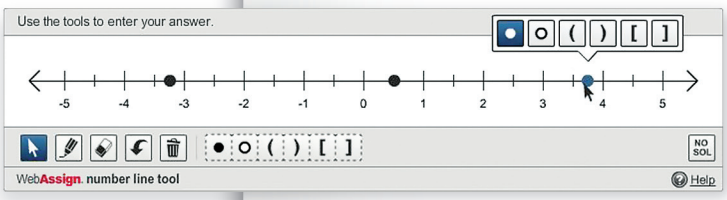

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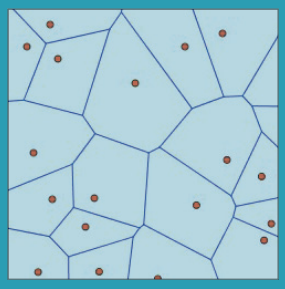

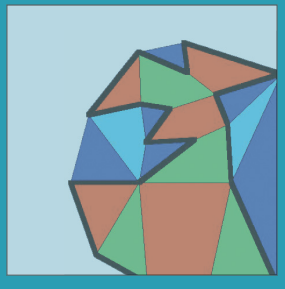

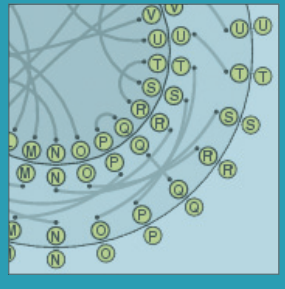

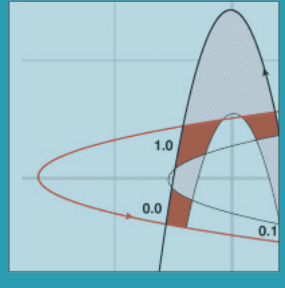

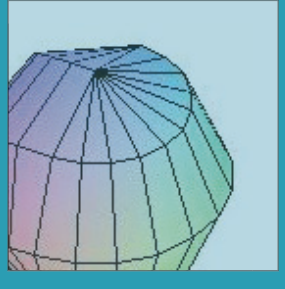

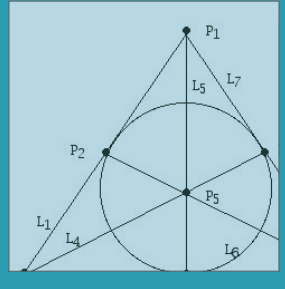

THE FEATURE COLUMN

monthly essays on mathematical topics

www.ams.org/featurecolumn

Each month, the Feature Column provides an online in-depth look at a mathematical topic. Complete with graphics, links, and references, the columns cover a wide spectrum of mathematics and its applications, often including historical figures and their contributions. The authors—David Austin, Bill Casselman, Joe Malkevitch, and Tony Phillips—share their excitement about developments in mathematics.

Recent essays include:

Marian Rejewski and the First Break into Enigma

A Non-Commutative Marriage System in the South Pacific

School Choice

We Recommend a Singular Value Decomposition

How Much Longer Can This Go On?

Simon Newcomb and "Natural Numbers" (Benford's Law)

Mathematics and Climate

No Static at All: Frequency modulation and music synthesis

The Mathematics of Rainbows

People Making a Difference

Trees, Teeth, and Time: The mathematics of clock making

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The Sky Is Not Falling, It's Just Shifting

Two recent articles (*Notices*, January and April 2009) have addressed the question of whether "the sky is falling". This refers to the fact that mathematics enrollments in four-year colleges and universities have been flat or declining since 1985 and dropping sharply as a percentage of overall enrollments. It is noted in these articles that there is a very large and growing number of high school students studying calculus, including the 300,000 per year who now take the AP calculus exam. It is also noted that college statistics enrollments are growing rapidly (CBMS 2005, page 3).

Our experience in mathematics at the University of Nebraska at Omaha, a comprehensive university with about 15,000 students, is different. Statistics is included in the Mathematics Department but comprises less than 10% of enrollments. Our total departmental enrollments are growing rapidly:

Ten-year increase in student credit hour production in mathematics at UNO

Year	Mathematics	UNO
1999–2000	15,313	260, 020
2009–2010	22,235	310,785
percentage increase	45%	20%

We are very much aware of the growth trends in high school calculus and college statistics referred to above. We respond by embracing these trends. Seven years ago we started a dual enrollment program in calculus with area high schools which continues to grow every year. More and more of these DE calculus students are enrolling at UNO and successfully taking follow-up math courses. A secondary benefit is our growing relationship with high school calculus teachers in the Omaha area, with whom we now hold joint workshops. We use DE tuition funds to give scholarships to high school teachers to work on a master's degree in our department in order to qualify to teach AP and DE calculus. We employ many of these same high school teachers as part-time instructors.

At least one-third of our majors are following an actuarial or related statistical track. Only four of our seventeen Ph.D. faculty are statisticians and we need more. Our statisticians are in great demand to give independent studies to our majors. Of the new courses created in recent years, most are at least somewhat statistical in nature. Consider the following additional valuable contributions made by the small number of statistics faculty:

- For our most difficult required course for undergraduate majors, "Introduction to Analysis", two of the most popular and successful instructors are statisticians, who use analysis in their own research.

- Our newest, and pretenured, statistician has organized an undergraduate colloquium series with such talks as "The Use and Misuse of Statistics in the Real World", "How to Get a Good Night's Sleep (Cure for Mathematical Insomniacs)", and "Magic and Mathematics". These colloquia are attracting large audiences of students, especially from our calculus-level courses.

Here are some other recent outreach-related developments in our department:

- Our senior-level course in number theory has become "Number Theory and Cryptography" and has thereby increased its enrollments by appealing to more computer science majors.

- One of our graduate students is the vice president of risk management for a national energy development company. He wants to deepen his understanding of analysis, which he uses in his work. He recently gave a talk to our math club on financial mathematics. As a result of this talk two of our undergraduate majors now have internships at his company. His talk also generated interest in having a course in financial mathematics, which was offered for the first time in Spring 2010.

- A program in biomechanics on the UNO campus sends so many students to our graduate course "Dynamical Systems and Chaos" that we are able to justify offering this course every year. Our willingness to serve this student audience has now led to the development of a follow-up course in nonlinear time series.

- There is growing interest in online instruction in mathematics at UNO. Already we offer intermediate algebra, college algebra, trigonometry, calculus I, discrete mathematics, and applied linear algebra totally online. We are experimenting with operations research, numerical methods, and partial differential equations hybrid online.

Conclusion: national data suggest a growing interest in mathematics, broadly construed, among American high school and college students. There really are many opportunities for growth in the mathematics curriculum. Yes, we have favorable demographics at UNO. But many other schools and locations have their own natural advantages and could adopt similar strategies.

—Jack Heidel, chair
Department of Mathematics, UNO
jheidel@unomaha.edu

Papanicolaou Received the First William Benter Prize in Applied Mathematics

George Papanicolaou

City University of Hong Kong (CityU) has awarded the first William Benter Prize in Applied Mathematics, a newly launched international award in the field, to George C. Papanicolaou, Robert Grimmett Professor of Mathematics at Stanford University, in recognition of his exceptional contributions across a wide spectrum of research areas in applied mathematics.

George Papanicolaou, an internationally acclaimed mathematician, has devoted his research career to bridging theoretical research and applied problems in areas including multi-scale and stochastic analysis, fluid dynamics, electrodynamics and, more recently, imaging analysis and financial applications, advancing the understanding of a vast range of phenomena.

The William Benter Prize in Applied Mathematics was established by the Liu Bie Ju Centre for Mathematical Sciences at the City University of Hong Kong in honor of Mr. William Benter for his dedication and generous support to the enhancement of the University's strength in mathematics research. The Prize is a biennial award that carries a cash prize of US$100,000 and aims to recognise outstanding mathematical contributions that have a direct and fundamental impact on scientific, business, finance, and engineering applications.

The Prize was presented to Professor George Papanicolaou by Mr. William Benter, its donor, at the opening ceremony of the International Conference on Applied Mathematics, organised by the Liu Bie Ju Centre for Mathematical Sciences at CityU on 7 June 2010.

Biographical Sketch

Professor George C. Papanicolaou was born on January 23, 1943 in Athens, Greece. He obtained his bachelor's degree in engineering in 1965 from Union College in Schenectady, New York, and his master's degree (1967) and PhD degree (1969) in Mathematics from the Courant Institute at New York University, where he began his career as an Assistant Professor in 1969. He became a full Professor in 1976 and was appointed Director of the Division of Wave Propagation and Applied Mathematics in 1979. In 1993, he joined Stanford University, and became the Robert Grimmett Professor of Mathematics in 1997. He is a Member of the U.S. National Academy of Sciences and won the SIAM von Neumann Prize in 2006.

Citation

Over the past 40 years, Papanicolaou has made many fundamental contributions in developing and applying multi-scale and stochastic techniques to a wide array of emerging scientific problems ranging from geophysics, materials science, fluid dynamics, imaging process, to finance. He has always been interested in modeling volatility in markets and the effects on derivatives. Since the financial crisis, he has become more conscious of the importance of risk assessment in various aspects of financial modeling.

In recent years, Papanicolaou has made pioneering contributions in developing innovative mathematical analysis for the emerging field of time-reversal imaging in heterogeneous random media and actively exploring its wide range of applications from imaging analysis to communications. This line of research has generated a great deal of interest in both mathematics and the broad scientific community. Papanicolaou has also made many other outstanding contributions, which include the dynamic rescaling method to study singularity formation in focusing nonlinear Schrödinger equations, convection of microstructures in incompressible flows, new variational methods for turbulent transport, bounds on effective properties of composite materials, and homogenization theory for random elliptic systems.

— News release from City University of Hong Kong

Letters to the Editor

Ethics and the Plagiarized Teaching Statement

This letter concerns the article "Awareness of ethical pitfalls… " in the April 2010 issue of the *Notices*.

In my view the big ethical problem here is that it is unethical to demand a teaching statement from young graduates who clearly have only little or no teaching experience. Requesting this statement means requesting a lie; it is then secondary whether this lie is fabricated by using one's fantasy; by asking older friends, relatives, or teachers for help; or by copying something from the Internet.

Apart from favoring applicants who have relatives in the teaching profession whose help they can enlist, the only qualifications that this statement can possibly measure are the willingness to faithfully complete a meaningless task and the ability to write an essay on a topic about which one has little knowledge—a cynic might say that these are indeed important qualifications in modern academic life, but I think one shouldn't base hiring decisions on them. The key phrase in the article is for me "selling oneself as a job candidate": We shouldn't try to hire a gifted salesperson but an able mathematician.

In fact, thinking about it, I come to believe that the best answer to this request is what happened in the reported case: To send the hiring committee the teaching statement of one of its members, thereby exposing the absurdity of the process. It is sad that the only reply that our academic system comes up with is activation of "the internal process for penalizing the ethical violation" instead of a hearty laugh and some self-critical thoughts about what we are doing.

—Rainer Schulze-Pillot
Universität des Saarlandes,
Saarbrueken, Germany
schulzep@math.uni-sb.de

(Received June 8, 2010)

Submitting Letters to the Editor

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A Tribute to Henri Cartan

This collection of articles paying tribute to the mathematician Henri Cartan was assembled and edited by Pierre Cartier, IHÉS, and Luc Illusie, Université Paris-Sud 11, in consultation with Jean-Pierre Serre, Collège de France. The collection begins with the present introductory article, which provides an overview of Cartan's work and a short contribution by Michael Atiyah. This overview is followed by three additional articles, each of which focuses on a particular aspect of Cartan's rich life.

—Steven G. Krantz

Jean-Pierre Serre

Henri Cartan
8 July 1904–13 August 2008

Henri Cartan was, for many of the younger generation, the symbol of the resurgence of French mathematics after World War II. He died in 2008 at the age of 104 years.

Personal Life

Henri was the eldest son of the mathematician Élie Cartan (1869–1951), born in Dolomieu (Isère), and of his wife Marie-Louise Bianconi, of Corsican origin.

Born in Nancy in 1904, he entered the École Normale Supérieure (ENS, 45 rue d'Ulm) in 1923. It was there that he forged the friendships with mathematicians who were to play a major role in his life, beginning with André Weil, who had entered the ENS a year before; others included Jean Dieudonné, Jean Delsarte, René de Possel, and Charles Ehresmann. He left the ENS in 1926, supported by a grant until the completion of his thesis in 1928, and briefly became a teacher at the Lycée Malherbe de Caen. He was then appointed to positions at the University of Lille and subsequently the University of Strasbourg, where he taught from 1931 to 1939. The year 1935 was a particular high point of both his professional and his personal life: with his friends Weil, Dieudonné, de Possel, and others, he founded the Bourbaki group, which he left only at the statutory age of fifty years; and he married the young and charming Nicole Weiss, daughter of one of his physics colleagues at Strasbourg University. This happy marriage, which lasted until his death (followed, a few months later, by that of his wife), produced five children: Jean, Françoise, Étienne, Mireille, and Suzanne.

In September 1939, at the beginning of the war, he moved to Clermont-Ferrand, where the University of Strasbourg had been evacuated. A year later he got a chair at the Sorbonne, where he was given the task of teaching the students of the ENS. This was a providential choice that allowed the "normaliens" (and many others) to benefit for more than twenty-five years (1940–1965) from his courses and seminars. In fact there was a two-year interruption when he returned to Strasbourg from 1945 to 1947—alas for me, because I was then a student at the ENS and could not make his acquaintance until my final year.

He left the ENS in 1965 and, a few years later, to escape the internal disputes between the component parts (Paris VI and Paris VII) of the former Sorbonne, he accepted a chair at Orsay, where he taught until his retirement in 1975. A lecture theatre in the mathematics building has recently been named after him.

Further details on the life of Henri Cartan can be found in two interviews (Schmidt 1990, Jackson 1999).

Mathematical Work

Henri Cartan worked on many subjects but there was one to which he was particularly attached, and that was the theory of functions of several complex variables (which later became the theory of complex varieties and also "analytic geometry"). I will begin with this topic.

His thesis ([Oe], no. 3)[1] dealt with analytic functions of one variable, one of the most popular topics of the period in France. Cartan continued the work of André Bloch and Rolf Nevanlinna,

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[1] *References in this form refer to the bibliography at the end of the text.*

studying in particular the properties of analytic curves in complex projective spaces of any dimension (for example, curves not meeting a given family of hyperplanes). This sort of topic was highly fashionable at the time, but it became less so in later years (despite the work of Lars Ahlfors and H. and J. Weyl). It finally came back into the limelight thanks to the work of Shoshichi Kobayashi on hyperbolic manifolds (1970–1980) (see Demailly 1997) and also to that of Paul Vojta (around 1980), who created an astonishing dictionary relating Nevanlinna invariants to the heights of rational points on algebraic varieties.

Shortly after writing his thesis, his eyes were opened, by Weil, to the charms of functions of several complex variables. Cartan was definitely seduced by this new field. Between 1930 and 1940 he published many articles in collaboration with the German school (Heinrich Behnke and Peter Thullen), with whom he made great bonds of friendship that withstood World War II. A summary can be found in [An], sections 2–5. In particular, we can note the following:

- the introduction in ([Oe], no. 23), with Thullen, of the notion of "convexity" relative to a family of holomorphic functions.

- the following result ([Oe], no. 32), related to the work of Élie Cartan: the group of automorphisms of a bounded domain in $\mathbf{C}^n$ is a real Lie group, and the subgroup that fixes a point is compact and embeds into $\mathbf{GL}(n,\mathbf{C})$.

Starting in 1940 it was the "Cousin problems" that attracted him most ([An], section 6). This involves the construction of functions whose local singularities (additive or multiplicative) are given. Is this possible, and if not what are the conditions that need to be met? The problem is reasonable only if one works in a domain of holomorphy, which is what Cartan assumes. He gets very close to his aim, thanks to a theorem on invertible holomorphic matrices ([Oe], no. 35), but he lacked two auxiliary results (which he later interpreted as statements of "coherence"). It was the Japanese mathematician K. Oka who proved the first of these two results. He published the proof and sent it to Cartan, who immediately saw how the same methods led at once to the second result ([Oe], nos. 36 and 38). The first Cousin problem was thereby solved, at least for domains of holomorphy.

The second Cousin problem, in contrast, does not always have a solution. There are obstructions of a topological nature: the problem should have continuous solutions (a minimal requirement if one is searching for holomorphic solutions). How can one concretely exhibit these obstructions and, moreover, show that there are no others? I suppose (I never thought of asking him) that this was one of the reasons[2] that led Cartan to become interested in algebraic topology around 1945–1950. There were some striking analogies—for those who could see them—between certain concepts introduced by Oka (the "ideals of indeterminate domains") and the theory of sheaves, which was being created by Jean Leray. In his first seminars at the ENS (1948–1951), Cartan took up Leray's theory in a slightly modified form that was easier to use. In a subsequent seminar (1951/1952) he reaped the fruits of his labors. He began by clarifying the notion of "coherence", implicit in Oka's work, defined "coherent analytic sheaves", and proved a vast generalization of the Cousin-type theorems: the famous "Theorems A and B".

Henri Cartan, at his home desk in Paris, 1961.

The stronger statement is "Theorem B", which says that the higher cohomology groups of a coherent analytic sheaf are zero; in other words that every reasonable problem (of additive type) has a solution (provided the underlying manifold is a "Stein manifold", the natural generalization of a domain of holomorphy).

Theorems A and B are very powerful tools. Cartan and I described several applications of them in a colloquium in Brussels in 1952; apparently these theorems made a strong impression on the participants because one of them (a German) said to his neighbor, "The French have tanks (Panzern); we only have bows and arrows" (see Remmert 1995). Indeed the idea of applying the (algebro-topological) theory of sheaves to objects relevant to analysis (holomorphic functions) was a new idea; it was used later in many other situations (for example, solutions of partial differential equations) and has now become standard.

Another original idea of Cartan (now equally standard) was that, developed in the 1953/1954 seminar, of defining a complex analytic space (possibly with singularities) as a topological space

[2] *Another reason may have been the translation by Weil of the Cousin problems in terms of holomorphic fiber bundles with additive structure group (for the first problem) and multiplicative structure group (for the second problem)—see ([Oe], no. 39, section 5).*

endowed with a sheaf of rings. For Cartan this sheaf was a sub-sheaf of the sheaf of continuous functions; Grauert-Remmert and Grothendieck showed a little later that it was better not to make such a hypothesis so as to allow nilpotent elements.

In subsequent years Cartan never lost interest in functions of several complex variables. He took great pleasure in expounding in Bourbaki seminars the works in this area of other mathematicians, notably those of Hirzebruch (exposé 84), of Grauert (exposé 115), of Douady (exposé 296) and of Ramis (exposé 354).

Nicole and Henri Cartan, Paris,

Let us now change the subject slightly and turn to topology. I have already mentioned the expository talks, clarifying sheaf theory, in the seminars of 1948/1949 and 1950/1951. He had done something similar for fiber spaces in the seminar of 1949/1950. Other results: the spectral sequence giving the cohomology of a Galois covering (with J. Leray), the method of "killing homotopy groups" (with me), and the study of the real cohomology of principal fiber bundles of Lie groups (with Chevalley, Koszul, and Weil). However, his most original contribution to topology was without doubt the long series of lectures in the 1954/1955 seminar (reproduced in [Oe], no. 93), where he determined the homology of the Eilenberg-Mac Lane complexes ("which required great efforts", as he said in an interview in 1982—I can readily believe it). This work is now classified not as part of topology but as part of what is called "homological algebra", a terminology introduced by Cartan and Eilenberg in their book with that title ([CE], completed in 1953 but only published in 1956). A "fundamental" book in the precise sense of that term, it collected scattered results and organized them in a systematic way, transforming them into an instrument of great power.

Cartan also worked on other subjects, which I will simply mention:

- Classes of infinitely differentiable real functions (with S. Mandelbrojt) ([Oe], nos. 63–68);
- General topology: introduction of the notion of a filter ([Oe], nos. 61 and 62) and construction of the Haar measure ([Oe], no. 69);
- Potential theory ([Oe], nos. 70–75 and 84); see the report by J. Deny (1975);
- Harmonic analysis (with R. Godement ([Oe], no. 80);
- Real analytic spaces (with F. Bruhat) ([Oe], p. XVI; [Oe], nos. 45–46).

Cartan's Influence

One cannot reduce the influence of Cartan to a mere list of the theorems he proved. He did much more than that. As I said at the outset, Cartan represented (both in France and abroad) the revival of mathematics in France after World War II. How did this come about? It is difficult to answer precisely. There were several factors, among which were the following.

- The large numbers of students whom he trained (in chronological order: Deny, Koszul, Godement, Thom, myself, Cerf, Douady, Karoubi, and several others); he did not give them a research topic (believing, no doubt, that a mathematician who does not ask himself questions is not a real mathematician), but once they had started he helped them to prove their results, to clarify them, and to write them up properly. This took him on occasion much time (I am thinking in particular of a certain thesis in topology on which he—and I—spent many hours). But the pupil learned much.
- Another reason for his influence: the Cartan Seminars. I have mentioned several above. There were sixteen of them (from 1948 to 1964), and all except one (that of 1952/1953) have been written up; a summary can be found in Serre (1975). What made these seminars original and interesting was that they started from scratch and gave essentially complete proofs; despite this, at the end of the year (and after some twenty lectures) they culminated in interesting and occasionally novel results. Many mathematicians, French and foreign, learned their topology or their functions of several complex variables from these seminars.[3]

[3] *The Cartan Seminars had a predecessor: the "Séminaire Julia", organized between 1935 and 1938 by Weil, Chevalley, Cartan and others. Here also there was an annual theme (such as class field theory, Hilbert spaces, the work of Élie Cartan, …) and the lectures were written up. And there was a successor: the impressive "Séminaire de Géométrie Algébrique" of Grothendieck at the Institut des Hautes Études Scientifiques (1960–1969), where the proofs were even more complete—if I may say so—and the results even more novel. Since 1970, mathematical seminars have multiplied, in France as elsewhere, but none, to my knowledge, has tried to follow the difficult model of Julia-Cartan-Grothendieck: one settles for inviting, week after week, a lecturer who presents (usually without proofs) his latest results, and then discusses them with specialists. This is not the same thing.*

• Going beyond his own mathematics, I should mention the efforts that Cartan made to improve relations between French and German mathematicians after World War II. He was also active, with L. Schwartz and M. Broué, in the "Comité des Mathématiciens" that came to the aid of mathematicians imprisoned for political reasons in various countries (notably in the USSR), for example L. Pliouchtch, A. Chtcharanski, A. Chikhanovitch, and L. Massera.

Distinctions

Henri Cartan was a member of the Académie des Sciences de Paris and of several Academies in Germany, Belgium, Denmark, Spain, Finland, Italy, Japan, Poland, Russia, Sweden, and the United States. He was also an honorary member of the London Mathematical Society and a Foreign Member of the Royal Society of London.

He had honorary degrees from ETH (Zürich), Athens, Cambridge, Münster, Oslo, Oxford, Saragossa, Stockholm, and Sussex.

In France he had received the Gold Medal of the Centre National de la Recherche Scientifique in 1976 and he was Commandeur des Palmes Académiques, Grand Officier de l'Ordre National du Mérite, and Commandeur de la Légion d'Honneur.

He received the Wolf Prize in 1980 and the Heinz R. Pagels Human Rights of Scientists Award in 1989.

He had been president of the French Mathematical Society (1950) and of the International Mathematical Union (1966–1970). He had also been president (and subsequently honorary president) of the Mouvement Fédéraliste Européen (1974–1985).

Michael Atiyah

I got to know Cartan mainly through serving with him on the Executive Committee of the International Mathematical Union. This gave me a chance to see him operate on the international scene. By then he was an elder statesman, and he looked the part, always impeccably dressed in a style that one associates with earlier periods. But this formality hid a charming and friendly personality, and the twenty-five years that separated us were no barrier to our friendship.

I first met Cartan at a conference in Mexico in 1956, and, although he was then over fifty, I was struck by his restless intellectual energy. During the lectures his eyes were alarmingly alert; he seemed to be on the verge of springing from his seat with impatience at the slow pace of the

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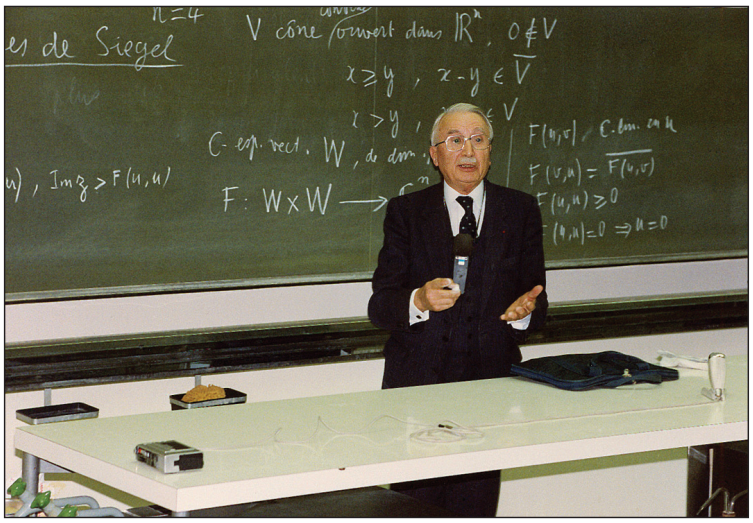

Henri Cartan, Freiburg, March 13, 1987.

lecturer. But he was never aggressive or rude, just interested and enthusiastic. I can only imagine what a live wire he would have been twenty years earlier.

I was very pleased when in 1973 Oxford gave him an honorary degree. The public orator in his (Latin) speech referred (as Serre has done) to the important role played by Cartan in maintaining links with German mathematicians after 1945. He also mentioned the fact that a younger brother of Henri, a talented composer who died young, had one of his compositions played in a prewar concert in the same theater (the Sheldonian) where Henri received his honorary degree.

My last memory of Cartan is of his attending a lecture of mine in Paris when he was at a very advanced age and seriously infirm. It was a touching symbol, both of his friendship and of his dedication to mathematics.

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1948/49 Topologie algébrique

1949/50 Espaces fibrés et homotopie

1950/1951 Cohomologie des groupes, suites spectrales, faisceaux

1951/1952 Fonctions analytiques de plusieurs variables complexes

1952/1953 Groupes d'homotopie (unwritten)

1953/1954 Fonctions automorphes et espaces analytiques

1954/1955 Algèbres d'Eilenberg-Mac Lane et homotopie

1955/1956 (with C. Chevalley) Géométrie algébrique

1956/1957 Quelques questions de topologie

1957/1958 (with R. Godement and I. Satake) Fonctions automorphes

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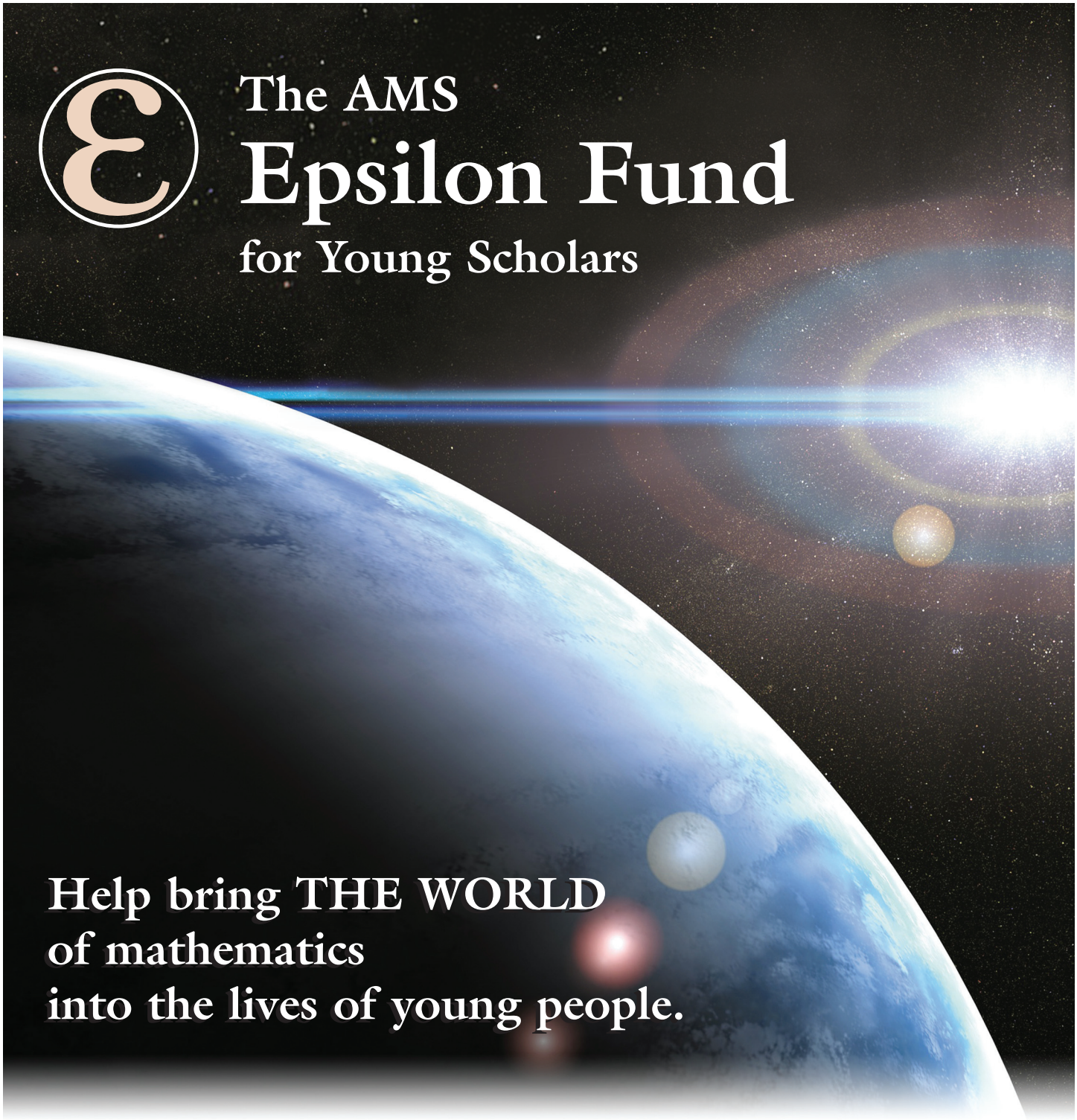

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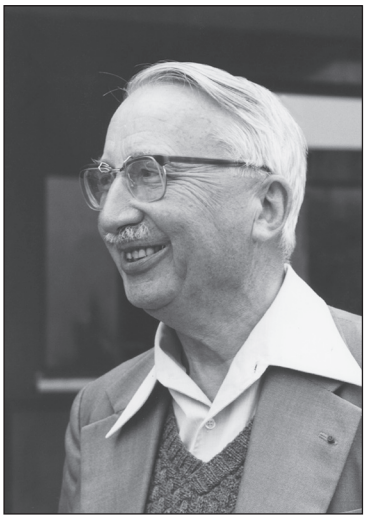
09/04

Cartan and Complex Analytic Geometry

Jean-Pierre Demailly

On the Mathematical Heritage of Henri Cartan

Henri Cartan left us on August 13, 2008, at the age of 104. His influence on generations of mathematicians worldwide has been considerable. In France especially, his role as a professor at École Normale Supérieure in Paris between 1940 and 1965 led him to supervise the Ph.D. theses of Jean-Pierre Serre (Fields Medal 1954), René Thom (Fields Medal 1958), and many other prominent mathematicians such as Pierre Cartier, Jean Cerf, Adrien Douady, Roger Godement, Max Karoubi, and Jean-Louis Koszul.



Henri Cartan at Oberwolfach, September 3, 1981.

However, rather than rewriting history that is well known to many people, I would like here to share lesser known facts about his career and work, especially those related to parts I have been involved with. It is actually quite surprising, in spite of the fact that I was born more than half a century later, how present Henri Cartan still was during my studies. My first mathematical encounter with Cartan was when I was about twelve, in 1969. In the earlier years, my father had been an elementary school teacher and had decided to go back to Lille University to try to become a math teacher in secondary education; there was a strong national effort in France to recruit teachers, due to the much increased access of pupils and students to higher education, along with a strong research effort in technology and science. I remember quite well that my father had a book with a mysterious title: *Théorie Élémentaire des Fonctions Analytiques d'une ou Plusieurs Variables Complexes* (Hermann, 4th edition from 1961) [Ca3], by Henri Cartan, which contained magical stuff such as contour integrals and residues. I could then, of course, not understand much of it, but my father was quite absorbed with the book; I was equally impressed by the photograph of Cartan on the cover pages and by the style of the contents, which had obvious similarity to the "New Math" we started being taught at school—namely set theory and symbols like $\cup, \cap, \in, \subset, \ldots$ My father explained to me that Henri Cartan was one of the leading French mathematicians and that he was one of the founding members of the somewhat secretive Bourbaki group, which had been the source of inspiration for the new symbolism and for the reform of education. In France, the leader of the reform commission was A. Lichnerowicz, at least as far as mathematics was concerned, and I got myself involved with the new curriculum in grade ten in 1970. Although overly zealous promoters of the "New Math" made the reform fail less than fifteen years later, for instance by pushing abstract set theory even down to kindergarten—a failure which resulted in very bad counter-reforms around 1985—I would like to testify that in spite of harsh criticism sometimes geared toward the reform, what we were taught appeared well thought out, quite rigorous, and even very exciting. In the rather modest high school I was frequenting at the time, the large majority of my fellows in the science class were certainly enjoying the menu and taking a large benefit. The disaster came only later,

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from the great excess of reforms applied at earlier stages of education.

In any case, my father left me from that period three books by Henri Cartan, namely the one already described and two other textbooks: *Differential Calculus* and *Differential Forms* [Ca4] (also by Hermann, Paris), which I never ceased using. These books are still widely used and are certainly among the primary references for the courses I have been delivering at the University of Grenoble since 1983. I find it actually quite remarkable that French secondary school teachers of the 1960–90 era could be taught mathematics in the profound textbooks by such mathematicians as Cartan, Dieudonné, or Serre, especially in comparison with the general evolution of education in the last two or three decades in France, and other Western countries as well, about which it seems that one cannot be so optimistic….

In 1975 I entered École Normale Supérieure in Paris, and although Henri Cartan had left the École ten years earlier, he was still very much in the background when I began learning holomorphic functions of one variable. His role was eminently stressed in the course proposed to first-year students by Michel Hervé, who made great efforts to introduce sheaves to us, for example, as a means to explain analytic continuation and the maximal domain of existence of a germ of a holomorphic function.

Two years later I started a Ph.D. thesis under the supervision of Henri Skoda in Paris, and it is only at this period that I began realizing the full extent of Cartan's contributions to mathematics, in particular those on the theory of coherent analytic sheaves and his fundamental work in homological algebra and in algebraic topology [CE, CS1]. Taking part of its inspiration from J. Leray's ideas and from the important work of K. Oka in Japan, the celebrated Cartan seminar [Ca2] ran from 1948 to 1964, and as an outcome of the work by its participants, especially H. Cartan, J.-P. Serre, and A. Grothendieck, many results concerning topology and holomorphic functions of several variables received their final modern formulation. One should mention especially the proof of the coherence of the ring of holomorphic functions $\mathcal{O}_X$ in an arbitrary number of variables, after ideas of Oka, and the coherence of the ideal sheaf of an analytic set proved by Cartan in 1950. Another important result is the coherence of the sheaf of weakly holomorphic meromorphic functions, which leads to Oka's theorem on the existence of the normalization of any complex space. In this area of complex analysis, Henri Cartan had a long record of collaboration with German mathematicians, in particular H. Behnke and P. Thullen [CT] already before World War II, and after the dramatic events of the war, during which Cartan's brother was beheaded, a new era of collaboration started with the younger German generation represented by K. Stein, H. Grauert, and R. Remmert. These events were probably among the main reasons for Cartan's strong engagement in politics, especially toward human rights and the construction of Europe; at age eighty, Henri Cartan even stood unsuccessfully for election to the European Parliament in 1984, as head of list for a party called "Pour les États-Unis d'Europe", declaring himself to be a European Federalist.

In 1960, pursuing ideas and suggestions of Cartan, Serre [CS2, Se], and Grothendieck [Gt], H. Grauert proved the coherence of direct images of coherent analytic sheaves under proper holomorphic morphisms [Gr]. Actually, a further important coherence theorem was to be discovered more than three decades later as the culmination of work on L^2 techniques by L. Hörmander, E. Bombieri, H. Skoda, Y. T. Siu, A. Nadel, and myself: if φ is a plurisubharmonic function, for instance a function of the form $\varphi(z) = c \log |\sum g_j(z)|^2$ where $c > 0$ and the g_j are holomorphic on an open set Ω in $\mathbb{C}^n$, then the sheaf $\mathcal{I}(\varphi) \subset \mathcal{O}_\Omega$ of germs of holomorphic functions f such that $|f|^2 e^{-\varphi}$ is locally integrable is a coherent ideal sheaf [Na]. The sheaf $\mathcal{I}(\varphi)$ is now called the Nadel multiplier ideal sheaf associated with φ; its algebraic counterpart plays a fundamental role in modern algebraic geometry. The main philosophical reason is probably that L^2 theory is a natural framework for duality and vanishing theorems. It turns out that I got the privilege of explaining this material to young students of École Normale Supérieure around 1992. It was therefore a considerable honor to me that Henri Cartan came to listen to this lecture along with the younger members of the audience. Although he was close to being ninety years old at that time, it was a rare experience for me to have somebody there not missing a word of what I was saying—and sometimes raising embarrassing questions about insufficiently explained points! I remember that the lecture actually had to be expanded at least half an hour beyond schedule, just to satisfy Cartan's pressing demands….

During the 1990s, my mathematical interests went to the study of entire curves drawn on projective algebraic varieties, especially in the direction of the work of Green-Griffiths [GG] on the "Bloch theorem"—for which they had provided a new proof in 1979. Henri Cartan had also taken an eminent role in this area, which is actually the subject of his Ph.D. thesis [Ca1] under the supervision of Paul Montel, although these achievements are perhaps not as widely known as his later work on sheaves. In any case, Cartan proved after A. Bloch [Bl] several important results in the then nascent Nevanlinna theory, which, in his own terms, can be stated by saying that sequences of entire curves contained in the complex projective n-space minus $(n+2)$ hyperplanes in general position form an

"almost normal family": namely, they either have a subsequence that has a limit contained in the complement or a subsequence that approaches more and more closely a certain union of the "diagonal" hyperplanes. These results were put much later in geometric form by Kobayashi and Kiernan [KK] in terms of the concepts of taut and hyperbolically embedded domains. Very recently, M. Ru and P. M. Wong [RW], E. Nochka and P. Vojta [Vo] found various generalizations and improvements with a more arithmetic flavor. It is remarkable that Cartan's early work already contains many important ingredients, such as the use of Nevanlinna estimates for Wronskians, that are still at the heart of contemporary research on the subject, for example in the form of the study of the geometry of jet bundles [De1, De2]. I had once again the privilege of explaining some of these modern developments in front of Henri Cartan in 1997, still as vigilant as ever, on the occasion of a celebration of his work by the French Mathematical Society.

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Shoshichi Kobayashi

My Memory of Professor Henri Cartan

In 1953, the year I graduated from the University of Tokyo, I had the good fortune to spend a year in France as a boursier of the French government. On the hottest day on record in August, I left the port of Yokohama aboard "Viet-Nam" of the Messageries Maritimes for a four-week journey to Marseilles. I was twenty-one, not sure of myself. I was interested in differential geometry and several complex variables. During my senior year I was a member of Professor Yano's seminar, giving talks on harmonic integrals. At the same time, I was fascinated by the Cartan seminar notes, 1951/1952, on several complex variables.

As Professor Iyanaga had written to Professor Cartan about me, I was to visit Professor Cartan to pay my respects upon my arrival in Paris. Unfortunately, as soon as I got settled in Maison du Japon of Cité Universitaire, I became ill with typhoid fever, which I had picked up on my way to France in spite of the vaccination. After five weeks in Cité's hospital, I returned to Maison du Japon and went to see Professor Cartan. He said that he had had the same illness years ago and that, from his own experience, I would become healthier than before the illness—very encouraging words.

The Cartan seminar in 1953/1954 was fortunately again on several complex variables.

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Although I could not follow some of the lectures, such as those on automorphic functions, I faithfully attended the seminar. This is partly because every talk was written up in a complete form within a week and was distributed at the time of the following seminar. During my stay in Paris, I had an opportunity to listen to talks by Karl Stein, whom I had known only by name. His two lectures in March were the last seminar talks I attended.

In the meantime, I also attended a series of lectures by Lichnerowicz at Collège de France, and I took part in a private geometry seminar with Marcel Berger (about to finish his thesis), Paulette Libermann (already with a doctorate), Warren Ambrose (on sabbatical from MIT), and Katsumi Nomizu (on CNRS).

After Stein's lectures, I left Paris for Strasbourg to spend the remaining four months of the fellowship under Ehresmann, and I did not see Professor Cartan for more than a decade.

When *Foundations of Differential Geometry* with Nomizu appeared, I sent a copy to Professor Cartan as a token of my gratitude. When the second volume appeared in 1969, he wrote me to the effect that he was happy to see that our volume 2 really came out, since the promised second volume of some books had never come out. I found out much later which books he was referring to.

Around 1967 I shifted my focus from differential geometry to several complex variables. When I saw Professor Cartan (if my memory is correct) in the late 1960s in Berkeley, I mentioned to him the then newly discovered invariant pseudo-distance. He immediately asked whether the topology defined by the new distance gives the manifold topology, and I realized that I had taken for granted that that was the case. (This fact was later proved by T. Barth). I suspect that he must have raised this question because of his experience with the Carathéodory distance, which he had made use of in his work on transformations of bounded domains. (It is as recently as 1984 that Vigué constructed a bounded domain whose natural topology is not given by its Carathéodory distance.)

In the late 1960s I became interested in the Picard theorems in higher dimension and, as a consequence, in the hyperbolicity question for complements of hyperplanes. This led me to old papers of Emile Borel and André Bloch and then to the thesis of Cartan. In 1953 when I went to Paris, I did not dream of one day ever reading Cartan's 1928 thesis. In 1973, Peter Kiernan, one of my former students, and I wrote a paper reinterpreting Cartan's main results in terms of the invariant pseudo-distance. In his *Collected Works*, Cartan wrote a brief analysis of his own thesis and kindly mentioned our paper. We felt very honored.

To me, the 1950s still seem like yesterday. But many of the people I mentioned here, Ambrose, Ehresmann, Iyanaga, Libermann, Lichnerowicz, Nomizu, and Yano, are all gone, and now Professor Cartan. I must admit that my year in Paris was indeed long ago.

Raghavan Narasimhan

Henri Cartan

Henri Cartan came to the Tata Institute of Fundamental Research, Bombay (now Mumbai), in January 1960 to take part in an International Colloquium on Function Theory. There were many well-known participants besides Cartan, including C. L. Siegel, H. Grauert, L. Bers, L. Nirenberg, H. E. Rauch, W. Baily, M. Kuranishi, and others. I had joined the Tata Institute as a beginning member in July 1957 and had become interested in several complex variables.

The colloquium was immediately followed by a conference on mathematical education in South East Asia. Again, there were many well-known participants, including E. Artin, M. H. Stone, E. E. Moise, A. D. Alexandrov, and Y. Akizuki, as well as several of those who had come for the colloquium. In the course of the two weeks that these meetings lasted, one thing became very clear: Cartan's standards of mathematical quality and precision were perhaps equalled, but they were not exceeded.

Let me recount an incident from these two weeks. During the education conference, Cartan and I attended a lecture on topological 3-manifolds. Near the end of the lecture, the speaker said that he would conclude the proof with some hand-waving. Cartan obviously did not approve. He turned to me and said: "Now I understand why Indian Gods have so many hands; they want to give proofs in n dimensions."

I spent two months in Paris in the fall of 1960 and was able to meet with Cartan several times. He had received (for publication in the *American Journal of Mathematics*) a paper by Errett Bishop entitled "Mappings of partially analytic spaces". The paper contained a beautiful theorem (that a Stein manifold of dimension n admits a proper holomorphic map into $\mathbb{C}^{n+1}$) but was formulated in terms of a somewhat complicated generalization of complex spaces. Cartan seemed a little skeptical about its correctness. Since I was very interested in mapping problems on Stein spaces, he asked me to look at the paper. Only after I had explained the details of the proof to him would he recommend publication; he was not satisfied with a statement that the proof was correct.

Cartan showed me great kindness both in Bombay and in Paris. Although I was just a beginner,

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he spent time with me discussing mathematics, opening vistas and suggesting improvements to the work that I was trying to do. I think that he had this nurturing quality with any young person who had a serious interest in mathematics with whom he came in contact.

Cartan's first major achievements dealt with (biholomorphic) automorphisms of bounded domains in $\mathbb{C}^n$. This work was extremely influential, and I shall say more about it below.

He introduced new methods and ideas into the study of domains of holomorphy, Stein manifolds, and global problems (such as the Cousin problems). These were complemented by work of K. Oka; this body of work transformed the entire field. There is a story, which I first heard from Karl Stein: When, during the Brussels Colloquium of 1953, Serre presented the results that he and Cartan had obtained, one of the German participants said: "We have bows and arrows; the French have tanks."

A good part of Cartan's work on these topics appeared in the Séminaire Cartan notes for the years 1951/1952 and 1953/1954. A large part of his seminal ideas concerning *real* analytic spaces appeared in two joint papers with F. Bruhat. This latter work took a more satisfactory form when H. Grauert proved that any real analytic manifold (connected, countable at infinity) admits a real analytic imbedding as a closed submanifold of $\mathbb{R}^N$ for some N. The work that he initiated on *complex* analytic spaces, especially in the Séminaire Cartan notes mentioned above, was developed further by Serre, Grauert, Remmert, Grothendieck, and others in the years that followed.

All this work forms but a small part of his contribution to complex analysis. His many fundamental contributions to other fields (such as algebraic topology and homological algebra) have not even been hinted at.

I shall describe just two of his contributions to complex analysis which, I believe, demonstrate both his great influence and his penetrating insight.

Automorphisms of Bounded Domains

Let D be a bounded domain (connected open set) in $\mathbb{C}^n$, $n \geq 1$. Denote by $\mathrm{Aut}(D)$ the set of biholomorphic maps $g : D \to D$ (i.e., g is holomorphic, bijective and g^{-1} is holomorphic). We provide $\mathrm{Aut}(D)$ with the topology of uniform convergence on compact subsets of D. Cartan proves the following: Let $\{g_p\}$, $(p \geq 1)$ be a sequence of elements of $\mathrm{Aut}(D)$, such that $\{g_p\}$ converges to a map $f : D \to \mathbb{C}^n$ as $p \to \infty$, uniformly on compact subsets of D. Then, either $f \in \mathrm{Aut}(D)$, or f is degenerate in the sense that $f(D) \subset \partial D$ (the boundary of D). This implies that $\mathrm{Aut}(D)$ is a locally compact group acting properly on D.

In connection with earlier studies of his concerning automorphisms of so-called "circled" domains, Cartan had proved the following beautiful theorem (by a remarkably simple iteration argument). Let $f : D \to D$ be a holomorphic map. Assume that there is a point $a \in D$ such that $f(a) = a$ and $f'(a) =$ identity (where $f'(a)$ is the tangent map of f at the point a). Then f *is* the identity map of D. These results show that for any $a \in D$, the map $\mathrm{Aut}(D) \to D \times GL(n, \mathbb{C})$ given by $g \mapsto (g(a), g'(a))$ is a homeomorphism of $\mathrm{Aut}(D)$ onto a closed subset of $D \times GL(n, \mathbb{C})$.

In 1935, Cartan published a fascicule entitled *Sur les groupes de transformations analytiques,* which contains the following theorem:

$\mathrm{Aut}(D)$ is a real Lie group, acting real analytically on D.

In the proof, Cartan proceeds as follows. Consider the set V of (holomorphic) vector fields $z \mapsto X(z) = \sum_{k=1}^{n} X_k(z) \frac{\partial}{\partial z_k}$, which can be obtained in the following way: there exist sequences $\{g_p\} \subset \mathrm{Aut}(D)$ and $\{m_p\} \subset \mathbb{N}$, $g_p \to$ identity, $m_p \to \infty$ as $p \to \infty$ such that $m_p(g_p(z) - z) \to (X_1(z), \cdots, X_n(z))$ as $p \to \infty$ (uniformly on compact sets).

Cartan proves that V is a finite dimensional real Lie algebra of vector fields on D whose corresponding local Lie group of transformations of D is isomorphic to the germ of $\mathrm{Aut}(D)$ at the identity.

This theorem was the first major result concerning a question that belongs to the circle of ideas around Hilbert's fifth problem. Hilbert asked: To what extent is the assumption of differentiability essential to Lie's theory of continuous groups? This is usually interpreted as asking whether a locally Euclidean topological group is actually a Lie group. It is, however, natural to ask the following more general question (which, as far as I am aware, is still open in this form): if a locally compact group acts effectively as a topological transformation group on a manifold, is it necessarily a Lie group?

As mentioned above, Cartan's theorem was the first result in this direction. Moreover, Bochner and Montgomery added some new techniques to Cartan's method (to prove finite dimensionality) and obtained the following theorem: A locally compact group acting effectively as diffeomorphisms of a smooth manifold is, in fact, a Lie group acting smoothly.

Another major development in the study of the geometry of Lie groups was directly influenced by Cartan's work on $\mathrm{Aut}(D)$. Élie Cartan's important paper "Sur les domaines homogènes bornés de l'espace de n variables complexes" was also published in 1935. In the introduction to this paper, Élie Cartan calls Henri Cartan's work a remarkable contribution to the pseudo-conformal (=biholomorphic) representations of domains in the space of $n \geq 2$ variables. He says that Henri

Cartan's theorem suggested to him that it might be possible to classify bounded homogeneous domains in $\mathbb{C}^n$. He succeeded in doing this for $n = 2$ and $n = 3$, and he classified all bounded *symmetric* domains in $\mathbb{C}^n$ for $n \geq 4$. He found that all bounded homogeneous domains in $\mathbb{C}^2$ and $\mathbb{C}^3$ are symmetric and raised the question of whether this was true in general (without really expressing an opinion). We now know, thanks to the work of I. Piatetski-Shapiro, that, for $n \geq 4$, there exist bounded homogeneous domains in $\mathbb{C}^n$ which are not symmetric.

A Theorem on Holomorphic Matrices

As mentioned earlier, the work of Cartan and Oka transformed the study of global problems on Stein manifolds into an extensive theory with powerful tools. There are two major results that are crucial in this theory. One, due to Oka, is the coherence of the structure sheaf of $\mathbb{C}^n$. The other, chronologically the first, is a theorem on holomorphic matrices published by Cartan in 1940.

Let R be a closed rectangle, $a_k \leq Re z_k \leq b_k$, $c_k \leq Im\ z_k \leq d_k (k = 1, 2, \cdots, n, z = (z_1, \cdots, z_n) \in \mathbb{C}^n)$. Let $R_1 = \{z \in R | Re z_1 \geq 0\}$, $R_2 = \{z \in R | Re z_1 \leq 0\}$ and set $R_0 = R_1 \cap R_2$. We assume that $R_0 \neq \emptyset$, and, as usual, denote by $GL(q, \mathbb{C})$ the group of invertible $q \times q$ matrices with entries in $\mathbb{C}$ ($q \geq 1$ being a given integer).

Cartan's theorem is as follows.

Let f_0 be a holomorphic map of a neighborhood of R_0 into $GL(q, \mathbb{C})$. Then, there exist holomorphic maps f_ν of neighborhoods of R_ν into $GL(q, \mathbb{C})$ $[\nu = 1, 2]$ such that $f_0 = f_1 \cdot f_2^{-1}$ on some neighborhood of R_0.

It is this result that makes it possible to pass from the local to the global in the theory of coherent analytic sheaves on Stein spaces.

It is natural to try to prove this result as an implicit function theorem by solving the linearized problem $h_1 - h_2 = h_0$ (in a neighborhood of R_0). Today, one does this by working with bounded holomorphic functions on open rectangles and an implicit function theorem in Banach spaces. Cartan deals directly with Fréchet spaces. The solution of the linearized problem (with bounds) involves shrinking the domain of definition of the functions h_ν. In general, implicit function theorems in Fréchet spaces involve the loss of some kind of smoothness at each stage of the iteration, and a smoothing operator is required to restore fast convergence (so-called Nash-Moser technique). Cartan's iteration scheme produces fast convergence without the need for a smoothing operator and compensates for the shrinking of the domain of definition.

Thus, as early as 1940, Cartan had recognized the use of fast convergence in studying iteration in Fréchet spaces.

I believe that Cartan's work and the standards of quality and precision in mathematics that he set have influenced most mathematicians in the second half of the twentieth century.

Yum-Tong Siu

Tribute to Henri Cartan from a Complex Analyst

Henri Cartan was an intellectual giant in the world of mathematics in the twentieth century. His fundamental contributions spanned a wide range of fields: complex variables, algebraic topology, potential theory, homological algebra, and many others. This tribute is from the point of view of a complex analyst and touches only the field of complex variables. Even within complex analysis the work of Henri Cartan is very broad. We choose here only two areas.

The first area is value distribution theory in which he wrote his thesis [2]. His thesis, though written so long ago, is still one of the most fundamental and most elegant results in value distribution theory in higher dimension. To the general mathematical community this result of his, being overshadowed by his many other achievements, is not as well known. In recent years, because of the parallelism with diophantine approximation pointed out by Vojta [18], value distribution theory has taken on a new dimension. Cartan's thesis is being highlighted here to make the general mathematical community aware of this very beautiful piece of work.

The second area is what is now known as the theory of Cartan and Oka concerning Stein manifolds. In his interview with Allyn Jackson in March 1999 [11], to the question posed by Jackson, "You have worked in many areas of mathematics. Do you feel equally at home in analysis, in algebra, in geometry…?" Cartan replied, "Geometry—not exactly geometry. Topology, I would say. But I could also see the relations between them. One day I discovered that topological notions, and in particular sheaf theory, could be applied to analytic functions of several variables. This was very important. One can use results from topology in order to get some important results for analytic functions. I think that is interesting." When Cartan recalled his wide-encompassing work in many fields of mathematics, this second area seems to occupy a special position.

As a way of paying tribute to one of the first-ranked mathematicians of the twentieth century, without going too much into the technical details we explain here his contributions to the two areas

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so that the general mathematical community can appreciate and enjoy more the wonderful mathematical legacy he left us.

Value distribution theory was started by R. Nevanlinna [12] to relate the zero-set of a holomorphic function f on $\mathbb{C}$ to its growth, as a way of generalizing the fundamental theorem of algebra which states that the number of zeroes of a polynomial P is equal to its degree.

The degree of the polynomial P is replaced by the growth behavior of the *characteristic function* $T(r,f)$ which is defined as the average of $\log^+|f| := \max(\log|f|, 0)$ over the circle C_r of radius r centered at 0. For any complex number a the number of zeroes of the polynomial $P-a$ is replaced by the growth behavior of the *counting function* $N(r,f,a) := \int_{\rho=0}^{r} \frac{n(\rho,a)d\rho}{\rho}$, where $n(\rho,f,a)$ is the number of zeroes of $f-a$ inside the disk Δ_ρ of radius ρ centered at 0.

Unlike the case of a polynomial, the closeness of the value of f to a has to be counted together with the value of f actually equal to a. The growth behavior of $N(r,f,a)$ is not yet the same as $T(r,f)$ and has to be compensated by a function $m(r,f,a)$ known as the *proximity function,* which is defined as the average of $\log^+\frac{1}{|f-a|}$ over C_r. The sum $m(r,f,a)+N(r,f,a)$ is equal to $T(r,f)+O(1)$ as $r\to\infty$ for some bounded term $O(1)$, which is known as the *First Main Theorem*. The theory works also for the case of a meromorphic function f on $\mathbb{C}$.

The infimum $\delta(f,a)$ of $\frac{m(r,f,a)}{T(r,f)}$ as $r\to\infty$ is the *defect* of f for a, which measures the shortfall in the number of hits of a by f relative to the growth behavior of f. Nevanlinna's defect relation states that the sum of all defects is at most 2, which nowadays is interpreted as the Chern class of the projective line $\mathbb{P}_1$ when the meromorphic function f is interpreted as a holomorphic map from $\mathbb{C}$ to $\mathbb{P}_1$. The defect relation is a consequence of the *Second Main Theorem,* which states that

$$\sum_{j=1}^{q} m(r,f,a_j) \le (2+\varepsilon)\,T(r,f) - \sum_{j=1}^{q}\left(N(r,f,a_j) - N_1(r,f,a_j)\right) + O(1)$$

for any $\varepsilon>0$ and any set of distinct points $a_1,\cdots,a_q$ when $r\to\infty$ avoids a subset of $\mathbb{C}$ which has finite measure with respect to $\frac{dr}{r}$, where $N_k(r,f,a)$ is the k-truncated counting function $\int_{\rho=0}^{r}\frac{n_k(\rho,a)d\rho}{\rho}$ with $n_k(\rho,f,a)$ counting any zero of order $\ge k$ in Δ_ρ only as of order k.

Cartan's thesis obtains the *Second Main Theorem*

$$\sum_{j=1}^{q} m(r,f,H_j) \le (n+1+\varepsilon)\,T(r,f) - \sum_{j=1}^{q}\left(N(r,f,H_j) - N_n(r,f,H_j)\right) + O(1)$$

for a holomorphic map $f:\mathbb{C}\to\mathbb{P}_n$ and any collection of hyperplanes $H_1,\cdots,H_q$ in general position. Later Cartan's theorem was obtained with much longer proofs involving so-called *associated curves* by Hermann and Joachim Weyl [19] and Lars Ahlfors [1].

In the parallelism between value distribution theory and diophantine approximation formulated by Vojta [18], without the contribution from the truncation of counting zeroes, the Second Main Theorem of Nevanlinna corresponds to Roth's theorem [15] on the impossibility of approximating an algebraic number by a rational number $\frac{p}{q}$ with error $\le \frac{1}{q^{2+\varepsilon}}$ for an infinite number of q. Cartan's theorem corresponds to Schmidt's subspace theorem [16].

The theory of Cartan-Oka originally was motivated by the two problems of Cousin [9] for a class of domains known as domains of holomorphy or Stein domains. Cousin's first problem asks whether, from locally given meromorphic functions with the property that the difference of any two is holomorphic, we can find a global meromorphic function whose difference with each of the locally given meromorphic functions is holomorphic. Cousin's second problem asks the corresponding multiplicative question whether, from locally given holomorphic functions with the property that the quotient of any two is holomorphic, we can find a global holomorphic function whose quotient by each of the locally given holomorphic functions is holomorphic.

Domains of holomorphy were introduced because Hartogs [10] observed that any holomorphic function of two complex variables (z,w) on $\{|z|<1,|w|<2\}\cup\{|z|<2,1<|w|<2\}$ extends always to $\{|z|<2,|w|<2\}$ by considering the Laurent series extension in w and the vanishing of the coefficients of negative powers of w as functions of z, first for $|z|<1$ and automatically also for $|z|<2$. A domain for which extension of every holomorphic function on it to a larger domain is not possible is called a domain of holomorphy. Cartan [3] introduced the notion of holomorphic convexity as a characterization of domains of holomorphy. A domain Ω is holomorphically convex if for every compact subset K its holomorphic convex hull is also compact, which is defined as consisting of all points P with $|f(P)|\le\sup_K|f|$ for any holomorphic function f on Ω. Cartan [3] proved the necessity of holomorphic convexity for any domain of holomorphy and also the sufficiency when the domain is also circular in the sense that $(z_1,\cdots,z_n)$ is in it if and only if $(|z_1|,\cdots,|z_n|)$ is in it. The full equivalence was given in the joint paper of Cartan and Thullen [8].

For an abstract complex manifold the analog of a domain of holomorphy is a Stein manifold which, besides being holomorphically convex, satisfies

the condition that global holomorphic functions on it separate any pair of distinct points.

Cartan's seminal contribution is the incorporation of sheaf theory from topology into his work on complex variables to introduce the very important notion of a coherent sheaf [5, 6]. He finally crowned the success of his work in this direction by proving Theorems A and B for coherent sheaves on Stein manifolds [7]. Theorem B states that the cohomology group $H^p(X,\mathcal{F})$ of degree p over a Stein manifold X with coefficients in a coherent sheaf $\mathcal{F}$ over X vanishes if $p > 0$. Theorem A states that at every point P of X global sections of $\mathcal{F}$ generate $\mathcal{F}$ at P over the ring of holomorphic function germs on X at P.

On an open subset Ω of $\mathbb{C}^n$ a coherent sheaf is locally described as consisting of the set of all p-tuples of holomorphic function germs on Ω modulo those in the range of the homomorphism given by a $p \times q$ matrix of holomorphic functions on Ω. A global coherent sheaf on a complex manifold is obtained by piecing together locally defined coherent sheaves. In Theorem B the vanishing of $H^p(X,\mathcal{F})$, for example, when $p = 1$, means that, for an open cover $\{U_\alpha\}$ of X by Stein open subsets, local sections $f_{\alpha\beta}$ of $\mathcal{F}$ over $U_\alpha \cap U_\beta$ with $f_{\alpha\beta} = -f_{\beta\alpha}$ and $f_{\alpha\beta} + f_{\beta\gamma} + f_{\gamma\alpha} = 0$ on $U_\alpha \cap U_\beta \cap U_\gamma$ can be expressed as $f_{\alpha\beta} = f_\beta - f_\alpha$ with f_α being a section of $\mathcal{F}$ over U_α. The case of $\mathcal{F}$ being the sheaf of holomorphic function germs of X and $f_{\alpha\beta}$ being the difference of the locally given meromorphic function F_α on U_α and the one on U_β would solve immediately the additive first Cousin problem with the global meromorphic function given by $F_\alpha - f_\alpha$ on U_α.

One crucial ingredient in the proofs of Theorems A and B is the following important gluing lemma of Cartan [4]. Denote by $R_{a,b;c,d}$ the rectangle in $\mathbb{C}$ with coordinate $z = x + \sqrt{-1}\,y$ defined by $a < x < b$ and $c < y < d$. When $a_1 < a_2 < b_1 < b_2$, let $D_j = R_{a_j,b_j;c,d} \times G$ for some polydisk G and $D = D_1 \cap D_2$. Cartan's gluing lemma enables him to write a nonsingular matrix A of holomorphic functions given on the topological closure $\overline{D}$ of D as the product A_1A_2 on D, where A_j is a nonsingular matrix of holomorphic functions on D_j.

Oka [13, 14] contributed to Cartan's program by proving the existence of local "pseudobases" for the kernel defined by a $p \times q$ matrix A of holomorphic functions on a domain Ω in $\mathbb{C}^n$. It means that any point P of Ω admits some open neighborhood U and a finite number of q-tuples $f_1, \cdots, f_k$ of holomorphic functions on U with $Af_j \equiv 0$ for $1 \le j \le k$ such that any q-tuple g of holomorphic function germs at any point Q of U with $Ag \equiv 0$ can be written as $\sum_{j=1}^{k} h_j f_j$ for some holomorphic function germs $h_1, \cdots, h_k$ at Q. Oka also showed that, for the common zero-set V of a finite number of local holomorphic functions, similar local "pseudobases" exist for the ideal of function germs defined by their restrictions to V being identically zero.

Serre [17] later transported the theory of coherent sheaves to algebraic geometry. It has since become a very powerful indispensable tool in algebraic geometry.

In the early 1970s I had the good fortune of meeting Cartan in person on two occasions when I was at a relatively early stage of my career. One occasion was when I gave a talk in a seminar in the École Normale Supérieure and had dinner with him and a couple of other mathematicians afterward. Another occasion was at a big party he hosted in his house on Boulevard Jourdan. He was very kind, caring, warm, and inspiring. I still vividly remember how in mathematical discussions he chose very thoughtful and insightful questions posed with an encouraging tone to point to thought-provoking new ideas and directions.

As time goes by with further involvement in complex analysis on my part, my admiration for Cartan's work is ever elevated to higher planes. Even after eighty years of value distribution theory in higher dimension, his thesis is still being used as a starting point in lectures given in conferences on the subject. Both the result and the presentation of his thesis are so very elegant and natural.

As for the theory of Cartan and Oka, it will always be a shining gem in the crown of mathematics.

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[8] Henri Cartan and Peter Thullen, Zur Theorie der Singularitäten der Funktionen mehrerer komplexen Veränderlichen, *Math. Ann.* **106** (1932), no. 1, 617–647.

[9] Pierre Cousin, Sur les fonctions de n variables complexes, *Acta Math.* **19** (1895), no. 1, 1–61.

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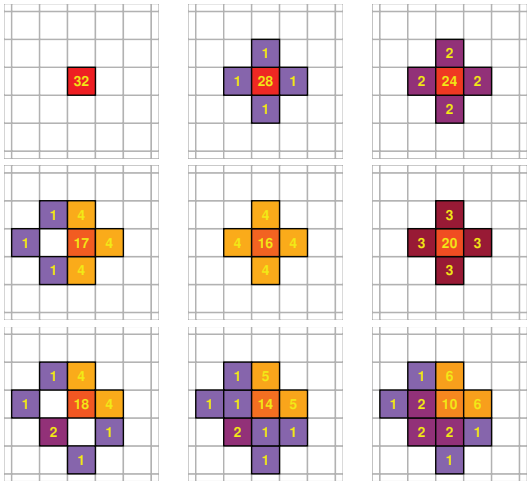
About the Cover

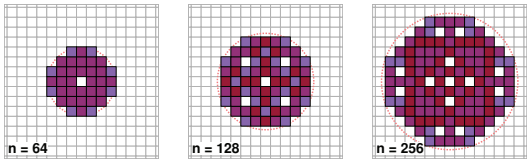
Sandpile

This month's cover theme is taken from this issue's article "What is a sandpile?" by Lionel Levine and James Propp. A sandpile associated to the 2D lattice $\mathbb{Z}^2$ is a simple cellular automaton. At any moment is given a function $f(i,j)$ on the lattice, non-zero at only a finite number of points. A point (i,j) at which $f(i,j) \geq 4$ is selected. The function at (i,j) is decremented by 4, and the value at each of its 4 neighbors is incremented by 1. This is called *toppling* the sandpile at (i,j). In general, one toppling may lead to an avalanche, but the process will eventually reach a stable state with no more topplings possible. Here are the first 9 steps of the process on the cover, which starts out with an initial value of $n = 32$ at the origin.



Here, as on the cover, this is to be read in boustrophedon mode, alternating left-to-right and right-to-left from one row to the next. The selection criterion in this example was lexicographic, but in fact this sandpile is *abelian*, which means that the state after n steps depends only on the set of nodes toppled, not the order in which they are toppled.

As the article by Levine and Propp mentions, and as it is with many cellular automata (my favorite is Langton's ant) it is the conjectural large-scale and/or long-term behavior of sandpiles that fascinates the physicist, who see them as simple examples of behavior near critical points. The conjectured scaling behavior shows up weakly in the growth of the diameter, even for small n.



I have found useful "The abelian sandpile; a mathematical introduction" by Ronald Meester, Frank Redig, and Dmitri Znamenski, which can be found at `www.cs.vu.nl/_rmeester/preprints/sandpile.ps`

–Bill Casselman
Graphics Editor
(notices-covers@ams.org)

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Cartan as a Teacher

Pierre Cartier

"We Are All Your Students, Mr. Cartan"

At the end of June 1965, at the (then) new mathematics library of the École Normale Supérieure in Paris (ENS), a party was held in honor of Henri Cartan. He was leaving his position of "directeur des études mathématiques" at the ENS, after twenty-five years of service. Many mathematicians gathered on the occasion of this farewell. Cartan, in one of his customary understatements, commented: "I asked to extend the invitation to my former pupils, and I see so many people…". To which Vladimir Arnol'd, visiting France for the first time, and with his standard wit, answered: "But… Mr Cartan…in Moscow as well as in Paris, we are all your students." Cartan was extremely pleased.

Of the two great creations of the revolutionary Convention (1793), if École Polytechnique is, in the words of Arthur Wightman, a "peculiar combination of West Point and M.I.T.", École Normale is properly the highest in a network of teacher's colleges.

When I was admitted at ENS in 1950, the mathematics department consisted of a rich and spacious library, with two offices at the entrance gate, shared by the professor, his teaching assistant (a "caïman"[1] in our student's slang), and the librarian. The professor was Henri Cartan; his caïman was Jean Frenkel, a veteran from WWII;[2] the librarian was the wife of the head librarian of the school, named Madame Martin. There were two more classrooms, called E and F, with the standard joke that every event was announced to take place in Room E *or* F. Everything took place in these two small rooms: the Bourbaki Seminar, the standard lectures for the students, the entrance examination, and also the Cartan seminar (see later).

Mathematics students were allowed only three years for the standard curriculum, whereas our friends in the other departments were given four years. Obtaining a fellowship for a supplementary year (to begin a doctoral thesis) was quite hazardous.

Cartan was everywhere. He himself taught the three years. In the first year, he supplemented—and modernized—the Sorbonne course on calculus. In this first year, we were supposed to follow at the Sorbonne the main courses: calcul différentiel et intégral (calculus), general physics, and classical mechanics. These courses were quite old-fashioned.

In the second year, instead of writing a master's thesis, the mathematics students were required to follow an advanced course: algebra (or analysis, or "géométrie supérieure"). But the main feat was for us Cartan's course called "cours aux carrés".[3] Having married during the summer of 1951, to the great dismay of Cartan, rather conservative in social habits, I was less faithful a student, but I remember memorizing hastily Erdös-Selberg's proof of the prime number theorem[4] as part of "algèbre supérieure". Cartan impressed me very much with a course on potential theory, using the new tool of distributions and a simplified version of Sobolev spaces known as Dirichlet space.

For many years, the main academic obligation for the students of ENS was to submit to a national competition called "agrégation". Officially, this is a qualifying examination for the profession of high school teacher, in an extended sense, from junior

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[1] *=alligator*

[2] *And a Jew who left France in 1942 to join de Gaulle's Free French Forces.*

[3] *Second-year students*

[4] *A so-called "elementary proof", a tricky and uninformative extension of Čebičev reasoning!*

Élie Cartan, Henri Cartan's father, 1932

high school to the elite undergraduate program known as "classes préparatoires".

In our third year, still under the guidance of Cartan, we prepared for the "agrégation". He read very carefully our memoirs, twice a month, and trained us for the oral examination. I hated the completely old-fashioned curriculum and was impatient to return to more serious—and modern—matters. But preparing for the oral examination—a course in which one *teaches how to teach*—is a fruitful exercise, and I was later happy to teach such a course.

I remember a somewhat embarrassing episode. I was supposed to explain the standard result that a function, whose derivative exists everywhere and is identically zero, is a constant. I prepared carefully during the Christmas vacation, using a proof in Bourbaki allowing some exceptional points. When it was my turn, I explained to the class that I intended to "improve" Bourbaki's proof by allowing an exceptional set of measure 0. I remember Cartan commenting: "Now, listen carefully, Cartier is going to prove his first theorem!" I understood, by his tone, that something was wrong. I often taught Lebesgue's integral and never slipped again!

But the real event was Cartan's seminar. I vividly remember my first class at ENS, the second Monday of November 1950. According to what became the weekly routine, I attended in the morning Cartan's class for the "conscrits" (freshmen), then at 2:30 p.m. his seminar, and in the late afternoon, we were supposed to learn from the craftsmen the art of cutting and assembling metal, wood, glass, for a possible career in experimental physics. I was not very good at that and learned just enough to help my friends prepare fantastic illuminations for the school's night in the next spring.

Cartan had an indomitable curiosity and openness. He was also very tenacious, and his friends often called him "mosquito" for his insistence on biting. Though not a Huguenot, he was as rigorous. I recently learned that, during the summer, he was the organ player for a small Protestant community in Die, where the mourning took place after his death. He could be quite formal, but in a very British way, compatible with wit. I remember my first visit to his just reunited family (in their summer home). His daughter was wearing trousers for the first time, and in a very formal tone he asked his wife: "My dear friend, have you noticed the dress of your daughter?" Despite this formality, he had an open mind: always well dressed, he never blamed me for my sloppiness, intended to provoke my elders!

A glance at the table of contents of his seminar shows an unusual diversity of topics: algebraic topology, sheaf theory, several complex variables, automorphic functions, algebraic geometry, index theorem.… He himself gave many of the lectures, the other speakers spent long hours with him for preparation, and he wrote (and typed) a large part of the proceedings himself.

After a few weeks, during which I understood nothing, I had acquired an elder brother, Jean-Pierre Serre, and a benevolent uncle, Samuel Eilenberg, a Protestant and a Polish Jew, well in line with my roots in Mittel Europa. I made an acquaintance with all—or almost all—French mathematicians. At that time, everything in mathematics was in Paris, around Cartan, with two extensions in Nancy[5]—where Dieudonné, Delsarte, and Schwartz maintained Bourbaki's spirit—and in the University of Strasbourg with Ehresmann (for a while a Bourbaki accomplice). The glorious generation—Hadamard, Borel, Fréchet, Paul Lévy, Élie Cartan[6]—was very old or already gone, and the ambitious youth gathered around Cartan. By his central position at the ENS, Cartan was more or less the thesis advisor of everyone (at least formally).

From Eilenberg, in the academic year 1950–51, we heard a long series of lectures in which he developed an axiomatic theory of group homology as a model for his well-known axiomatization of algebraic topology in his book with Steenrod. This series was to be followed by a similar attempt toward the cohomology of sheaves—a much more difficult subject, whose completion was one of the first major achievements by Grothendieck.

Three times a year, the same group of people attended the Bourbaki seminar in its ascending

[5] *The other arm of Bourbaki was in Chicago; hence the famous series of Nancago mathematics books.*

[6] *Father of Henri Cartan!*

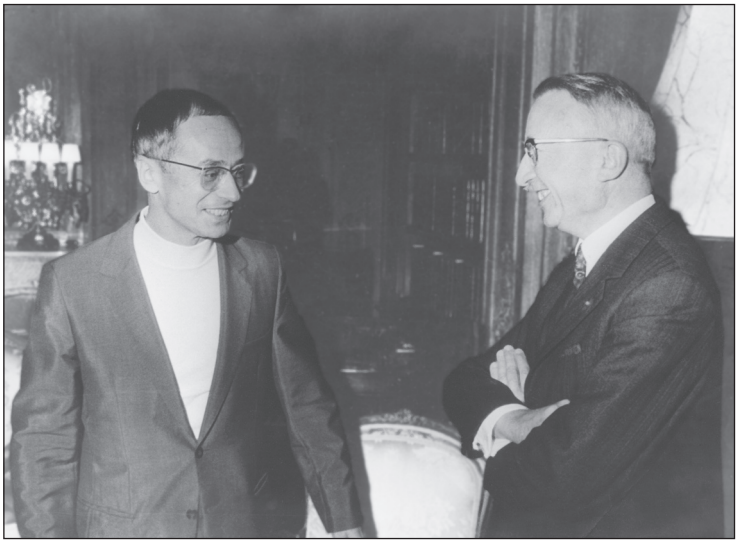
phase.[7] There we learned about Weil's proof of the Riemann hypothesis in the case of function fields, Zariski's work (as reported by P. Samuel), Koszul's thesis about the homology of Lie algebras, the work of Petrowsky in partial differential equations and of Gelfand in the theory of group representations…all the hot subjects in mathematics. Moreover, the supposedly secret drafts of forthcoming Bourbaki volumes were freely circulated by Serre, Cartan, and others. Among the closest friends of Cartan were André Weil, who visited France every summer and gave a series of lectures at the ENS in the winter of 1951 (about adeles and ideles), Armand Borel, who introduced Cartan to Leray's work on sheaves, and Claude Chevalley, who became a professor at La Sorbonne after 1954 (and one year in Japan).

* * * * * * * * * * *

French mathematics was at a turning point. The undergraduate curriculum (even in its enhanced form for the "classes préparatoires") was a mix of coordinate geometry, synthetic geometry (based on the "theorem" that every one-to-one correspondence between the points of a projective line is given by a Möbius transformation),[8] differential calculus with applications to geometry and kinematics. The foundations were sometimes shaky, there was hardly any hint of groups of transformations (in geometry), and the use of matrices was ignored or not advised.[9] The good teachers dared to give the foundations of the real number system, but in the absence of set-theoretical terminology, the exposition was quite obscure. In the land of Lebesgue, hardly any mention was made of the Lebesgue integral, and we had to learn Lie groups from the thesis of Élie Cartan or in Pontrjagin!

By a sequence of well-planned steps, Cartan made General Bourbaki win! He managed to hire the ambitious youth at La Sorbonne: Schwartz, Choquet, Dixmier, Godement, and Chevalley. In 1957 the takeover was complete (except for André Weil, who was never forgiven for his refusal to be drafted in 1939, at the beginning of WWII!). The curriculum was deeply renovated, and the textbook of textbooks became Bourbaki (whose golden age extends from 1950 to 1975!). The forceful gesticulations of Dieudonné, as well as the power of persuasion of Choquet and Lichnerowicz (both not members of Bourbaki) convinced everyone to worship general topology, linear algebra, functional analysis, and group theory. Henri Cartan was always a moderate in this debate and never threw the baby out with the bath water. He made one major mistake—discarding classical mechanics with this comment: "The teaching of classical mechanics (in France) is very poor"—which was true!— "and for the physicist, only quantum mechanics matters." We know better, as no one can understand quantum mechanics without a thorough acquaintance with its Newtonian (or Hamiltonian) version. One of the reasons for this mistake was the almost complete ignorance of the challenges of mathematical physics by the members of the Bourbaki *coterie*. It is also to be said that the teaching of physics in France was even more backward than in mathematics. One example: the first serious course on quantum mechanics was given in 1964, not in Paris, but in the National Center for Nuclear Physics (at Saclay).

Cartan and Samuel Eilenberg at a Bourbaki congress, Pelvoux, 1951.



Henri Cartan and Jean-Pierre Serre, Paris, July 1970, on the occasion of the awarding of the Gaston Julia Prize to Serre.

[7] *To reach its peak of fame and attendance from 1970 to 1990, followed by a slow decline.*

[8] *Laurent Schwartz embarrassed his teacher with the counterexample of going to the complex conjugate!*

[9] *Ostensibly because there was supposedly no agreement about the product rule: lines by columns or columns by lines!*

So around 1960, Bourbaki had won, in main part due to the efforts of Cartan, helped by the political know-how of Schwartz. There followed the dubious episode of the so-called "modern math", or the failed attempt to use Bourbaki as a textbook for kindergarten! The fiercest proponents were ultra-zealous disciples of Bourbaki, not of the same mathematical caliber, helped by an attraction toward abstractness, an integral part of the then prevalent fashions (in art and elsewhere).

For about fifteen years French mathematics was ruled by two enlightened despots: Cartan and Schwartz, controlling between them most of the academic world. Nominally, every doctoral student in mathematics had one of them as thesis advisor, and they suggested research topics. Cartan's way was more open and deep, but everyone benefited from their valued advice. Committee work was reduced to a couple of days off for our masters, where everything was settled, and in most cases, in an optimal way.

Under this reign, what was the fate of the young French mathematician? Let me take myself as an example. At the end of my first year at ENS, I was at pain to choose my future; I was attracted by philosophy and (experimental) physics as well as by mathematics. The advice of Althusser, the professor of philosophy, was warm support, with a fatherly caution about the degrees to be earned. Yves Rocard, head of the physics department, whose son Michel was later a prime minister of France, wanted to recruit me to build with him the French atom bomb, to be exploded ten years later. Cartan, following the advice of Eilenberg, invited me to one of those secret meetings of Bourbaki! My fate was decided.

A few years later, Cartan turned me down for the Princeton fellowship (awarded later on to Douady) on the excuse that this didn't fit a married man[10] (he was not especially happy about my early marriage!). Then he turned me down for the position of "caïman" at the ENS, explaining to me later that I would have sacrificed my research work because of my involvement in teaching (he was perfectly right!).

A deeper interference came later in 1961. After completing my thesis, two years of postdoc at the Institute for Advanced Study in Princeton, and almost three years of military service at the time of the war of independence of Algeria, it was time for me to apply for a professorship (I was almost thirty!). For each position I applied to, I got the same answer: "Why should you come here, since Cartan says that you have been appointed at Strasbourg?" (where I didn't apply!). There was no way out. I tried to rebel and told Cartan I would stay only two years in Strasbourg—no more. He laughed, and I willingly spent ten years there—in the opinion of my wife, our best years! He later gave me an explanation. He was enormously interested in bringing back together French and German mathematicians, as witnessed by his long-lasting friendship with Behnke and Hirzebruch. In Cartan's opinion, I was the best fit in the young generation to work in this direction. He was right, and I immensely enjoyed working for the *Versöhnung*[11] with the help of my German friends Dold and Puppe. I was from that time on as convinced as he was of the necessity of a Federal Europe (still in the making), well in line with the thoughts of my mother, who explained to me, when I was five, that I should see the day of the United States of Europe.

Some years later, in 1974, I didn't yield to his pressure to join Orsay University, but it was already another time, in the aftermath of the 1968 student revolution… Grothendieck was gone already…

Thank you, Henri Cartan, for your fatherly influence on me! It made me grow up!

[10] *But not much later, I was invited for two years at the Institute for Advanced Study, where my wife was welcomed!*

Jacques Dixmier

Our Teacher

I was a student at the École Normale, from October 1942 to September 1945. This was a time of war, and Cartan was unable to return to his alma mater in Strasbourg, which was then under Nazi rule. In this way, we could benefit from an outstanding teacher.

In my first year in the school, I had to attend the calculus course at La Sorbonne, Cartan's course being officially a kind of tutorial to help us master the curriculum in calculus. But this curriculum was rather outmoded, and the aim of Cartan was to "modernize" the subject matter. The main point was to introduce us to so-called modern algebra (groups, rings, vector spaces…). Therefore, Cartan's lectures were combining a rather standard course on calculus but in the spirit of the not yet published volume of Bourbaki, entitled *Functions of a Real Variable (Elementary Theory)*. So, for instance, the Γ-function was described as in the famous booklet by Emil Artin. In the more "modern" or "advanced" part, we were told about integers mod p, Grassmann calculus, Fourier transforms, and fixed-point theorems.

Cartan knew how to involve us in the class, and we would have been more impressed if we had known his research work. We were seventeen in the class, to be reduced to nine during the second year, because of the hardships of the war and also

[11] *Mutual forgiveness, in German!*

Jacques Dixmier is professor of mathematics, retired from the Université Paris VI.

because in the second year he taught only the students who had chosen mathematics as a major. After consulting the class, he decided to teach a course on Lie groups. He developed all the important notions from a rather general point of view but always illustrated by elementary examples. His goal was to lead us up to Lie's third theorem (reconstructing a Lie group from its Lie algebra). Because we were lacking the relevant background in topology, he concentrated on the local theory. I would not claim it was an easy course, and he admitted it frankly.

In our third year, our curriculum was centered around the so-called "agrégation", a national competition for prospective teachers. The main emphasis of the course was—and still is—to prepare the students to deliver a lecture—in a sense *teaching how to teach*.

So, for each of many years, he offered to the second-year students a new basic course. These courses were enormously influential, and he offered them besides his many commitments: research work, doctoral students, academic infighting, family tragedies… He was a real master, and we cannot be too grateful to him.

Adrien Douady

Memories of the Cartan Seminar

On June 28, 2004, a celebration was held at the École Normale Supérieure in Paris in honor of Henri Cartan on the occasion of his 100th birthday. Among the speakers was Adrien Douady.[12] *Douady gave recollections of the Cartan seminars. Here are excerpts of his talk,*[13] *prepared by Régine Douady, his widow, from his handwritten notes, translated into English and slightly edited by P. Cartier and L. Illusie.*

Nowadays there are two kinds of seminars: the *colloquia*, in which a prestigious visitor is invited to talk on a topic of his or her choice, and *groupes de travail* (work groups) in which a small team decides to study some question, to fully understand an important article. The Cartan seminar was of this second type. Cartan would choose a theme or a recent result that he wanted to understand in detail. He would assemble around him a team of speakers and assign the talks to be given, reserving a good number of them for himself. The seminar took place in Room U of the ENS. In the audience you would sometimes find Serre, Weil, Dieudonné, Godement, Chevalley (who ran his own seminar right afterward), and, of course, Cartan. He did not tolerate the slightest inaccuracy, the slightest imprecision, and he criticized the speaker to the point of totally destabilizing him. You had to be well prepared. One month earlier Cartan would hand you a paper to read and digest. He would sometimes explain the plan. You were allowed, and even encouraged, to reconstruct the whole thing. I was of course happy to do that. I've never been able to read a paper (I go to sleep after page 3).

I remember my talks, and those of Bernard Morin as well. I wrote on the blackboard for him. Blind, he had an acute geometric vision. That was his revenge: seeing what others don't.

But what really mattered for Cartan were the notes of the exposés. Again he would tolerate no imprecision. It was out of the question to say that two groups were isomorphic without specifying an isomorphism between them, or to say that a diagram commuted up to sign: the sign had to be given. Above all he wanted the text to be perfectly clear. For this he asked you to revise your text as many times as necessary. *Vingt fois sur le métier remettez votre ouvrage* (*Redo your work twenty times*), said Boileau. With Cartan it was rather thirty times than twenty. His point was that a text should have at least thirty readers, otherwise there's no need to write it. Therefore, if you spend half an hour to spare the reader a minute of perplexity, then it's well worth it. He would return your manuscript covered with annotations made with a red pen in his small, curly handwriting. Then you would revise it and give him back a new version. There was no word processor at the time. I typed. I had a green typewriter, given to me by my father, which I still have. I photocopied my text, cut out shreds of 2 or 3 lines, pasted, photocopied again. I was allergic to the droplets falling from the ribbon of the typewriter when you type. You worked hard. A good reason for this is that when your text was eventually "Cartan acceptable", another person was to work on it: Denise Lardeux, the secretary of the IHP (Institut Henri Poincaré). She used stencils, whose smell impregnated her office and her blouse. You could make corrections—with a correcting red ink having an even worse smell—but only by replacing one letter by another one, or a word by another one of the same length. All that made you confident that your text was really in final form.

Through this hard training all Cartan's students acquired a solid mathematical style. Serre's style reached perfection: it's a model of clarity, saying all that has to be said without an unnecessary word. Unfortunately Serre had very few Ph.D. students.

We try to pass the torch to our students. They toil and sweat, but they are grateful to us. One of them recalled that after I had said to her, "This is not clear", she had replied, "But it's clear in my

Adrien Douady was professor of mathematics at the Université de Paris-Sud 11.

[12] *Adrien Douady died accidentally on November 2, 2006.*

[13] *A recording of his talk is available at the website of the Diffusion des savoirs de l'ENS.*

1923 ÉNS Sciences, Paris, 1926. Front row, left to right: | (1) René de Possel, (2) Henri Cartan, (3) Paul Dubreil, (5) Jean Coulomb.

head". Then I said: "What do you want to give to the reader: your text or your head?"

A few words, now, about the contents of the Cartan seminars. There were two main themes: algebraic topology and complex analytic geometry. In the 1940s one discovered the extraordinary power of the cohomological methods created for algebraic topology. These methods were later applied to algebraic geometry, complex analytic geometry, number theory, etc. Their development in each of these fields, as well as in their foundations (homological algebra), occupied a large (too large?) part of the activity of mathematicians up to the 1980s. Weil, Zariski, Cartan, Serre, Grothendieck, and Dieudonné were leaders in this vast movement, with the Cartan seminar as a prominent place for it.

Just after I had passed the "agrégation", I spent 1957–58 in Princeton. I attended the course of John Moore on algebraic topology and of Spencer in complex analytic geometry (I had tried to attend Kodaira's, but in vain, as he did not speak loudly, and I was already a little deaf). I had benefited from many conversations with Cartan and, above all, Andreotti. When I came back, in October 1958, Cartan immediately enrolled me in his seminar, starting with two exposés on spectral sequences. The goal was a construction of Adams to prove that the only spheres admitting a continuous composition law with neutral element are S^0, S^1, S^3, S^7 and are parallelizable. At the time K-theory didn't exist, and you used "secondary cohomological operations". They were horrible, ill-defined machines. A few years later, thanks to K-theory, a much simpler proof was found, and it was observed that all "secondary cohomological operations" are actually differentials in the Atiyah-Hirzebruch spectral sequence relating cohomology and K-theory.

Christian Houzel

Henri Cartan and the École Normale Supérieure

When I was admitted at the École Normale Supérieure in 1956, I had not yet made up my mind between mathematics and physics. During the first week, I attended Cartan's lectures to the first-year students. They were devoted to the characterization of the additive group of real numbers as a totally ordered group which is a complete lattice. As the multiplicative group of positive real numbers has the same properties, this gives an elegant construction of the exponential function. I immediately understood that I was in the right place, and I chose mathematics as a major.

It was a great privilege to be in Paris at this time, in the late 1950s. Our professors were Henri Cartan, Gustave Choquet, Laurent Schwartz, Roger Godement, Jean-Pierre Serre, Jacques Dixmier, Claude Chevalley… This generation of mathematicians accomplished the renovation of French mathematics after the war, and Henri Cartan played a central role in it, due to his strong personality and his position at the École Normale Supérieure.

There was a sharp contrast between the mathematics I had learned in the *classes préparatoires*, which had a definite archaic taste, and the mathematics taught by Cartan. In each of the three years at the École, he gave us lectures on different topics. I remember a course on measure and integration in the first year, directly inspired by Bourbaki, and a luminous course on Lie groups in the second year. The third year was dedicated to the preparation of the *agrégation*, a special competitive examination to become a teacher. We had to give lessons as if in front of a class in a secondary school, and Cartan commented on our choices and our way of teaching. His remarks were always right and useful. In the other years, Cartan gave lectures on the calculus of variations, on analytic functions of several complex variables, on homology, and more.

To assist him in teaching, there was an assistant professor called a caïman. When I was in the third year, the caïman was Adrien Douady, from whom we learned much, but we were conscious that the task was heavy, and we asked Cartan whether it was possible to get a second assistant professor. Cartan managed to obtain the creation of a new position and at the beginning of 1961, he offered me that position, which I occupied for almost three years. So I had the privilege of collaborating with Cartan and Douady and meeting younger generations. These were very happy years.

Cartan's seminar, held every Monday afternoon at the École, was a must for the Parisian

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mathematicians. It existed for sixteen years, up to 1964, and it was not replaced afterward. Each year, Cartan devoted his seminar to the proof of a recent result. He started from scratch so that a student with a general knowledge in mathematics was able to understand. He developed the necessary tools, gave complete proofs, and, at the end of the year, he obtained a proof of the chosen result, very often better than the original one. Each year, the seminar was written down, and it remained a classical reference.

I had the opportunity to attend this seminar for six years. In the first one, I was very young and ignorant. The subject was automorphic functions, and I was astonished by such things, completely new for me. In the second and third year I learned some algebraic topology. The seminar was dedicated to Adams's works on Hopf spaces, with the theory of secondary cohomological operations, then to the periodicity of stable homotopy groups. In the next year, Cartan returned to functions of several complex variables and analytical spaces. The topic was suggested by Kodaira and Spencer's works on families of complex analytical manifolds and by the new results of Ahlfors and Bers on the moduli of compact Riemann surfaces. The seminar began with talks by Douady on Kodaira and Spencer's works. Then Cartan asked me to explain Ahlfors and Bers's work. At this time, Grothendieck, who attended the seminar, said that he had a way of constructing the moduli space of compact Riemann surfaces of given genus. His method was connected with his work in algebraic geometry. He proposed to Cartan to explain it, and his explanation occupied eleven sessions of the seminar: Cartan's seminar became Grothendieck's seminar! Cartan generously welcomed the new state of affairs. At the end of the year, Grothendieck asked me to explain local properties of analytical spaces. In his talks, he had used some of these properties without proof, and this complement was necessary. For me, this was hard work, and I still remember the care with which Cartan read my text.

For people of my generation, Henri Cartan was a master and a model. We were impressed by the power of his mathematical work but also by his moral qualities and by his sense of humor. He was engaged in the defense of persecuted mathematicians in dictatorial countries and in the construction of a political Europe. He was a good pianist and a fine musician. Through the reading of his correspondence with André Weil and Jean Dieudonné just after the war, I got a better knowledge of him. I hope I can publish these letters someday.

Jean-Pierre Kahane

Cartan at Orsay

Henri Cartan spent the last years of his academic career, the years from 1969 to 1975, at Orsay. Although it was a short period of time, Cartan played a decisive role in the development of Orsay, and he remains a glorious figure in the brief history of Université Paris-Sud. There are no archives of this interesting time, and I didn't try to collect testimonials; this article relies on my personal recollections.

Before 1968

The scientific center of Orsay was created around 1955, when the laboratories of nuclear physics moved from Paris to Orsay, under the supervision of Irène Joliot and Frédéric Joliot-Curie. Shortly afterward other important physics laboratories also moved from Paris or were created directly at Orsay. Until 1965 all these laboratories were part of the Faculté des Sciences de l'Université de Paris. This Faculté des Sciences, together with the Faculté des Lettres, were both located at the Sorbonne, but the building of the Sorbonne was too small to contain everything. A new location in Paris was necessary; it was built at the end of the 1960s on the former site of the wine market, La Halle aux Vins, and became the Jussieu campus. In the meantime, the mathematicians gathered at Institut Henri Poincaré, where the mathematics department of the Faculté des Sciences was located.

In 1958 it was decided to organize part of the teaching in all scientific subjects at Orsay. The first professors of mathematics who had their teaching duties at Orsay were successively Delange, Deny, Lesieur, Malgrange, myself, Malliavin, Néron, Cerf, and Poitou. We were professors at the Faculté des Sciences of Paris, and Orsay was merely a part of this Faculté, "annexe de la Faculté des sciences".

That situation changed in 1965, when Orsay became the second Faculté des Sciences de l'Université de Paris, with a dean having the same status as the Parisian dean. We then became professors at the Faculté des Sciences d'Orsay. However, we kept only one mathematics department, common to the two Facultés. During those years the president of the department was Henri Cartan (except in 1967 when he spent one year in Princeton and asked me to replace him). In this position he became a key actor in the development of mathematics at Orsay, treating his younger colleagues as equal members of the department (for example, though it was not so convenient at the time, he decided that one or two plenary meetings of the department should take place at Orsay instead of Paris). We organized

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together the advanced courses and the thesis defenses; the *commission des thèses* in mathematics had no formal power, but the simple procedure of registering and discussing every planned defense proved very efficient in ensuring a good standard for the theses accepted by the department. Scientific life was developing at Orsay, with advanced courses and seminars, and a mathematical library that soon became quite good.

1968–1969

In 1968 the Faculté des Sciences de Paris moved to its new location, the quadrangle of Jussieu. Meanwhile Orsay developed all branches of science. The cooperation-competition was supervised by the two deans, Marc Zamansky and Georges Poitou, both mathematicians.

Occasionally there were common meetings of all professors of both Facultés. The joint mathematics department met regularly at Institut Henri Poincaré.

The student uprising of May 1968 was an explosion in Paris and a happening at Orsay. As a sign of solidarity with the students, Laurent Schwartz and Henri Cartan initiated a dangerous action, namely individual resignations from their academic positions. This act was emulated by a number of professors and became a kind of dramatic collective resignation during a joint Paris-Orsay meeting chaired by the dean, Zamansky. Zamansky disapproved and left the meeting; Poitou took the chair and collected all papers and signatures and did what had to be done, that is, nothing. The action had taken place, and the danger, having the resignations accepted, was over.

Poitou had a special style as dean and grand views about the future of universities. The same can be said about Zamansky, except that the style and the views were mutually opposed. It was agreed by everybody that the old universities, as empty shells, were dead. The dead body of the enormous University of Paris had to be replaced by new and living universities. For Zamansky there was no doubt: the Faculté des Sciences de Paris had to become the Scientific University of Paris. For Poitou all new universities should be multidisciplinary, and he acted in order to include Orsay in a much larger thematic and geographic domain that became the Université de Paris-Sud (now Université Paris-Sud). Zamansky failed, and the Faculté des Sciences de Paris split into two parts, which became the scientific parts of Université Paris 6 (now Université Pierre et Marie Curie) and Université Paris 7 (now Université Denis Diderot). The splitting involved different factors, including political and personal antagonisms. Mathematicians suffered from strong and partly artificial oppositions (now forgotten). Chevalley chose a new university, Paris 8-Vincennes, and Cartan chose Orsay.

Of course Cartan was more than welcome at Orsay and also at the new Université de Paris-Sud. A constitutive council of the university was created, elected by the different sections of the new university; that is, medicine at Kremlin-Bicêtre and other important hospitals and research laboratories; pharmacology at Châtenay-Malabry, with the greatest number of pharmacology students in France; law in Sceaux; institutes of technology in different branches at different places: Sceaux, Cachan and Orsay, with Orsay becoming the scientific center of the new university. Cartan was elected a member of this constitutive council. Then the first meeting of the council elected him as president. Though he didn't keep this position very long, his academic experience and the unique way he had of chairing a meeting were highly appreciated: he was always exquisitely polite and perfectly clear. Among the members of the council was the director of the Institute of Technology of Sceaux, Mrs. Alice Saulnier-Seïté, a trade-unionist at the time, who became minister of the universities a few years later. There were strong personalities, opposing views, bright speakers, and challengers, and Cartan proved a perfect helmsman of this moving boat.

1969-1975

As soon as he joined Orsay, Cartan took part in all aspects of the life of the mathematics department. By the way, the math building at Orsay, bâtiment 425, is named Mathématique, without an "s", as in Bourbaki "Éléments de mathématique". Cartan could feel at home.

The scientific environment was, and still is, quite favorable: Institut des Hautes Études Scientifiques (IHÉS) at Bures-sur-Yvette, a large campus of CNRS (National Center of Scientific Research) in Gif-sur-Yvette, several engineering schools in the immediate neighborhood (École Supérieure d'Électricité, École Supérieure d'Optique, and, in the mid-1970s, École Polytechnique). The IHÉS is within walking distance of the math department, and Cartan kept a strong relationship with permanent and visiting members of this institute.

We had several foreign members in the math department. They were invited on a temporary basis, and many of them wanted to settle in France and become French citizens. The same was true for some of the research people working at IHÉS. This was never easy and sometimes very difficult. Cartan got involved in the more difficult or urgent cases; he made the necessary steps and proved efficient in a sometimes incredible way.

The scientific life in the math department was organized around the library. From the very beginning we had decided to use all the funds we had for buying books and collections. We had obtained substantial help from the CNRS and a large endowment from the State through an occasional

resource called 5e Plan (the French policy included at that time some large programs, called Plans).

We had used this fund very carefully, but it came to its end as Cartan arrived at Orsay. We had an ordinary allowance for mathematics from the university, but we needed more. Cartan was a regular user of the library, and he appreciated the policy we had in this matter. Together with Gustave Choquet, who later moved from Paris to Orsay, he collected the information about the holdings and needs of the library, which he presented to the newly elected president of the University, Bernard Picinbono. Picinbono was convinced, all relevant committees and councils were equally convinced, and the library was saved.

Actually the needs of the library were also the first reason to organize the scientific life in a new way. We had a strong but informal link with CNRS, and the policy of CNRS (a very good policy) was to favor formal associations between CNRS and university laboratories or research teams. From the university point of view the math department was a laboratory; for purely financial reasons it appeared that it would be advantageous to have associated research teams. We formed research teams in harmonic analysis, topology, number theory, numerical analysis, and probability. Cartan was a member of the topology team, directed by Jean Cerf. Not only did he play an important role in the recruitment of topologists, but he perfectly understood the need to favor the fledgling teams in applied mathematics, numerical analysis, and probability and statistics. This enlargement of the mathematical field proved essential to maintaining and improving the scientific level of the department.

Cartan was a teacher. He had been the teacher of generations of mathematicians before moving to Orsay. In Orsay he had ordinary university students, and he taught classical subjects. The ordinary students of this time were actually quite decent students, interested in mathematics, interested in their studies, and very demanding of their teachers. Cartan impressed them and made them work. He, too, was very demanding of students and collaborators, checking everything with his personal style, blending rigor and irony. On the other hand he was extremely kind and thoughtful toward students and collaborators when they had personal difficulties. As a mathematician his figure was severe, but he was sensitive to other aspects of life and more than friendly as a human being.

His course was called "Algebra and Geometry". It included hyperbolic geometry and some important theorems in number theory (the Dirichlet theorem on prime numbers, for example). There was a mimeographed version of the course, but it was never published. His style of exposition was not what could be expected from a founder of Bourbaki. He wanted things to be understood in the most intuitive way. Examples (recollected by one of his assistants): an affine space is nothing but a linear space that lost its origin; or, a homographic transformation in the plane is simply a dilation/rotation (or a translation), if you place the fixed points at a right place.

Photograph © Mark Marian Schmidt.

Nicole and Henri Cartan, Paris, 1982.

When Cartan moved to Orsay, he was president of IMU, the International Mathematical Union. He chaired the Fields Medals Committee for the Fields Medals awards of 1970 (Baker, Hironaka, Novikov, Thomson). Just before retiring he was elected a full member of the French Academy of Sciences (he had been a corresponding member for nine years).

After the Retirement

Henri Cartan retired on October 1, 1975.

A symposium in his honor, on analysis and topology, was organized in the main amphitheater of Orsay on June 18, 19, and 20, 1975. I had been elected president of the university one month earlier, and it was the first scientific event that I attended in this capacity. A special booklet was issued by the university with the general nontechnical speeches, and the scientific contributions were published by *Astérisque*.

Cartan stayed on as emeritus in the department; he only had to share his office, and his name remained on the door until he died. He continued to use the library. For some time he was the only mathematician at Orsay who was a member of the Academy of Sciences. He was very active as an academician. The Academy of Sciences still applies an unwritten rule, *la règle de Cartan*, for electing new members: the number of people to be considered should be strictly larger than twice the number of available positions. He took part in a most important decision of the Academy: to decrease the average age of the members of the Academy, a number of new members are required to be younger than fifty-five at the time of

Cartan with a granddaughter, Dolomieu, August 1977.

election. He took part in every meeting as far as he could, and even after he was 100 he never failed to send a proxy when important votes were going to occur. I had the privilege of being called to the telephone on these occasions and hearing his firm, clear voice.

He was awarded the Médaille d'Or du CNRS in 1976 and the Wolf Prize in 1980, as well as being a member of a number of foreign academies. A celebration of his 100th anniversary took place in Paris. The most recent celebration was organized at Orsay, when the main amphitheater of the university was named Amphithéâtre Henri Cartan.

Of course, Cartan didn't need this in order to be remembered in Orsay. He had been one of the founders of the university and a kind of father of the mathematics department. We are proud to be part of his heritage.

Max Karoubi

Some Souvenirs of Henri Cartan

The first time I met Henri Cartan was at the École Normale Supérieure in Paris, when I was admitted in 1959. Despite excellent results in previous mathematics studies, the contact with the École Normale was a shock to me, as for most students of my generation. Actually, according to French tradition, we spent a lot of time at the École Normale, trying to understand Bourbaki's books, although we had no research experience…

Personally, I was not very successful at this exercise and largely preferred to attend Cartan's lectures, either at the École Normale or at the University of Paris. Indeed, Cartan was the best professor I ever knew. He had a unique way of captivating the audience from his first words, by the depth of his knowledge, of course, but also by his eloquence and perfect French. Nothing was left in the dark, no proof was omitted. It was clear that everything was thought out, not only in the details, never boring, but more importantly in the research on the most elegant way to prove theorems. At the end of his lectures, we all felt more clever!

Cartan was also supervising carefully the math studies of everyone, and we often had the opportunity to meet him during our four years at the École Normale. This was particularly important at the end of this period, when we started a research project. Then I naturally applied to a position at the CNRS (Centre National de la Recherche Scientifique), the analog of a "predoc" position today. Unfortunately, the application was rejected, probably because my research records were too thin… Cartan was surprised by this bureaucratic decision, not only for me, but also for other rejections he had heard about. He had the conviction that young students should not miss a chance to start scientific research if they were willing to. What happened then gives an idea of his prestige and influence: the French administration shifted gears over the following days, after some vigorous phone calls from Cartan to high rank officials in the government!

After this event, I had no other choice than starting to work seriously on a Ph.D. As a matter of fact, Cartan did not suggest any research project; his point of view (shared by some university professors) was simple. A student really interested in math should be able to raise problems according to his own taste, solve them, and, if sufficiently clever, write his Ph.D. after their solution… The role of Cartan was to check the interest of the questions involved and the correctness of the proofs.

This situation was at the same time stressful and challenging. Therefore, I started to look at many books; among them was Marston Morse's *Calculus of Variations in the Large*, a basic reference for the subject I was interested in. Reading this book was for me like swimming across the Atlantic Ocean, since I was not mature enough to understand the deep connections between differential geometry and algebraic topology.

Being Cartan's student saved me again. Indeed, I attended the 1963/1964 Cartan/Schwartz

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seminar about the Atiyah-Singer index theorem [2]. Its purpose was not only to understand the proof of this remarkable achievement but also to offer an opportunity for the students to approach exciting new research. The seminar was organized so that each student had the responsibility of some "exposés" which Cartan wanted written the "right" way. For instance, I was in charge of the exposés 4 and 5, and this was all right. However, Cartan was not satisfied with the exposé 16 I was in charge of, too. He decided to rewrite it completely (under my name). Actually, Cartan himself wrote many exposés during the years his famous seminar was running.

This Cartan/Schwartz seminar was the starting point of my research. After this experience, I did exactly what Cartan asked us to do: raised my own questions and tried to solve them. The new field of *K*-theory was a fascinating one (and still is), after the fundamental work of Grothendieck, Bott, Atiyah, Singer, Hirzebruch, and others. Many questions were left over, like the relation between Clifford algebras and Bott periodicity, the possibility of deriving the *K*-functor in order to get cohomology theories on a wide class of objects… During this period (1964–65), I had the chance to meet Grothendieck at the IHÉS. Although I was not formally his student, he helped me a lot, together with Cartan, to get my Ph.D. finally written. This was not finished, however: Cartan was asking for a "second thesis", which meant a different subject I should be able to master! Serre was kind enough to recommend to me a book about modular forms, a course he was giving at the Collège de France.

The positions at the CNRS were not supposed to be permanent (this has now changed). Therefore, after my thesis in 1967, I applied for a position at the University of Strasbourg, where Cartan was professor before the war and a little bit after. At that time, and also in 1972, when I applied for another position at the University of Paris, Cartan wrote a letter of recommendation. Of course, I don't know the contents of these letters, but from the decisions of the committees, I believe that the recommendations were positive in both cases. This is leading me to the special filial relationship between Cartan and his former students. He was ready to help when he had an opportunity, such as giving lectures about our work, so that we could get some recognition. For instance, when in Princeton during the years 1966–67, Cartan gave a lecture about my thesis before I visited the United States myself. He also gave a talk at Bourbaki's seminar about my work, as he did previously for others: Koszul, Douady, and so on. After this period, he was always inquiring about my research advances, reading my notes in the *Comptes Rendus*, asking about my own students, and this continued until the last years of his life.

Cartan influenced my mathematics directly much later than my thesis, not just in the field of *K*-theory but also in another aspect of my research linked with classical algebraic topology. The story started from a lecture Grothendieck gave at the IHÉS about a possible generalization to the integral case of the Quillen-Sullivan theory of rational homotopy types. Cartan wrote a short paper in *Inventiones* (in honor of Serre) about this subject [1]. In particular he wrote this sentence: "L'auteur expose ici ce qu'il croit avoir compris lors d'une conférence de Grothendieck á l'IHÉS le 12 décembre 1975."[14] Despite this modesty, I found Cartan's paper very inspiring and going beyond what Grothendieck explained in his lecture. Although the problem of algebraically determining integral homotopy types is still open and difficult, the way Cartan presented it was the origin of many of the papers I wrote the following years, for instance, the recent reference [4].

It is important to underline the deep European convictions of Cartan, after the two wars that were a devastation in Europe and caused so many deaths (including that of Cartan's own brother). I had the opportunity to work with him in more favorable circumstances when the first European Congress of Mathematics was launched in Paris during the year 1992. It had a difficult birth, due to the skepticism of many influential French mathematicians. I deeply think that, without Cartan's support, this Congress, and the ones which followed it,[15] would have had no chance to take place.

As a conclusion, I would like to add some words about the affability of Cartan and his wife, unfortunately deceased six months after him. When invited a few times to their homes, in Paris or Dolomieu, and also on many other occasions, I was greeted so warmly that I had the feeling of being part of the family circle.

We have lost a great mathematician and a man with a great sense of human values.

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[14] *The author explains here what he thought he has understood from a lecture of Grothendieck at the IHÉS on December 12, 1975.*

[15] *In Budapest, Barcelona, Stockholm, Amsterdam…*

Cartan, Europe, and Human Rights

Jean-Pierre Bourguignon

Remembering Henri Cartan, a Highly Influential Mathematician, a Passionate Advocate for Europe and Human Rights

Henri Cartan died on August 13, 2008, at the age of 104. His professional life had been extremely full, with many commitments, some strictly mathematical and others addressing more general societal issues.

His scientific achievements, and in particular his involvement in the birth and development of the Nicolas Bourbaki group, will be presented and discussed elsewhere.

His role as a teacher at the Université de Strasbourg, both in Strasbourg and in Clermont-Ferrand, where the university moved during the war, then at the Université de Paris, and most notably at the École Normale Supérieure (ENS), left a long-lasting impression on the many mathematicians who attended his lectures. The seminar that he organized and forcefully led at ENS in the 1950s has become legendary. His role in shaping a new generation of mathematicians cannot be underestimated, as he both attracted exceptional people and offered them the most advanced teaching, while orienting them towards worthwhile and challenging problems.

I personally followed his famous "Introduction à la topologie algébrique" course in 1967–68 but had to do it at a distance, as I was at that time a student at École Polytechnique with a busy schedule there.

Henri Cartan spent the last years of his career in the early 1970s as professor in Orsay at the mathematics department of the newly founded Université Paris-Sud.

He kept informed about what was happening in the mathematical community at large up to the very end of his life. Getting a few words from Henri Cartan on one of his personal cards was always moving and a delight because of the care taken in the wording.

A first manifestation of Henri Cartan's public concern for the free circulation of scientists occurred in connection with the International Congress of Mathematicians held in Boston in 1950. The visa application Laurent Schwartz had made to attend the ICM, where he was to receive the Fields Medal, had been set aside by the U.S. Embassy in Paris. In order to exert maximum pressure, Henri Cartan collected the passports of all the French ICM participants and threatened that there would be no French participation if Schwartz was not allowed to enter the United States. Schwartz received his visa at the very last minute, but still in time for the French delegation, led by Henri Cartan, to take the boat in Le Havre to cross the Atlantic.

Later, in 1974, he, Schwartz,[1] and a few concerned mathematicians engaged in the defense of a number of mathematicians prosecuted by their governments, such as Leonid Pliouchtch, Andrei Chikhanovitch, and Anatoli Chtcharanski in the Soviet Union, José Luis Massera in Uruguay, and Sion Assidon in Morocco. All kinds of pressures were exerted, and in the end the action of the Comité des Mathématiciens proved remarkably successful.

Later in this article, two eminent German mathematicians discuss Henri Cartan's remarkable contributions to the German-French cooperation in difficult times, and in particular his (communicative) determination to restore the flow of exchanges right after the Second World War. His scope was broader than German-French relations and embraced Europe as a whole. He in particular tried and set the practical foundations of an academic Europe by ensuring that students would be able to move from one institution to another while progressing in their studies.

He made a very public political stand for Europe through his engagement in the "Mouvement Fédéraliste Européen". This led him to become a candidate for the European Parliament.

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[1] *See L. Schwartz,* A Mathematician Grappling with His Century*, translated by L. Schneps from* Un Mathématicien aux Prises avec le Siècle *(Odile Jacob, 1997), Birkhäuser, Basel-Boston-Berlin, 2001 (ISBN 3-7643-6052-6).*

Reinhold Remmert

Henri Cartan 1904–2008

In December 1949 Henri Cartan came to Münster for the first time after World War II. I was a freshman. Heinrich Behnke encouraged me to attend Cartan's lecture. I went out of curiosity. The speaker discussed his forthcoming paper on ideals and modules of holomorphic functions, *Oeuvres II*, p. 618. I understood nothing. However, I felt as if I were in good company. After the talk there was a reception. Cartan concluded his short address (in German) with the toast "À l'Europe!" I must have looked like a doubting Thomas.

In 1952 Cartan became Doctor Honoris Causa of the University of Münster. This was his first honorary degree. In his words of thanks he pleaded strongly for the reconciliation of scientists on both sides of the Rhine.

In 1953 Karl Stein attended a conference on several complex variables in Brussels. Cartan and Serre presented their Theorem A and Theorem B for Stein manifolds to a dumbfounded audience. Back in Münster, Stein said to me: "The French have tanks. We only have bows and arrows." ("Die Franzosen haben Panzer, wir nur Pfeil und Bogen.")

Complex manifolds with many holomorphic functions were baptized "variétés de Stein" by Cartan. In the late 1950s Cartan teased Stein at a conference in Oberwolfach: "Cher ami, avez-vous aujourd'hui une variété de vous dans votre poche? (Dear friend, do you have one of your varieties in your pocket today?)" Stein looked embarrassed and said: "I never use that expression." Cartan advised him to circumvent the notation by using a variation of a well-known phrase of Montel: "… les variétés dont j'ai l'honneur de porter le nom (… the varieties whose name I have the honor of bearing)."

Henri Cartan was on very friendly terms with Heinz Götze, the wizard of Springer Verlag, Heidelberg. Both men were extremely pleased when, in 1979, the *Oeuvres* of the French mathematician Cartan were published by the German publishing house. During the ceremony at La Tour d'Argent, where the leather-bound volumes were presented, numerous jubilant toasts à l'Europe were given.

In 1981 Götze suggested having the famous ten papers by Kiyoshi Oka edited. I asked Cartan for advice. He immediately agreed to write commentaries. Later he told me that he enjoyed doing this, however completely underestimated the work involved.

The last time I met Cartan was in 1997 in Paris at the "Journée en l'honneur d'Henri Cartan". We talked about bygone years and his friendship with Behnke and Stein.

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Cartan with Laurent Schwartz and André Weil, Murols, 1954.

Henri Cartan and Laurent Schwartz, Paris, 1994.

Friedrich Hirzebruch

Henri Cartan 1904–2008

I met Henri Cartan for the first time in Oberwolfach in 1951. We met for the last time during the celebration of his 100th birthday in Paris 2004. I gave a lecture with the title "Henri Cartan: A great friend, mathematician, and European". I shall use the part of this talk that does not overlap Remmert's report.

On the occasion of Behnke's eightieth birthday on October 8, 1978, celebrated in Münster, Henri Cartan gave a beautiful dinner speech. We were all sad that Heinrich Behnke unexpectedly could not attend the dinner because of illness. He died

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Orly Airport, 1976, Cartan with Schwartz (left) and Haniack (right).

With Mrs. Cartan, Orlov, and Sakharov, Paris, 1988.

one year later. Cartan's dinner speech was printed by Springer-Verlag under the title "Quelques souvenirs par Henri Cartan". In his speech Cartan recalled his first visit to Münster in 1931. Behnke, a young professor, then thirty-two years old, had decided to make Münster an active and interesting center for the young people around him. For this purpose he had invited a young French mathematician of twenty-six years having related interests who gave four lectures in German and one in French during his one-week visit. Cartan met Peter Thullen, and this was the beginning of a scientific cooperation and long-lasting friendship. Cartan reported also about his second visit to Münster in 1938. In the meantime the famous *Ergebnisse-Bericht* (Springer-Verlag) by Behnke and Thullen had appeared in 1934. Thullen had left Germany. The political atmosphere was depressing. There were not many students. But still mathematics went on. Behnke's assistant was Karl Stein, who had received his Ph.D. degree in 1936.

During the war, the friendship between Cartan and Behnke was not interrupted; Behnke, for example, received a mathematical letter from Oka in December 1940 and informed Cartan about it. In 1943 Cartan's brother Louis was deported to Germany. About this tragedy, Cartan says in "Quelques souvenirs" addressed to Behnke:

> "Je ne puis pas non plus oublier toutes les démarches que vous avez faites durant les années 1943 et 1944 (en vain, hélas) pour tenter de retrouver la trace de mon frère Louis, déporté en Allemagne au mois de février 1943, et qui ne devait jamais revenir. (I cannot forget, too, all the efforts you made during the years 1943 and 1944 (in vain, alas) to try to find any trace of my brother Louis, who was deported to Germany in the month of February 1943, and who never returned.)"

Already in 1946 Cartan came to Oberwolfach, where he met Behnke again after eight years. The Oberwolfach guest book records that Cartan participated in a concert (Haydn, Bach, Beethoven) on November 1, 1946, and lectured on Galois theory for noncommutative fields on November 4, 1946. In this way Cartan began his efforts to reconcile the mathematicians on both sides of the Rhine (cf. Remmert's contribution).

Cartan was always interested in the work of Behnke and his students, in particular Stein, Grauert, Remmert, and myself.

For Stein's sixtieth birthday (1973) Cartan lectured at a conference in Munich and wrote an article "Sur les travaux de Karl Stein". He reported in particular about Stein's *Habilitationsschrift* (1940), which concerns Cousin's second problem. The title (translated into English) is: "Topological conditions for the existence of holomorphic functions with a given zero divisor". This is related to the famous Theorem B of Cartan and Jean-Pierre Serre.

Cartan reported about my thesis (written under Behnke and Hopf) in the Bourbaki seminar of December 1953. In the thesis I had introduced complex spaces of dimension 2 and described the resolution of their singularities.

In his *Habilitationsschrift*, Hans Grauert proved that, for a Stein manifold X and a complex Lie group L, the classification of topological principal fiber bundles over X with structural group L coincides with the classification of analytic principal fiber bundles over X with structural group L. This includes the solution of Cousin I and II ($L = C$ or C^*, respectively). Grauert published his work in three parts in *Mathematische Annalen* in 1957 and 1958 and thanked Cartan for advice. Cartan lectured on

With Marston Morse, Princeton, 1966.

Grauert's results in the "Symposium Internacional de Topologia Algebraica, Mexico 1956".

In his contribution Remmert shows that Henri Cartan was a real European. I want to emphasize this by the following remarks:

The first European Congress of Mathematics took place in Paris from July 6 to July 10, 1992. In his opening speech, Cartan calls the congress an event of great importance showing that the mathematicians know the solidarity of the countries of Europe, which are different in so many ways but have a rich common heritage and a common future. Cartan was especially glad that this first European Congress reunited the mathematicians from the two parts of Europe that were separated for such a long time. Cartan's eighty-eighth birthday was celebrated during the first European Congress at the residence of the German Ambassador in Palais Beauharnais.

The Association Européenne des Enseignants (European Association of Teachers) was founded in Paris in 1956. Cartan was president of the French section. As such he took the initiative to invite participants from eight European countries to a meeting in Paris in October 1960. Emil Artin, Heinrich Behnke, and I were the German members. The second meeting of this committee was in Düsseldorf in March 1962. As a result, the *Livret Européen de l'Etudiant* (*European Student's Record*) was published and distributed by the European Association of Teachers. The booklet contained a description of minimal requirements for basic courses. It was supposed to increase the mobility of students from one country to another. The professor of one university would mark in the booklet the contents of courses attended by the student. The professor at the next university would then be able to advise the student in which courses to enroll. The booklet was not used very much. For

Cartan with Shiing-Shen Chern, in front of Dolomieu town hall, 1984.

me it was often useful when reforms of the contents of courses were discussed.

The efforts of Cartan to harmonize mathematical studies in Europe date back more than forty-five years. Now we are implementing the Bologna process. In all European countries bachelor's and master's degrees are to be introduced. Is this the harmonization we wanted?

Cartan, the European, was also active at the international level. He was president of the International Mathematical Union for the four years 1967 to 1970. He addressed the International Congress of Mathematicians in Nice in 1970 during its opening ceremony and announced the names of the Fields Medal winners. Sergei Novikov, one of the four winners, was unable to attend, indicating the political difficulties of the time.

The mathematicians of my generation, from Germany and everywhere else, learned from Henri Cartan. His papers, books, and seminars were a source of inspiration. He showed us the right way of developing international cooperation. He and his wife were charming hosts for many visitors to Paris. He has left us, but we will always remember him with gratitude.

WHAT IS . . .

a Sandpile?

Lionel Levine and James Propp

An abelian sandpile is a collection of indistinguishable chips distributed among the vertices of a graph. More precisely, it is a function from the vertices to the nonnegative integers, indicating how many chips are at each vertex. A vertex is called *unstable* if it has at least as many chips as its degree, and an unstable vertex can *topple* by sending one chip to each neighboring vertex. Note that toppling one vertex may cause neighboring vertices to become unstable. If the graph is connected and infinite, and the number of chips is finite, then all vertices become stable after finitely many topplings. An easy lemma says that the final stable configuration is independent of the order of topplings (this is the reason for calling sandpiles "abelian"). For instance, start with a large pile of chips at the origin of the square grid $\mathbb{Z}^2$ and perform topplings until every vertex is stable. The process gives rise to a beautiful large-scale pattern (Figure 1). More generally, one obtains different patterns by starting with a constant number $h \leq 2d-2$ of chips at each site in $\mathbb{Z}^d$ and adding n chips at the origin; see Figure 3 for two examples.

Sandpile dynamics have been invented numerous times, attached to such names as chip-firing, the probabilistic abacus, and the dollar game. The name "sandpile" comes from statistical physics, in which the model was proposed in a famous 1987 paper of Bak, Tang, and Wiesenfeld as an example of *self-organized criticality*, or the tendency of physical systems to drive themselves toward critical, barely stable states. In the original BTW model, chips are added at random vertices of an $N \times N$ grid in $\mathbb{Z}^2$. Each time a chip is added, it may cause an avalanche of topplings. If this avalanche reaches the boundary, then topplings at the boundary cause chips to disappear from the system. In the stationary state, the distribution of avalanche sizes has a power-law tail: very large avalanches occur quite frequently (e.g., the expected number of topplings in an avalanche goes to infinity with N).

To any finite connected graph G we can associate an abelian group $K(G)$, called the *sandpile group*. This group is an isomorphism invariant of the graph and reflects certain combinatorial information about the graph. To define the group, we single out one vertex of G as the *sink* and ignore chips that fall into the sink. The operation of addition followed by stabilization gives the set M of all stable sandpiles on G the structure of a commutative monoid. An *ideal* of M is a subset $J \subset M$ satisfying $\sigma J \subset J$ for all $\sigma \in M$. The sandpile group $K(G)$ is the minimal ideal of M (i.e., the intersection of all ideals). The minimal ideal of a finite commutative monoid is always a group. (We encourage readers unfamiliar with this remarkable fact to prove it for themselves.) $K(G)$ is independent of the choice of sink up to isomorphism.

One interesting feature of constructing a group in this manner is that it is not at all obvious what the identity element is! Indeed, for many graphs G the identity element of $K(G)$ is a highly nontrivial object with intricate structure (Figure 2).

To realize the sandpile group in a more concrete way, we can view sandpiles σ as elements of the free abelian group $\mathbb{Z}^V$, where V is the set of nonsink

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vertices of G. Toppling a vertex v corresponds to adding the vector Δ_v to σ, where

$$\Delta_{v,w} = \begin{cases} -d(v) & \text{if } v = w, \\ 1 & \text{if } v \sim w, \\ 0 & \text{otherwise.} \end{cases}$$

Here $v \sim w$ denotes adjacency in G, and $d(v)$ is the degree of vertex v. This observation suggests that we view two vectors $\sigma, \tau \in \mathbb{Z}^V$ as equivalent if and only if their difference lies in the $\mathbb{Z}$-linear span of the vectors Δ_v.

The sandpiles lying in the minimal ideal of M are called *recurrent*. It turns out that each equivalence class in $\mathbb{Z}^V$ contains exactly one recurrent sandpile, and hence

$$K(G) = \mathbb{Z}^V / \Delta\, \mathbb{Z}^V .$$

The matrix $\Delta = (\Delta_{v,w})$ is called the *reduced Laplacian* of G (it is reduced because it does not include the row and column corresponding to the sink vertex). According to the *matrix-tree theorem*, the determinant $\det \Delta$ counts the number of spanning trees of G. This determinant is also the index of the subgroup $\Delta\mathbb{Z}^V$ in $\mathbb{Z}^V$, and so the order of the sandpile group equals the number of spanning trees.

A refinement relates sandpiles to the Tutte polynomial $T(x, y)$ of G. The number of spanning trees of G equals $T(1, 1)$. By a theorem of Merino López, $T(1, y)$ equals the sum of $y^{|\sigma|-m+\delta}$ over all recurrent sandpiles σ, where δ is the degree of the distinguished sink vertex, m is the number of edges of G, and $|\sigma|$ denotes the number of chips in σ.

The sandpile group gives algebraic manifestations to many classical enumerations of spanning trees. For example, Cayley's formula n^{n-2} for the number of spanning trees of the complete graph K_n becomes

$$K(K_n) = (\mathbb{Z}_n)^{n-2},$$

and the formula $m^{n-1}n^{m-1}$ for the number of spanning trees of the complete bipartite graph becomes

$$K(K_{m,n}) = \mathbb{Z}_{mn} \times (\mathbb{Z}_m)^{n-2} \times (\mathbb{Z}_n)^{m-2}.$$

The name "sandpile group" is due to Dhar, who used the group to analyze the BTW sandpile model.

A deep analogy between graphs and algebraic curves can be traced back implicitly to a 1970 theorem of Raynaud, which relates the component group of the Neron model of the Jacobian of a curve to the Laplacian matrix of an associated graph. In this analogy, the sandpile group of the graph plays a role analogous to the Picard group of the curve. Many of the authors who explored this analogy chose different names for the sandpile group, including "group of components" (Lorenzini), "Jacobian group" (Bacher et al.) and "critical group" (Biggs). Recent work of Baker and Norine carries the analogy further by proving a Riemann-Roch theorem for graphs.

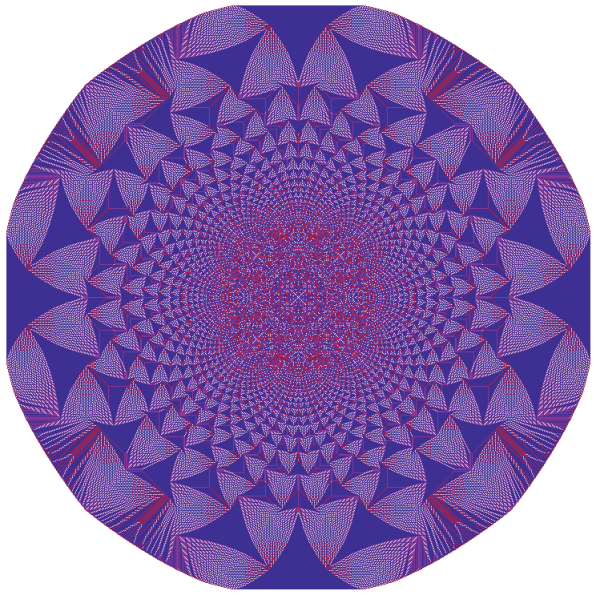

Figure 1. Stable sandpile of $n = 10^6$ chips in $\mathbb{Z}^2$. Color scheme: sites colored blue have 3 chips, purple 2 chips, red 1 chip, white 0 chips.

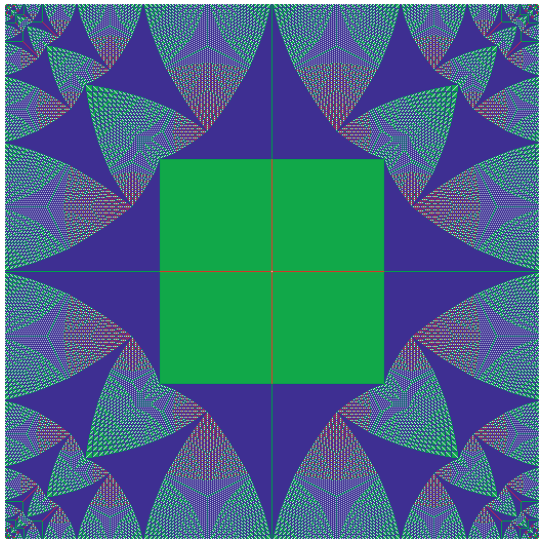

Figure 2. Identity element of the sandpile group of the 523×523 square grid graph, with all boundary vertices identified and taken as the sink. Color scheme: sites colored blue have 3 chips, green 2 chips, red 1 chip, orange 0 chips.

The *odometer* of a sandpile σ is the function on vertices defined by

$$u(v) = \#\text{ of times } v \text{ topples}$$
during the stabilization of σ.

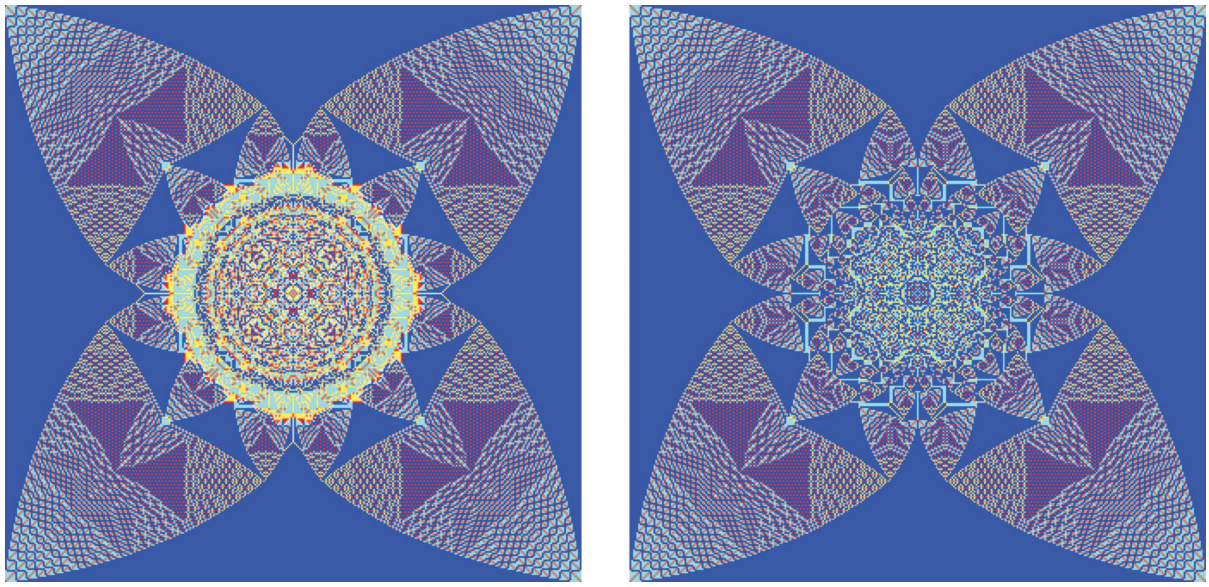

Figure 3. Left: A two-dimensional slice through the origin of the sandpile of $n = 5 \cdot 10^6$ particles in $\mathbb{Z}^3$ on background height $h = 4$. Right: The sandpile of $m = 47465$ particles in $\mathbb{Z}^2$ on background height $h = 2$. Color scheme on left: sites colored blue have 5 particles, turquoise 4, yellow 3, red 2, gray 1, white 0. On right: blue 3 particles, turquoise 2, yellow 1, red 0.

The final stable configuration τ is given in terms of σ and u by

$$\tau = \sigma + \Delta u.$$

In particular, u obeys the inequalities

$$u \geq 0, \tag{1}$$

$$\sigma + \Delta u \leq d - 1. \tag{2}$$

One can show that the sandpile toppling rule implies a kind of *least action principle*: the odometer function is the pointwise minimum of all integer-valued functions u satisfying (1) and (2).

The least action principle says that sandpiles are "lazy" in a rather strong sense: even if we allow "illegal" toppling sequences that result in some vertices having a negative number of chips, we cannot stabilize σ in fewer topplings than occur in the sandpile dynamics. What is more, sandpiles are locally lazy: not only is the total number of topplings minimized, but each vertex does the minimum amount of work required of it to produce a stable final configuration.

The least action principle characterizes the odometer function as the solution to a type of variational problem in partial differential equations called an *obstacle problem*. The problem takes its name from an equivalent formulation in which one is given a function called the *obstacle* and asked to find the smallest superharmonic function lying above it.

The obstacle problem for the sandpile odometer has one extra wrinkle, which is the constraint that u be integer-valued. Relaxing this constraint yields the odometer function for a different model called the *divisible sandpile*, in which the discrete chips are replaced by a continuous amount of mass which may be subdivided arbitrarily finely during topplings. The divisible sandpile has dramatically different behavior: starting with mass m at the origin in $\mathbb{Z}^2$, one obtains a region A_m of fully occupied sites, bordered by a strip of partly filled sites. The set A_m is very nearly circular, reflecting the rotational symmetry of the continuous Laplacian. Amazingly, the anisotropy, as well as the intricate patterns of Figure 1, arises entirely from the extra integrality constraint.

Two fundamental features of sandpiles in lattices $\mathbb{Z}^d$ remain unexplained by theorems. One is *scale invariance*: large sandpiles look like scaled-up small sandpiles. The picture in Figure 1, rescaled by a factor of $1/\sqrt{n}$, appears to have a limit as $n \to \infty$. The limit is a function f on the unit square $[0,1]^2$ which is locally constant on an open dense subset. Each region where f is constant corresponds to a patch on which the sandpile configuration is periodic. The second unexplained feature is *dimensional reduction*: d-dimensional slices of $(d+1)$-dimensional sandpiles look like d-dimensional sandpiles, except in a region near the origin. Figure 3 compares a sandpile in $\mathbb{Z}^2$ with a 2-dimensional slice of a sandpile in $\mathbb{Z}^3$.

As a way of measuring avalanches, Dhar considered the odometer function associated with the operation of adding a single chip to a sandpile. Starting from the stationary state and adding a single chip at v, let $u_v(w)$ be the expected number of times w topples. When the system stabilizes, it

is again in the stationary state, so the expected net change in height from topplings is $\Delta u_v(w) = -\delta_{v,w}$ (here δ is Kronecker's delta). In other words,

$$u_v(w) = (-\Delta^{-1})_{v,w}.$$

The entry $(-\Delta^{-1})_{v,w}$ of the inverse reduced Laplacian matrix has a natural interpretation in terms of random walks: it is the expected number of visits to w by a random walk on G started at v and stopped when it first visits the sink. For example, if G is the cube of side length n in $\mathbb{Z}^d$ ($d \geq 3$) with sink at the boundary of the cube, then this expectation has order $|v - w|^{2-d}$ for v, w away from the boundary. Summing over w, we see that the expected number of topplings diverges as $n \to \infty$. The situation is even more extreme for $d = 2$: the expected number of times each individual site near v topples goes to infinity with n.

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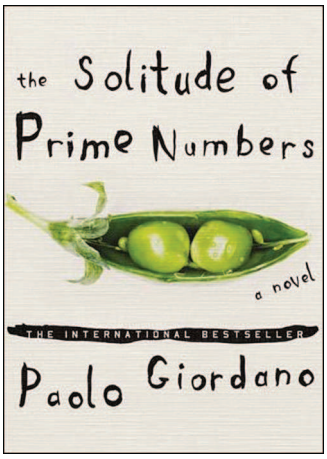
Book Review



The Solitude of Prime Numbers

Reviewed by Joel Spencer

The Solitude of Prime Numbers
Paolo Giordano
Pamela Dorman Books, 2010
US$25.95, 288 pages
ISBN-13:978-0670021482

Paolo Giordano's brilliant melancholy debut novel is a love story between two seriously flawed characters, Alice and Mattia. We follow them from childhood, through painful adolescence, the novel ending in still painful adulthood. Alice has extreme difficulty with relationships, though she eventually marries and finds a position she loves as a photographer's assistant. This reviewer, naturally enough, found Mattia more intriguing. Mattia is a mathematician.

Are mathematicians different from other people? Do they think differently? Do they act differently? Are their relationships with other people different from "normal" society? With Mattia one would have to answer yes to all of these questions.

The attempts of literature to capture the mathematical mind are usually so far from any reality as to be laughable to anyone in the field. The novel by Paolo Giordano is an exception. The biographical material states that he is a student himself in particle physics. Perhaps his own personal background allows him to write so convincingly.

> With meticulous ritualism, Mattia copied out the proofs of all the theorems he encountered in his studies. Even on summer afternoons he kept the blinds lowered and worked in artificial light. He removed from his desk everything that might distract his gaze, so as to feel truly alone with the page. He wrote without stopping. [page 113]

That is not me. Maybe it is not you. But it rings true. Mattia works in number theory, more particularly on the Riemann zeta function. His love of the integers is reminiscent of Ramanujan:

> Mattia liked to count, starting from 1 and proceeding through complicated progressions, which he often invented on the spur of the moment. He allowed himself to be led by numbers and he seemed to know each one of them. [page 114]

Mattia, examining a shelf of books, attempts to make a word from the first letters of all the titles. He stacks dishes, collecting them in the same order every evening. A coveted job offer arrives and he meticulously examines the logo on the letterhead. His apartment is spartan: "If he had simply upped and left the apartment that very evening and not come back, no one would have found any sign of his presence, apart from those incomprehensible pages stacked on his table" [page 185]. When he describes a breakthrough it is "as if he had performed this calculation hundreds of times, when in fact it was the first time he had pulled it out of his head" [page 197]. Sound familiar?

It is Mattia's inner life that is truly disturbing. More precisely, it is the absence of personal relationships in Mattia's life that is so difficult. Conversations with his father are strained, brief, and not informative. His mother, a character I wish had been more fully developed, is barely communicative. In adolescence, however, he meets Alice.

Twin primes (primes differing by 2, such as 101 and 103) are used as a beautiful metaphor for Mattia and Alice. Primes occur more and more rarely, so that each one is a gem. Usually they are in "solitude", far from other primes. They cannot

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touch (except for $2, 3$), as then one of them would be even. The closest they can be is two apart. Mattia and Alice are two rare spirits, almost but not quite touching.

Mattia and Alice would lie together on Alice's bed with their heads at opposite ends. They would bend their legs unnaturally so that their bodies would not actually touch. Mattia cannot, or will not, make an emotional commitment. He neglects to tell Alice of his graduation. When she appears anyway he "looked at her as one looks at a hallucination" [page 129]. He accepts a position abroad and has no contact with her for years. In the climax to this slender volume Alice sends him a photograph with the message "You've got to come here" [page 237]. Mattia arrives the next day. Their love for each other is profound, but will it be sufficient for these twin primes to touch?

This is a difficult book. Both Alice and Mattia suffer severe trauma in childhood. There are scenes of self-mutilation. There are scenes of intense embarrassment. There is a gaggle of adolescent girls of exceptional meanness. There is a marriage, Alice's, that does not go well. Yet I do think Paolo Giordano has done something rare. He has given his readers a glimpse into the mind of a mathematician.

"Exam-Hell" in Korea

Kang-Tae Kim

Perhaps you have heard of the terminology "Entrance-Exam Hell". Yes, it is the term that describes the "rigor" of the entrance exam to colleges and universities in certain Asian countries. The Korean term "Ji-ok" in this "Ip-si-ji-ok" (entrance-exam-hell) is translated to mean "hell". But perhaps the more correct translation may be "dungeon", in the sense that it does not carry any religious connotations and that the term just indicates an environment that is very difficult for anyone to survive.

Whatever the correct translation may be, "exam-hell" is the stage a young student goes through in order to enter a good university. All young Korean students know very well that, sooner rather than later, they have to be drawn into the dark mouth of exam-hell! They also know what "rigor"—read: difficult and harsh test—is waiting for them in exam-hell. In fact, a large part of the exam is national and standardized, whose contents are officially required by the Ministry of Education (MOE), one of the more important government agencies in Korea.

The exams and the curriculum leading up to them are national and standardized. Once the exam contents are announced, not only does the "power of exam-hell" reign over the lives of young Korean students, but it also shakes the whole of Korean society. Young students have to plan for their futures accordingly, and parents and all senior members of the family have to consider carefully what they can do for their delicate young. For better or for worse, the future of their young members of our cohort is, by and large, the future of the family.

The power of exam-hell is suffocating. Koreans feel that the preparation time is insufficient. Pressured young souls sometimes feel an urge to ask, "Why? Do I/we have to go through exam-hell? I mean, may I ask why I should?" The question is not forbidden, at least not in principle; but it is in real life. Grown-ups will immediately say, "No time to waste on such questions! Save time to study more." Yes, it is madness. But in Korean society—in which "obedience to seniors" is still a virtue—good girls and boys swallow their fireball deep down and walk, bravely, into the path leading eventually toward the mouth of exam-hell.

I fortunately teach at POSTECH, one of the most prestigious institutions in Korea. So I get to meet the most successful students who come through exam-hell in the freshman classes. Yes, they are good! They have mastered the basic concepts and techniques from first-year calculus—differentiation and integration of elementary functions, including some transcendental functions, and even some techniques of integration. The majority of them are ready, without fear, to learn ordinary differential equations, calculus of functions in several variables, and linear algebra. They are ready to absorb new, challenging knowledge. This is admirable! In fact, I remember the conversations I had with several prominent French colleagues on various occasions. They studied the Korean system of education in some of their national committees! I confirmed their finding, saying, "Yes, almost all Korean universities have a rigorous selection process for their entering freshmen." And they said, approvingly, *"Fantastique!"* They really admired that part of the Korean system. In this regard, exam-hell can be a system that even a more advanced country can envy.

There seems to be nothing in this world that is just "good". While exam-hell produces these "able

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and courageous soldiers", I get to witness many more than just a few frail young souls suffering "in the dark". Every year, some commit suicide, leaving a blood-stained note saying something like, "Happiness doesn't come in the order of academic achievements, does it?" Such extreme cases (thank heavens, there are not so many) in the news every year tear my heart apart. Some other young souls *merely* suffer mental difficulties, stresses, and anxious agitated depression. Other students accept their inferiority as "reality" at such a young age—they are not even twenty-years old!—and they try to be ready to live the life of a "delta" or "epsilon"—of the lower classes, as in Huxley's *Brave New World*. It is cruel, but would we say that such casualties just have to occur in any battle? Of course, Korean seniors, including the Korean MOE, do not have such a "hardened" heart to discount all these problems. Even at the time of this writing much effort is being given to correct some of these difficulties—at least I would like to believe so. It is just that these are very hard to resolve; new problems arise as soon as one appears solved.

Yielding unwillingly to the "encouraging" advice not to mourn for the "casualties" too long, shall we now look at the brighter side? How do our successful young people do? Let us not look only at the students at POSTECH but also include those who are in the "better half" of Korean universities (Korea has approximately 200 colleges and universities). It is also true that the "energy supply" of young Korean talent is limited. They show evidence of exhaustion at some stage, usually between the second and third years of their college life. During this period, many male students choose to fulfill their military service, which is mandatory in Korea. The military duty is such a time loss to many, but it is on the other hand viewed as a convenient "escape" from this wandering period—especially from the female point of view. Female students, who are not required to go to the military, also suffer the same wandering stage—they file leaves of absence. Many observers of this situation, ignoring the trauma that has already occurred, call this the "block" that formerly excellent Korean students often face in their academic progress. It is definitely the aftermath of exam-hell and the long effort preparing for it. Obviously students try everything—after all, it is their life—to overcome these "blocks". But why should they have to? A serious, careful study of the system could perhaps improve it, and many of the students could then resume progress in graduate schools or in professional careers. The recent statistics on the noticeable achievements by Koreans in many areas seem to support the observation that students are indeed managing to do this. All the same, I wish that the system could be improved so that the students do not have to suffer through the wandering period so much.

In Korea, entrance-exam-hell is generally understood as "evil". MOE's present intention seems to be to change it into a system similar to that of the United States, namely, each university runs an American-style admissions office. I wonder if they have considered the fact that Korea may be quite different. Last year POSTECH ran such a new system; I was amazed at reading the resumés of the applicants. They may not be going through the old exam-hell, but they are driven to perform many other new things—it is a new exam-hell. It is unthinkable for me and for anyone to insist that the old exam-hell is ideal. But this is the year 2010 and, to Koreans and to anyone, the systems of the more advanced countries are no longer a hidden secret. It is high time to study ourselves and the other systems carefully—together to build a good outcome for all of our youngsters. After all, they are our future, are they not?

Acknowledgments: I thank Professor Michael Fowler, Ed. D., at Handong Global University (in Pohang, Korea) for showing me some of his research results and sharing views.

An Update: Are Women Getting All the Jobs?

Mary E. Flahive and Marie A. Vitulli

In the 1990s some mathematicians questioned whether affirmative action efforts were skewing the job market in favor of women. With this in mind, twelve years ago we analyzed the 1991–1995 employment data collected by the AMS for possible gender bias in the employment of new Ph.D. mathematicians. A summary of our analysis appeared in [1], where we reported that the data showed that women were *not* getting more than their share of first jobs, but that there were gender differences in the *type* of employment. In the current article we summarize what has happened in the intervening years. We thank Jim Maxwell of the AMS for supplying the data collected from the AMS-ASA-IMS-MAA-SIAM Annual Surveys (`http://www.ams.org/employment/survey.html`), and Virginia Lesser, Department of Statistics, Oregon State University, for helpful discussions concerning the statistical framework of this article.

Each year the AMS conducts a census of new Ph.D.s by sending surveys to all departments that grant doctoral degrees in mathematics. The data are grouped by the AMS according to type of doctorate-granting department: Group I consists of the top 48 U.S. mathematics departments;[1] Group II contains the next 56 departments; Group III contains the remaining U.S. departments reporting a doctoral program in mathematics; Group IV contains U.S. departments (or programs) of statistics, biostatistics, and biometrics reporting a doctoral program; and Group Va consists of all U.S. departments (or programs) in applied mathematics/applied science reporting a doctoral program. Group IV is not considered in this report.

The response rate for all groups treated in this report has been on average at least 96% since 2002.[2] Despite the high overall response rate, over the past few years an increasing number of departments have sent the AMS only basic information on their new Ph.D.s and have often omitted data on employment status. The number of unknowns would be even higher but for Web searches by the AMS that secured additional employment information, especially for those in academia. This is among the reasons why the AMS conjectures new Ph.D.s who are categorized as Unknowns are skewed toward new Ph.D.s in non-academic employment and individuals who may no longer be in the U.S. The survey data also neither distinguish between one-year and multi-year jobs nor identify tenure-stream positions.

In this note we return to three questions raised in our original investigation:

- Do men and women have the same employment rates?
- Are there gender differences in the type of employment?
- With regard to academic jobs in Groups I, II, III, Va, are men and women equally successful in obtaining positions in departments whose ranking is at least comparable to the degree-granting department?

Although our current analysis is similar to the earlier one, there are some differences. In

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[1] *The ranking is based on the 1995 report* Research-Doctorate Programs in the United States: Continuity and Change, *published by National Academy Press.*

[2] *Our data as well as all response rates come from the Second Reports of the Annual Surveys from 2001 on. Prior to 2001 only the data from the First Reports were available.*

Table 1a. Observed Frequencies of First Jobs (Percentages of Column Totals) for Groups I–III Ph.D.s

	1991–1995			1996–2008		
Employer Type	Female	Male	Totals	Female	Male	Totals
Group Ia	108 (15.4%)	491 (19.6%)	597 (18.7%)	399 (18.1%)	1466 (22.4%)	1865 (21.3%)
Group II	34 (4.9%)	149 (5.9%)	183 (5.7%)	180 (8.2%)	552 (8.4%)	732 (8.4%)
Group III	65 (9.4%)	183 (7.3%)	248 (7.8%)	123 (5.6%)	229 (3.5%)	352 (4.0%)
Master's	82 (11.9%)	235 (9.4%)	317 (9.9%)	238 (10.8%)	467 (7.1%)	705 (8.1%)
Bachelor's	185 (26.9%)	422 (16.8%)	607 (19.0%)	489 (22.2%)	987 (15.1%)	1476 (16.9%)
Other Academic	155 (22.5%)	652 (26.0%)	807 (25.2%)	456 (20.7%)	1557 (23.8%)	2013 (23.0%)
Non-Academic	62 (9.0%)	379 (15.1%)	441 (13.8%)	317 (14.4%)	1277 (19.5%)	1594 (18.2%)
Totals	689 (100%)	2511 (100%)	3200 (100%)	2202 (100%)	6535 (100%)	8737 (100%)

the current study the data on new Ph.D.s from Group Va departments are included. Also, over the years there has been some change in the recording of data, principally the 1996 change in the groupings of doctorate-granting institutions already discussed. Finally, in Table 2 we report comparable employment percentages for all new Ph.D.s rather than for U.S. citizens only.

Do Men and Women Have the Same Employment Rates? As in the original study, we calculate a jobless rate; that is, the rate of unemployment based only on those individuals whose employment status is known.

Looking only at Groups I–III, each of our studies found no substantial gender difference in rates: for 1991–95 the jobless rate for women was 10.2% and for men was 12.0%; for 1996–2008 the jobless rates were 6.0% (women) and 5.2% (men). When Group Va is included, the 1996–2008 jobless rates decrease to 5.3% for women and 4.6% for men.

There were two anomalous years. In 2001 there was a significant difference in jobless rates by gender: 9.0% (women) and 4.1% (men). During the early 2000s there were a substantial number of NSF-sponsored postdocs including those from the VIGRE program. We wonder if there was a noticeable gender difference in these awards that contributed to the difference in jobless rates. The second year was 2008 when the jobless rates were considerably higher for both genders: 10.3% (women) and 11.9% (men).

Are There Gender Differences in the Type of Employment? (Refer to Tables 1a and 1b.) In order to analyze similar employment, we have combined several AMS categories of employers. For us, Other Academic employers combines the AMS categories of Groups IV, Va, Two-Year Colleges, Other Academic and Non-U.S. Academic employers; our Non-Academic refers to the three AMS categories of Government, Business and Industry, and Non-U.S. Non-Academic. In addition, we include research institutes with Group I academic institutions, collectively referring to them to as Group Ia. For Groups I–III (refer to Table 1a) there continues to be a marked gender difference in the employment rates with three employer types: Group Ia, Non-Academic, and Bachelor's. There is a higher percentage of employment of men both in Group 1a (18.1% female vs. 22.4% male) and in Non-Academic employers (14.4% female; 19.5% male). On the other hand, the first jobs for 22.2% of the women and 15.1% of the men are at four-year colleges. This difference in type of position translates into less opportunity for women to continue their mathematical research as well as a possible gender-biased salary disparity. As an aside, we note that the total employment for the groups Ia, II, and Non-Academic has increased in the last decade. During 1996–2008, 25.2% of the Groups I–III Ph.D.s were women.

For our analysis of the Group Va cohort (refer to Table 1b), the AMS groups IV and Va have been added as separate employer types and therefore deleted from Other Academic category. Table 1b indicates there is less gender difference in employment rates for new Ph.D.s from Group Va programs. There is still a gender difference for first jobs at four-year colleges (7.5% female vs. 3.7% male) and Non-Academic jobs (33.5% female and 39.2% male). In addition we observe a gender difference for Other Academic jobs (32.7% female; 26.4% male). During 1996–2008, 24.5% of the Group Va Ph.D.s were women.

With Regard to Academic Jobs, Are Men and Women Equally Successful in obtaining positions in departments whose ranking is at least comparable to the degree-granting department? (Refer to Table 2.)[3] As noted earlier, since the data collected from departments do not give detailed information on the type of position, a definitive answer to this question is not possible. Given that caution, the information in Table 2 again indicates that women are slightly less successful in obtaining positions

[3] *For Group I Ph.D.s we calculated the percentage who obtained jobs at Group Ia departments; for Group II Ph.D.s we calculated the percentage who obtained jobs at Group Ia–II departments; and for Group III Ph.D.s we calculated the percentage who obtained jobs at Group Ia–V departments.*

Table 1b. Observed Frequencies of First Jobs (Percentages of Column Totals) for Group Va Ph.D.s 1996–2008

Employer Type	Female		Male		Totals	
Group Ia	27	(10.6%)	96	(12.3%)	123	(11.9%)
Group II	7	(2.8%)	21	(2.7%)	28	(2.7%)
Group III	1	(0.4%)	13	(1.7%)	14	(1.4%)
Group IV	3	(1.2%)	9	(1.2%)	12	(1.2%)
Group Va	23	(9.1%)	79	(10.1%)	102	(9.9%)
Master's	6	(2.4%)	22	(2.8%)	28	(2.7%)
Bachelor's	19	(7.5%)	29	(3.7%)	48	(4.6%)
Other Academic	83	(32.7%)	206	(26.4%)	289	(27.9%)
Non-Academic	85	(33.5%)	306	(39.2%)	391	(37.8%)
Totals	254	(100%)	781	(100%)	1035	(100%)

Table 2. Comparable Employment Rates for New Groups I–III Ph.D.s

Ph.D. Granting Institution												
1991–1995						1996–2008					
Group I		Group II		Group III		Group I		Group II		Group III	
F	M	F	M	F	M	F	M	F	M	F	M
27.1%	31.0%	11.3%	17.4%	20.6%	17.7%	30.9%	33.7%	20.2%	19.8%	18.7%	19.2%

comparable with their training. We have included data summarizing our earlier findings, and note that the success rates for both females and males from Group II institutions have improved over the past decade, particularly for women. Group I continues to have the most success in obtaining employment comparable to their training.

For Ph.D.s from Group Va departments, we considered comparable academic employment to be jobs in either Group Ia or Group Va departments. Under this definition, Ph.D.s from Group Va have comparable employment rates of 19.7% for women and 22.4% for men, again slightly more favorable for men.

In summary, our analysis shows that,over the past two decades, men and women have been about equally successful in obtaining first jobs but there continue to be marked gender differences in the type of first jobs. We encourage all doctoral departments and programs to help minimize the number of Unknowns by supplying as much information about their recent Ph.D.s as possible.

References

[1] MARIE A. VITULLI and MARY E. FLAHIVE, Are women getting all the jobs?, *Notices of the AMS* **44** (1997), 338–339.

Bourgain Receives 2010 Shaw Prize

On May 27, 2010, the Shaw Foundation announced that it would award its annual Shaw Prize in Mathematical Sciences to JEAN BOURGAIN "for his profound work in mathematical analysis and its application to partial differential equations, mathematical physics, combinatorics, number theory, ergodic theory, and theoretical computer science." The prize carries a cash award of US$1 million.

The Shaw Prize in Mathematical Sciences committee made the following statement:

"Mathematical analysis deals with limiting processes such as the approximation of a circle by inscribed regular polygons with increasing numbers of sides (a method used by Archimedes) or the notion of instantaneous velocity used in dynamics. The calculus of Newton and Leibniz provided the machinery for its successful application, from the orbits of planets to flight of aeroplanes and the devastation of a tsunami. Underpinning this limiting process is a variety of inequalities, often of a combinatorial nature, whose precise formulation and proof require great insight and ingenuity. The tools and language of analysis form the foundation for vast areas of mathematics, ranging from probability theory and statistical physics to partial differential equations, dynamical systems, combinatorics, and number theory.

"Jean Bourgain is one of the most brilliant analysts of our times. He has resolved central and long-standing problems in each of the above fields. In doing so he has introduced fundamental techniques, many of which have become standard tools in these areas. His work and ideas have greatly enhanced the very fruitful cross-fertilizations between all these disciplines.

"A prime example of his work is his development of the sum-product phenomenon. This is a fundamental combinatorial property which quantifies the relation between the two most basic operations of addition and multiplication. He has used this sum-product theory to resolve problems connected with distribution and counting of symmetries, combinatorics, number theory, and solutions of algebraic equations.

"More surprisingly, these techniques of Bourgain are intimately related to the very subtle geometry of the Kakeya problem, where a car (idealized as a line segment) is to be reversed in an arbitrarily small area, using an N-point turn with very large N.

"In many areas of mathematics and science, random numbers play a key role, but they are in fact hard to produce: tossing a coin is not a practical solution, and the coin may be biased. Bourgain has applied his techniques to provide explicit structures that exhibit randomness, and these have important applications in theoretical computer science."

Jean Bourgain

Jean Bourgain, born in 1954 in Brussels, Belgium, has been a professor at the Institute for Advanced Study in Princeton since 1994. He obtained his Ph.D. from the Free University of Brussels in 1977. He served as professor of mathematics at the Free University of Brussels from 1981 to 1985, at the University of Illinois at Urbana-Champaign from 1985 to 2006, and at the Institut des Hautes Études Scientifiques, Paris, from 1985 to 1995. He is a foreign member of the Academies of Science of France, Poland, and Sweden.

The Shaw Prize is an international award established to honor individuals who are currently active in their respective fields and who have achieved distinguished and significant advances, who have made outstanding contributions in culture and the arts, or who have achieved excellence in other domains. The award is dedicated to furthering societal progress, enhancing quality of life, and enriching humanity's spiritual civilization. Preference is given to individuals whose significant work was recently achieved.

The Shaw Prize consists of three annual awards: the Prize in Astronomy, the Prize in Life Science and Medicine, and the Prize in Mathematical Sciences. Established under the auspices of Run Run Shaw in November 2002, the prize is managed and administered by the Shaw Prize Foundation based in Hong Kong.

Previous recipients of the Shaw Prize in Mathematical Sciences are Simon K. Donaldson and Clifford H. Taubes (2009), Vladimir Arnold and Ludwig Faddeev (2008), Robert Langlands and Richard Taylor (2007), David Mumford and Wen-Tsun Wu (2006), Andrew Wiles (2005), and Shiing-Shen Chern (2004).

—From Shaw Foundation announcements

Mathematical Sciences in the FY 2011 Budget

Samuel M. Rankin III

Highlights

• Federal support for the mathematical sciences is slated to grow from an estimated US$537.36 million in FY 2010 to an estimated US$558.34 million in FY 2011, an increase of 3.9 percent.

• The National Science Foundation's (NSF) Division of Mathematical Sciences (DMS) would increase by 5.0 percent to US$253.46 million.

• The aggregate funding for the mathematical sciences in the Department of Defense (DOD) agencies Air Force Office of Scientific Research (AFOSR), Army Research Office (ARO), Defense Advanced Research Project Agency (DARPA), National Security Agency (NSA), and Office of Naval Research (ONR) would increase by 4.9 percent from FY 2010.

• The aggregate funding for the mathematical sciences in the Department of Energy (DOE) would increase by approximately 0.7 percent.

Introduction

Research in the mathematical sciences is funded primarily through the National Science Foundation, the Department of Defense (including the National Security Agency), the Department of Energy, and the National Institutes of Health (NIH). As in previous years, the majority of federal support for the mathematical sciences in FY 2011 would come from the NSF, contributing approximately 45.4 percent of the federal total. The DOD accounts for around 20.4 percent of the total, the DOE 17.7 percent, and NIH supplies around 16.5 percent. The NSF currently accounts for over 65 percent of the federal support for academic research in the mathematical sciences and is the only agency that supports mathematics research broadly across all fields. The DOD, DOE, and NIH support research in the mathematical sciences that contributes to the missions of these agencies.

DOD supports mathematical sciences research and related activities in several programs: the Directorate of Mathematics, Information, and Life Sciences and the Directorate of Physics and Electronics, within AFOSR; the Information Sciences Division within ARO; the Mathematics, Computers, and Information Sciences Research division within ONR; the Defense Sciences Program and the Microsystems Technology Office within DARPA; and the Mathematical Sciences Program within NSA.

DOE funds mathematics through its Applied Mathematics and Scientific Discovery through Advanced Computing (SciDAC) programs within the DOE office of Advanced Scientific Computing Research. The National Institutes of Health funds mathematical sciences research primarily through the National Institute of General Medical Sciences (NIGMS) and through the National Institute of Biomedical Imaging and Bioengineering (NIBIB).

Trends in Federal Support for the Mathematical Sciences

The FY 2011 estimated aggregate spending for mathematical sciences research and related activities would be US$558.34 million, a potential increase of 3.9 percent over FY 2010 estimated spending. The NSF Division of Mathematical Sciences budget would increase by 5.0 percent in FY 2011, while the DOD agencies would increase by 4.9 percent over FY 2010. AFOSR increases its spending by 14.1 percent, while ONR and ARO increase spending for the mathematical sciences by 4.5 and 4.2 percent, respectively. DARPA decreases by 21.2 percent, and NSA is flat. The DOE

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mathematical sciences budget increases by 0.7 percent, while NIH funding grows by 3.3 percent.

The American Recovery and Reinvestment Act of 2009 (ARRA) provided the NSF Division of Mathematical Sciences with an additional US$97.34 million over the FY 2009 appropriated amount. This enabled the Division to provide support for deserving investigators who, because of lack of funds, were not supported in the past. Many of the researchers supported via Recovery funds are in the early stages of their careers. If the NSF budget, and consequently, the DMS budget, fails to grow adequately in the future, the ability to continue to support more high-quality mathematical researchers will severely diminish.

The mathematical sciences make major contributions to the country's intellectual capacity and provide the tools, insight, and capability needed for innovation and technological progress. Many disciplines depend on research in the mathematical sciences to open up new frontiers and advance discovery. Mathematical sciences research contributes to advances in many areas, such as: medicine, cyber security, weather prediction, digital data compression and mining, aeronautics, and computing.

National Science Foundation (NSF)

The Division of Mathematical Sciences (DMS), http://www.nsf.gov/div/index.jsp?div=DMS, is housed in the NSF Directorate of the Mathematical and Physical Sciences (MPS). This directorate also contains the Divisions of Astronomical Sciences, Chemistry, Materials Research, Physics, and Multidisciplinary Activities. DMS supports advances in the intellectual frontiers of the mathematical sciences and enables the advance of knowledge in other scientific and engineering fields.

DMS has essentially two modes of support: (1) research and education grants, and (2) institutes. Grants include individual-investigator awards; awards for groups of researchers, including multidisciplinary; and educational and training awards aimed at increasing the number of U.S. students choosing careers in the mathematical sciences. Each year, typically 60.0 percent of the DMS budget is available for new research grants, and the remaining 40.0 percent is used primarily to fund continuing grants made in previous years.

Table 1: Federal Funding for the Mathematical Sciences (millions of dollars)#

	FY 09	FY 10	FY 11 Request	Change 2010–11 Amount	Change 2010–11 Percent
National Science Foundation					
DMS*	322.18	241.38	253.46	12.08	5.0
Department of Defense*					
AFOSR	44.50	53.30	60.80	7.50	14.1
ARO	12.50	12.00	12.50	0.50	4.2
DARPA	20.78	17.52	13.80	-3.71	-21.2
NSA	4.00	4.00	4.00	0.00	0.0
ONR	22.60	22.00	23.00	1.00	4.5
Total DOD	104.38	108.81	114.10	5.29	4.9
Department of Energy					
Applied Mathematics	45.16	44.79	45.45	0.66	1.5
SciDAC**	59.70	53.29	53.30	0.01	0.0
Total DOE	104.86	98.08	98.75	0.67	0.7
National Institutes of Health					
NIGMS*	47.00	50.00	52.00	2.00	4.0
NIBIB*	38.10	39.09	40.03	0.94	2.4
Total NIH	85.10	89.09	92.03	2.94	3.3
Total All Agencies	616.52	537.36	558.34	20.98	3.9

#Budget information is derived from agency documents and conversations with agency program managers and representatives.

**FY 2009 NSF-DMS budget includes US$97.34 million from American Reinvestment and Recovery Act.*

***Scientific Discovery through Advanced Computing (SciDAC).*

DMS is slated to receive US$253.46 million in FY 2011, an increase of US$12.08 million, or 5.0 percent over FY 2010 funding. Funding for core research will increase by US$13.55 million to a total of US$219.74 million. Other programs receiving increases are Climate and Energy Research (+ US$2.50 million to a total of US$9.50 million); Science and Engineering Beyond Moore's Law (SEBML) (+ US$1.20 million, total of US$3.95 million); MPS-Life Science Interface (+ US$2.39 million, total of US$2.39 million).

SEBML continues the algorithmic "Moore's Law", the exponential increase in speed of basic computations due to innovative new algorithms and new mathematical frameworks for computation. As part of the Science, Engineering, and Education for Sustainability (SEES) portfolio, DMS will support development of potentially transformative mathematical, statistical, and computational methods needed for analysis and simulation of climate models and will increase its investment in the Solar Energy Initiative (SOLAR), a program supporting multidisciplinary teams engaged in research on the efficient harvesting, conversion, and storage of solar energy. MPS–Life Sciences supports potentially transformative research in mathematical and computational biology.

DMS will terminate these programs: Vertical Integration Research and Education (VIGRE); Proactive Recruitment in Introductory Science and Mathematics (PRISM); Scientific Computing Research Environments in the Mathematical Sciences (SCREMS); Interdisciplinary Grants in the Mathematical Sciences (IGMS); University-Industry Cooperative Research Programs in the Mathematical Sciences; and Computational Science Training for Undergraduates in the Mathematical Sciences (CSUMS). Savings from these programs will be reinvested in higher priority workforce and infrastructure programs.

Air Force Office of Scientific Research (AFOSR)

Portfolios for the mathematical sciences at AFOSR are found in the Directorate of Mathematics, Information, and Life Sciences and the Directorate of Physics and Electronics. The AFOSR mathematics program includes specific portfolios in dynamics and control, multiscale modeling, computational mathematics, optimization and discrete mathematics, electromagnetics, and sensing, surveillance, and navigation. For additional information on the focus areas within each of these portfolios, refer to the Broad Agency Announcement 2010–1 which can be viewed on the AFOSR public website at http://www.afosr.af.mil. The AFOSR FY 2011 budget estimate for mathematical sciences reflects an increase of 14.1 percent over FY 2010.

Army Research Office (ARO)

The Mathematics Program, housed in the Information Sciences Division, http://www.arl.army.mil/main/main/default.cfm?Action=29&Page=194, manages the following programs: modeling of complex systems, numerical analysis, probability and statistics, and biomathematics. The Mathematical Sciences Division plays an essential role in the modeling, analysis, and control of complex phenomena and large-scale systems which are of critical interest to the Army. The areas of application include communication networks, image analysis, pattern recognition, test and evaluation of new systems, sensor networks, network science, autonomous systems, mathematics of biological systems. The division also works closely with the Computing Sciences Division and Network Science Division of ARO to develop mathematical theory for systems control, information processing, information assurance, network design, and data fusion. The Mathematics Program FY 2011 budget would increase by 4.2 percent over FY 2010.

Defense Advanced Research Projects Agency (DARPA)

The Defense Sciences Office, http://www.darpa.mil/dso/index.htm (DSO), and the Microsystems Technology Office (MTO), http://www.darpa.mil/mto/index.html, inside DARPA both have mathematics programs cutting across mathematics and its applications. Current programs include Focus Areas in Theoretical Mathematics; Mathematics of the Brain; Foundational Computer Science; Mathematical Challenges; and Nanostructure in Biology. The aggregate DARPA mathematics budget would decrease by 21.2 percent from 2010.

Department of Energy (DOE)

Mathematics at DOE is funded through the Office of Advanced Scientific Computing Research (ASCR), http://www.science.doe.gov/ascr/, one of the interdisciplinary research offices within DOE's Office of Science. Research supported by ASCR underpins computational science throughout DOE. ASCR funding for the mathematical sciences is found primarily in the Applied Mathematics program and the Scientific Discovery through Advanced Computing (SciDAC) program. The Applied Mathematics activity supports the research, development, and application of applied mathematical models, methods, and algorithms to understand complex physical, chemical, biological, and engineered systems related to the department's mission. For example, topics of supported research efforts include: (1) numerical methods research for equations related to problems such as wave propagation, electrodynamics, fluid flow, elasticity, and other natural or physical processes; (2) advanced linear algebra research for fast and efficient numerical solutions of linear algebraic equations that often arise when simulating physical processes; (3) computational meshing research for developing ways in which space can be broken up into regions, often geometrically complex, for

the purposes of simulation; (4) optimization research for mathematical methods for minimizing energy or cost, finding the most efficient solutions to engineering problems, or discovering physical properties and biological configurations; (5) mathematics for the analysis of extremely large datasets for identifying key features, determining relationships between these key features, and extracting scientific insights; and (6) mathematics of cyber security from a basic research perspective for addressing the understanding and discovery of anomalies in existing network data, modeling of large-scale networks, and understanding dynamics and emergent behavior on networks. SciDAC supports nine multi-institutional Centers for Enabling Technologies that are a focal point for bringing together a critical mass of leading experts from multiple disciplines to focus on key problems in a particular area such as performance, data management, optimization, or visualization. SciDAC also supports four multi-institutional institutes that are university-led centers of excellence which complement the efforts of the SciDAC Centers but with a role in the education and training of the next generation of computational scientists. Aggregate funding for the mathematical sciences would increase by 0.7 percent over FY 2010.

National Institutes of Health (NIH)

NIH funds mathematical sciences research through the National Institute of General Medical Sciences (NIGMS), http://www.nigms.nih.gov/About/Overview/cbcb.htm and the National Institute of Biomedical Imaging and Bioengineering (NIBIB), http://www.nibib.nih.gov/Research/ProgramAreas/MathModeling. Mathematical sciences areas of interest are those that support the missions of NIGMS and NIBIB. The NIGMS Center for Bioinformatics and Computational Biology supports research in areas that join biology with the computer sciences, engineering, mathematics, and physics. The Center manages programs in computational biology, such as the generation of mathematical models of biological networks, the development of modeling and simulation tools, the conduct of basic theoretical studies related to network organization and dynamic processes, and the development of methods for the analysis and dissemination of computational models. NIGMS is currently supporting a biomathematics initiative at around US$12 million per year in cooperation with the National Science Foundation. NIBIB supports the mathematical sciences through its Mathematical Modeling, Simulation and Analysis Program Area. The aggregate budget for the mathematical sciences in NIBIB and NIGMS would increase by 3.3 percent over FY 2010.

National Security Agency (NSA)

The Mathematical Sciences Program of the NSA administers a Grants Program that supports fundamental research in the areas of algebra, number theory, discrete mathematics, probability, and statistics. The Grants Program also accepts proposals for conferences and workshops in these research areas. In addition to grants, the Mathematical Sciences Program supports an in-house faculty Sabbatical Program. The program administrators are especially interested in funding initiatives that encourage the participation of underrepresented groups in mathematics (such as women, African-Americans, and other minorities). As the largest employer of mathematicians in the United States, NSA has a vested interest in maintaining a healthy academic mathematics community in the United States. For more information, see the website http://www.nsa.gov/research/math_research/index.shtml. The NSA mathematics budget would remain unchanged from FY 2010.

Office of Naval Research (ONR)

The ONR Mathematics, Computers, and Information Sciences Research Division's scientific objective is to establish rigorous mathematical foundations and analytical and computational methods that enhance understanding of complex phenomena and enable prediction and control for Naval applications in the future. Basic research in the mathematical sciences is focused on analysis and computation for multiphase, multimaterial, multiphysics problems; predictability of models for nonlinear dynamics; electromagnetic and acoustic wave propagation; signal and image analysis and understanding. Also of interest are modeling pathological behaviors of large, dynamic complex networks and exploiting hybrid control to achieve reliability and security; optimization; formal methods for verifiably correct software construction; and computational foundations for machine reasoning and intelligence to support integrated sensing, computing, communication/networking, and control of cyber-physical systems. For more information see the website, http://www.onr.navy.mil/sci_tech/31/311/default/asp. The Mathematics, Computers, and Information Sciences Research Division's budget would increase by 4.5 percent over FY 2010.

Note: Information gathered from agency documents and from agency representatives.

NSF Fiscal Year 2011 Budget Request

This article is the 38th in a series of annual reports outlining the president's request to Congress for the budget of the National Science Foundation. Last year's report appeared in the September 2009 issue of the *Notices*, pages 962–966.

In February 2010 the Obama administration released its budget request for the 2011 fiscal year, which starts on October 1, 2010. Under the terms of this request, the National Science Foundation (NSF) would have a budget of US$7.4 billion, an 8.0 percent increase over the previous fiscal year. Even in sunnier economic times, such a requested increase would be quite substantial. Given the strains on the federal budget, it amounts to a big vote of confidence in the power of scientific research to fuel economic growth and address major issues confronting the nation. In fact, the administration's support for science could be seen early in Obama's term, in the form of theAmerican Recovery and Reinvestment Act (ARRA), which provided the one-time "stimulus package" funds designed to jump-start the flagging economy. ARRA upped the NSF's budget by almost 40 percent in fiscal 2009. ARRA brought a similar percentage increase to the budget of the NSF'sDivision of Mathematical Sciences (DMS). Now, as it adjusts to living without the extra funds, the DMS finds itself with a relatively small increase for fiscal 2011, just 5.0 percent, considerably less than the percentage increase for the foundation overall. Forced to do some belt-tightening, the division has decided to cancel some programs in the "workforce" portion of its portfolio, which focuses on education, training, and mentoring. But the main challenge for the DMS continues to be, as in previous years, keeping the right balance between participating in targeted initiatives and supporting core research in the mathematical sciences.

Looking Back: Fiscal 2009 and the Stimulus Package

The 2009 stimulus package allowed the DMS to run an unusual and possibly unique experiment: to spend almost US$100 million more than it had been counting on. ARRA gave the NSF overall a

Table 1: National Science Foundation (Millions of Dollars)

	2007 Actual	Change	2008 Actual	Change	2009 Actual*	Change	2010 Estimate	Change	2011 Request
(1) Mathematical Sciences Research Support	$ 205.7	2.9%	$ 211.7	6.2%	$ 224.8 (97.3)	7.4%	$ 241.4	5.0%	$ 253.5
(2) Other Research Support (Note a)	4718.9	1.9%	4808.3	5.8%	5088.4 (2219.4)	6.9%	5439.8	9.0%	5930.5
(3) Education and Human Resources (Note b)	695.6	10.2%	766.3	10.3%	845.5 (85.0)	3.2%	872.8	2.2%	892.0
(4) Salaries and Expenses (Note c)	264.1	12.7%	297.7	4.2%	310.1 (0.0)	2.7%	318.5	9.4%	348.4
(5) Totals	$5884.4	3.4%	$6084.0	6.3%	$6468.8 (2401.7)	6.2%	$6872.5	8.0%	$7424.4
(6) (1) as a % of the sum of (1) and (2)	4.18%		4.22%		4.23%		4.25%		4.10%
(7) (1) as a % of (5)	3.50%		3.48%		3.48%		3.51%		3.41%

Tables prepared by Notices *staff. Totals may not add up due to rounding.* *The amounts in parentheses indicate additional funds appropriated in fiscal year 2009 in accordance with the American Recovery and Reinvestment Act (ARRA) economic stimulus legislation. **Note a:** Support for research and related activities in areas other than the mathematical sciences. Includes scientific research facilities and instrumentation. **Note b:** Support for education in all fields, including the mathematical sciences. **Note c:** Administrative expenses of operating the NSF, including the National Science Board and the Office of the Inspector General.

37 percent boost to its budget, and, in the distribution of these funds across the foundation, the DMS received US$97.3 million, an increase of 43 percent over its 2009 appropriated budget of US$224.8 million. According to the rules set by Congress, the ARRA funds could be used only during fiscal years 2009 and 2010; the NSF chose to use the funds only for proposals it had in hand during fiscal 2009. Congress also stipulated that the ARRA money should be used to create jobs and stimulate the economy. As a result, the DMS made increasing support for postdocs and graduate students a main priority for the ARRA funds and in particular sought to relieve the difficulties young mathematicians face in the tight job market. Together with the directors of the seven mathematical sciences institutes that it funds, the DMS set up the Joint Institutes Postdoctoral Fellowship program. Through this program, the division created 45 one- and two-year postdoctoral positions at the institutes and at their partner institutions and corporations. Technically, the postdocs were

Table 2: Directorate for Mathematical and Physical Sciences (Millions of Dollars)

	2007 Actual	2007 % of Total	2008 Actual	2008 % of Total	2009 Actual*	2009 % of Total	2010 Estimate	2010 % of Total	2011 Request	2011 % of Total
(1) Mathematical Sciences	$ 205.7	17.9%	$ 211.7	18.1%	$ 224.8 (97.3)	18.1% (20.5%)	$ 241.4	17.9%	$ 253.5	18.0%
(2) Astronomical Sciences	215.4	18.7%	217.9	18.6%	228.7 (85.8)	18.4% (18.1%)	245.7	18.2%	251.8	17.9%
(3) Physics	248.5	21.6%	251.6	21.5%	262.5 (96.3)	21.1% (20.3%)	290.0	21.5%	298.2	21.2%
(4) Chemistry	191.2	16.6%	194.6	16.6%	211.7 (87.4)	17.0% (18.4%)	233.7	17.3%	247.6	17.6%
(5) Materials Research	257.3	22.4%	262.5	22.4%	282.5 (108.2)	22.7% (22.8%)	302.7	22.4%	319.4	22.7%
(6) Office of Multidisciplinary Activities	32.6	2.8%	32.7	2.8%	33.7 (0.0)	2.7% (0.0%)	38.3	2.8%	39.6	2.8%
(7) Totals	$1150.7	100.0%	$1171.3	100.0%	$1243.9 (475.0)	100.0% (100.0%)	$1351.8	100.0%	$1409.9	100.0%

Table 3: Compilation of NSF Budget, 2002–2008 (Millions of Dollars)

	2005 Actual	2006 Actual	2007 Actual	2008 Actual	2009 Actual	2010 Estimate*	2011 Request	2005–2009 Change	2005–2011 Change
(1) Mathematical Sciences Research Support	$ 200.2	$ 199.5	$ 205.7	$ 211.7	$ 224.8 (97.3)	$ 241.4	$ 253.5	12.3%	26.6%
Constant Dollars	*102.5*	*99.0*	*99.2*	*98.3*	*104.8 (45.4)*			*2.2%*	
(2) Other Research Support (Note a)	4199.7	4483.5	4718.9	4808.3	5088.4 (2219.4)	5484.9	5930.5	21.2%	40.6%
Constant Dollars	*2150.4*	*2224.0*	*2275.9*	*2233.3*	*2371.8 (1034.5)*			*10.3%*	
(3) Education and Human Resources (Note b)	843.5	700.3	695.6	766.3	845.5 (85.0)	872.7	892.0	0.2%	5.7%
Constant Dollars	*431.9*	*374.4*	*335.5*	*355.9*	*394.1 (39.6)*			*-8.8%*	
(4) Salaries and Expenses (Note c)	237.3	262.5	264.1	297.7	310.1 (0.0)	318.5	348.4	30.7%	46.8%
Constant Dollars	*121.5*	*130.2*	*127.4*	*138.3*	*144.5 (0.0)*			*18.9%*	
(5) Totals	$5480.8	$5645.8	$5884.4	$6084.0	$6468.8 (2401.7)	$6872.5	$7424.4	18.0%	35.5%
Constant Dollars	*2806.3*	*2800.5*	*2838.0*	*2825.8*	*3015.2 (1119.5)*			*7.4%*	

Current dollars are converted to constant dollars using the Consumer Price Index (based on prices during 1982–84).
For Notes a, b, and c, see Table 1.

not funded through ARRA, because Congressional rules forbade commingling of ARRA funds with existing grants. But the ARRA funds did allow the DMS to free up US$7 million to support the fellowships. As Ronald J. Stern put it, through this program, "dozens of postdocs were employed who otherwise would have been dropped into the worst job market in decades." Stern, who is at the University of California, Irvine, was chair of the Committee on Science Policy from the beginning of 2007 through 2009 (the current chair is Rebecca Goldin of George Mason University).

The ARRA money has helped young mathematicians stay employed in the field, but, Stern noted, there could be unintended negative consequences. "These stimulus funds have allowed for the funding of high-quality and high-impact research that otherwise would have gone unfunded," said Stern. However, "unless similar stimulus is injected until the economy fully recovers, this initial stimulus could have the contradictory effect of exacerbating an already disastrous job market, fueling the graduate student and postdoctoral work force, but dumping them into a significantly reduced pool of positions."

In addition to the Congressional rules, use of the ARRA funds was governed by two directives from the NSF: first, to increase funding rates (the number of proposals funded divided by the number received), so that new grants could be awarded, and second, to fund high-risk, potentially high-payoff research. Historically, the DMS has had a higher funding rate than the rest of the NSF. The DMS rate for research awards was 35 percent in 2007 and 31 percent in 2008; the corresponding rates for the foundation as a whole in those years were 22 percent and 21 percent. With the large increase afforded by the ARRA funds, one might think that the funding rates for research awards rose dramatically in 2009, but in fact, they were 37 percent for the DMS and 28 percent for the NSF overall. In addition, within the DMS, the total number of proposals received did not rise greatly in response to the stimulus package funding. NSF budget documents indicate that the number of proposals submitted to the DMS was around 2200 per year between 2005 and 2008; the number was about 2300 in 2009. In 2005, 2006, and 2008, the DMS made about 680 awards, and in 2007 it made 770. The number of awards made in 2009 was about 840.

One reason the DMS funding rate was not larger in 2009 is that the division used the ARRA funds partly to increase the median annualized award size, which went from US$61,200 in 2008 to US$70,100 in 2009. The division's emphasis on using the ARRA funds for postdocs and graduate students brought support for these groups substantially higher in total dollar amounts, dollars per person, and numbers of people supported than in the previous year. The funding rate for new researchers, that is, researchers without previous DMS support, was 26 percent, 6 percentage points more than in fiscal 2008. It is important to note that the DMS did not decide which proposals to fund with its original budget and then afterward choose additional proposals to support through the ARRA funds. Rather, the program directors looked at the whole spectrum of proposals received and made funding decisions, subject to the constraints on use of ARRA funds, to optimize the entire budget available to them.

As the main funder of mathematics in the federal government, and the only one that supports all branches of the field, the DMS is under perennial budget pressure. According to Peter March, who was division director at the time the ARRA funds came in, the boost to the division's budget helped, but it did not relieve the pressure as much as one might think. He noted that the additional funds did not close the gap between what he called the "science line"—the line between what one should and should not fund based purely on scientific excellence—and the "pay line"—the line "where available funds run out". "Even with ARRA funds available there is still too much unfunded excellence," he said. He believes the DMS would need, at a minimum, to double its base budget to around US$500 million to fully fund mathematics to the "science line". "I'm afraid this is not a realistic figure in the current fiscal environment but a cogent argument can be made for such a figure." (March is returning to his home institution of Ohio State University; his successor, as of September 2010, is Sastry Pantula of North Carolina State University.)

Looking Ahead: Fiscal 2011 and Interdisciplinary Initiatives

Unlike programs such as Social Security, for which funding is mandatory, the NSF falls under the discretionary portion of the federal budget. Exactly how much money is appropriated for the NSF is hashed out through negotiations between Congress and the administration, with Congress having the final say. There is no overt opposition to an increase for the foundation, but there is stiff competition from other urgent spending priorities. Whether Congress will appropriate a budget close to that requested for the NSF is an open question, one that will not be answered until the fall or later.

Even though the NSF's fiscal 2011 budget could ultimately be quite different from the amount proposed in the budget request, the request documents do provide insight into the areas the NSF will be emphasizing. Among these are information and communications technology, cybersecurity, climate change, and energy science. These priorities are reflected in the requested increases for the NSF directorates: the largest increases, 11 percent and 10.6 percent, would go, respectively,

to Engineering, and to Computer and Information Sciences and Engineering. The directorate with the smallest requested increase—though with the largest base budget—is Mathematical and Physical Sciences (MPS), with just 4.3 percent.

Of course, the mathematical sciences can contribute to each of the areas of emphasis mentioned above. Indeed, the DMS participates in several interdisciplinary initiatives within the NSF, such as the Solar Energy Initiative (SOLAR), Science and Engineering Beyond Moore's Law (SEBML), and Cyber-enabled Discovery and Innovation. Such initiatives have in recent years become the basis for the NSF's budget and have led to increases for the DMS. But they have also contributed to strains on the DMS budget.

In a document prepared in 2010 for the DMS Committee of Visitors, which provides the division with advice and evaluation, division director March wrote that "support for the core—meaning budget increases for undirected research across the whole range of the mathematical sciences—has not increased as fast as support for interdisciplinary activities in the last three fiscal years. Striking an appropriate balance between 'Discovery' [core research in the mathematical sciences] and 'Connections' [to other disciplines] remains a top priority for the Division."

One can see the struggle to strike this balance in the fiscal 2011 request. The DMS requests an additional US$13.6 million for "core research programs", an increase of 6.6 percent. These programs include grants for investigator-initiated research and for the seven NSF-supported mathematical sciences research institutes. The request for funds for interdisciplinary initiatives is far smaller in dollar terms, but much larger in percentage terms. The DMS would devote an additional US$2.5 million to "Climate and Energy Research" (which includes the SOLAR program), an increase of 36 percent; and SEBML would rise by US$1.20 million, an increase of 44 percent. The DMS budget would increase by US$2.4 million for the MPS Life Sciences Interface initiative, which starts in fiscal 2011.

The biggest change in the DMS budget for fiscal 2011 is the consolidation of its "workforce" portfolio. This set of programs has supported such activities as Vertical Integration of Research and Education (VIGRE), the Mathematical Sciences Postdoctoral Research Fellowships, and Mentoring Through Critical Transition Points. In the past the DMS considered workforce proposals only in response to specific solicitations. March said that, starting in 2008, the division began to accept unsolicited workforce proposals for one-of-a-kind projects that draw on the individual strengths of the principal investigators and their institutions, and that also meet the division's workforce goals. "This is a natural evolutionary step, after a decade or more of fairly prescriptive solicitations, that we hope will result in highly innovative workforce projects," he said.

VIGRE, the most visible of the DMS workforce programs, has now been phased out. Although a fall 2009 study by the National Academy of Sciences recommended that the DMS retain VIGRE, with some changes, the division decided nevertheless to discontinue the program. "We found the study very helpful in guiding our thinking, not just about VIGRE, but about workforce programs more generally," said March. But the DMS concluded that continuing VIGRE was not practical. "First, some of the additional recommendations, such as extension of VIGRE stipends to international students, were difficult to impossible to achieve," he said. "Second, VIGRE proposal pressure had declined to such low levels that the program was no longer viable." The DMS will still consider VIGRE-like proposals that mathematics departments submit as unsolicited workforce proposals.

The DMS has also terminated a couple of other workforce programs. Some of them were moribund, but others—notably Computational Science Training for Undergraduates in the Mathematical Sciences (CSUMS) and Proactive Recruitment in Introductory Sciences and Mathematics (PRISM)—had

An Opportunity for Math Students

The NSF Graduate Research Fellowships program supports graduate students across the sciences and mathematics. In fiscal 2009 the NSF began an effort to triple the number of new fellowships awarded each year, to reach a total of 3,000 in fiscal 2013. The requested increase for this program in fiscal 2011 is in keeping with this plan. Historically, the mathematical sciences have had low participation this program, perhaps because the "elite" image of the fellowships discouraged all but the very top undergraduates from applying—and discouraged their mentors from suggesting they apply. But this seems to be changing. According to Stern, "The word has gotten out to the mathematical community that these fellowships are (roughly) funded by area and proportional to the numbers of applicants within each area,' he said. "This year it appears that there were many more math applicants and hence more math awardees. It also appears that these awardees were not just restricted to the usual 'elite' institutions. This success should further engender broader participation of the mathematics community. This is an opportunity not to be missed." The webpage for this program is `http://www.nsf.gov/grfp`.

—*A.J.*

been established fairly recently and were still active. Regarding CSUMS and PRISM, March explained that it was a tough decision to end them, but "our projected budget growth did not permit us to grow these programs to a sustainable level." Again, as with VIGRE, the division is open to unsolicited proposals for projects that might previously have fallen under CSUMS and PRISM. The NSF budget request documentation indicates that the division's consolidation of its workforce programs will free up about US$3.5 million, which will be reinvested in workforce proposals.

As the DMS looks to the future, it will continue to face the challenge of making the case for strong support of investigator-driven research, in an environment where emphasis on targeted initiatives is increasing. Stern noted that, when it comes to solving specific societal and scientific problems, mathematicians offer unique skills that often allow them to uncover counterintuitive solutions. "However, at the core of this problem-solving skill is the ability to think deeply about problems that initially have no clear relevance to any of the problems of immediate interest," he said. "So while mathematical insight is essential into many of these immediate problems, the fuel for these insights is our ability to pursue internally-defined research programs. The NSF should not lose sight of this fact and should fund larger numbers of smart mathematicians and trust their instincts for further research agendas."

—Allyn Jackson

CBMS 2010 Survey of Undergraduate Mathematical Sciences Programs

Ellen Kirkman

Every five years since 1965 a comprehensive study of undergraduate programs in the mathematical sciences in the United States has been undertaken under the auspices of the Conference Board of the Mathematical Sciences (CBMS), with funding from the National Science Foundation and support from the mathematical sciences professional societies. A stratified random sample of 600 institutions has been selected for the 2010 survey from the roughly 2,500 institutions that are either public two-year colleges or (public or private) four-year colleges and universities that have undergraduate programs in mathematics or statistics. Depending upon their programs, the institutions selected will receive the survey instrument for undergraduate mathematics programs at four-year colleges and universities, for mathematics programs at public two-year colleges, or for undergraduate statistics programs at four-year institutions. This year, for the first time, the survey instrument will be available both online and in hard copy. The CBMS surveys request enrollment data for individual courses and information on majors, curricula, and pedagogy at the surveyed institutions; additional information on faculty is collected from the Annual Survey of the Mathematical Sciences (AMS-ASA-IMS-MAA-SIAM). A report based on the data gathered will be published in the spring of 2012, both online and in a paper monograph. The reports of the 2005, 2000, 1995, and 1990 CBMS surveys can be obtained online from links at `www.ams.org/cbms`.

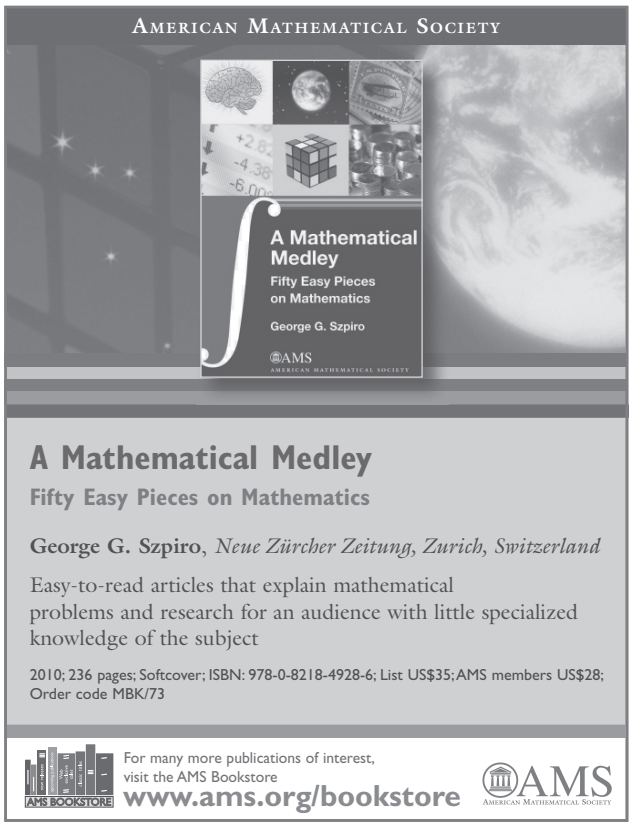
The CBMS surveys have been very useful to academic planners and department chairs seeking additional resources from college and university administrators, as well as those seeking funding for further programs in mathematics, science, and technology at the state and national levels. Some examples of findings from the 2005 survey are given below (in some cases MAA President David Bressoud's online columns "Launchings" give further discussions of the issues raised by the data):

• Between fall 1995 and fall 2005 total enrollment in U.S. four-year colleges and universities grew by about 21%, while enrollment in those institutions' mathematics and statistics departments grew by only about 8%. In the same period, total enrollments in public two-year colleges grew by about 21%, while their mathematics and statistics course enrollments grew by about 18%.

• In 2005 Calculus II, III, and IV enrollments were up from 2000 at Ph.D.-level universities but down at B.A.- and M.A.-level institutions (see also `http://www.maa.org/columns/launchings/launchings_06_08.html`).

• In fall 2005 there were about 20,000 students enrolled in dual-enrollment Calculus I classes; about 18% of two-year college Calculus I enrollments were in dual-enrollment courses (`http://www.maa.org/columns/launchings/launchings_07_07.html`).

Ellen Kirkman is professor of mathematics at Wake Forest University. Her email address is `kirkman@wfu.edu`.



• From 2000 to 2005 there was an 11% increase in the total number of full-time faculty in four-year mathematics departments—components of that increase were a 1% decrease in tenured faculty, a 33% increase in tenure-eligible faculty, and a 31% increase in other full-time faculty (including post-doctoral appointments).

• At Ph.D.-level institutions the percentage of calculus students taught by tenured and tenure-track faculty declined from 2000 to 2005 (see also `http://www.maa.org/columns/launchings/launchings_10_07.html`).

• The percentage of bachelor's degrees given to women has been declining from 2000 to 2005 (see also `http://www.maa.org/columns/launchings/launchings_09_09.html`).

• In 2005 about 30% of two-year colleges offered a program where preservice K–8 teachers could complete their entire mathematics or licensure requirements.

The 2010 Survey includes questions about special topics to be studied in 2010—including pedagogy in college algebra and elementary statistics courses, teacher preparation programs, and distance learning enrollments.

Given the data's importance to the mathematical community, administrators of those departments selected for the survey are urged to complete the survey. The new online system has a number of advantages over the hard copy form: it will automatically skip those questions that are not applicable (based on earlier responses), gray out portions of questions that do not apply, remind one of previous responses, and provide definitions when the cursor hovers over certain highlighted words. Questions about the survey may be addressed to the survey director, Ellen Kirkman (`kirkman@wfu.edu`).

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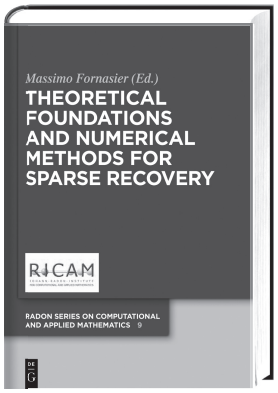

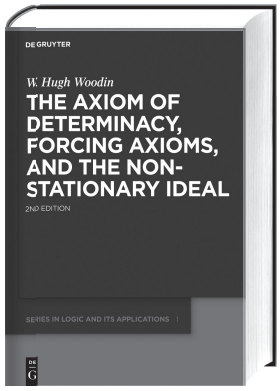

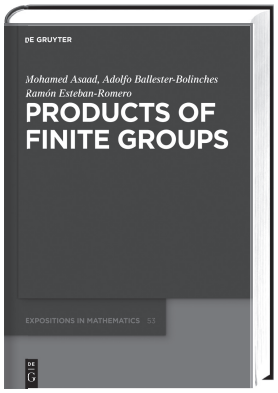

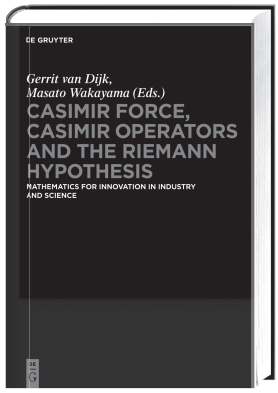

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Mathematics People

Arora and Mitchell Awarded Gödel Prize

SANJEEV ARORA of Princeton University and JOSEPH S. B. MITCHELL of the State University of New York at Stony Brook were named recipients of the Gödel Prize of the Association for Computing Machinery (ACM) at the International Colloquium on Automata, Languages and Programming (ICALP 2010), held July 5–10 in Bordeaux, France. The prize carries a cash award of US$5,000.

Arora and Mitchell were honored for their concurrent discovery of a polynomial-time approximation scheme (PTAS) for the Euclidean Traveling Salesman Problem (ETSP). Mitchell was chosen for his 1999 paper, "Guillotine subdivisions approximate polygonal subdivisions: A simple polynomial-time approximation scheme for geometric TSP, *k*-MST, and related problems", published in the *SIAM Journal of Computing* **28**(4), 1298–1309. Arora was selected for his 1998 paper, "Polynomial-time approximation schemes for Euclidean TSP and other geometric problems", published in the *Journal of the ACM* **45**(5), 753–782.

The Euclidean Traveling Salesman Problem in dimension 2 is one of those old, seemingly innocent, problems known to be NP hard but still not known to be in NP. At the time of publication, the impact of the Euclidean assumption was hardly understood: the best polynomial-time approximation scheme could only guarantee 50% error at best. Arora and Mitchell showed that solutions that are arbitrarily close to optimal in a relative sense can be found in polynomial time. These techniques, further simplified, improved, and then generalized, occupy a chapter of their own in the theory of approximation algorithms. The discovery of a PTAS for ETSP, with its long trail of consequences, counts as a crowning achievement of geometric optimization.

The 2010 Gödel Prize committee consisted of Cynthia Dwork (Microsoft Corporation); Johan Hastad (KTH Stockholm); Jean-Pierre Jouannaud (INRIA and Tsinghua University), chair; Mogens Nielsen (Aarhus University); Mike Paterson (University of Warwick); and Eli Upfal (Brown University).

The Gödel Prize for outstanding papers in the area of theoretical computer science is sponsored jointly by the European Association for Theoretical Computer Science (EATCS) and the Special Interest Group on Algorithms and Computation Theory of the Association for Computing Machinery (ACM-SIGACT). This award is presented annually, with the presentation taking place alternately at the International Colloquium on Automata, Languages, and Programming (ICALP) and the ACM Symposium on Theory of Computing (STOC). The prize is named in honor of Kurt Gödel in recognition of his major contributions to mathematical logic and of his interest, discovered in a letter he wrote to John von Neumann shortly before von Neumann's death, in what has become the famous "P versus NP" question.

—From an EATCS announcement

Mathematical Sciences Awards at the 2010 ISEF

The 2010 Intel International Science and Engineering Fair (ISEF) was held in May 2010 in San Jose, California. Fifteen hundred students in grades 9 through 12 from more than fifty countries participated in the fair. The Society for Science and the Public, in partnership with the Intel Foundation, selects a Best in Category contestant, who receives a cash award of US$5,000. The student chosen this year was JOSHUA W. PFEFFER, a seventeen-year-old student at North Shore Hebrew Academy High School in Great Neck, New York, for his project, "Super Kähler-Ricci Flow". He also received the First Award, which carries a cash prize of US$3,000. In addition, a grant of US$1,000 was given to his school. Pfeffer also received the Seaborg SIYSS award. He will receive an all-expenses-paid trip to attend the Stockholm International Youth Science Seminar (SIYSS) during the Nobel Prize Ceremonies in December 2010. The award is named for the late Glenn T. Seaborg, Nobel Laureate in chemistry.

—From an ISEF announcement

Ford Foundation Diversity Fellowships Awarded

The Ford Foundation has named the recipients of its Diversity Fellowships for 2009. The Ford Foundation's predoctoral, dissertation, and postdoctoral fellowship programs seek to increase the presence of underrepresented

minorities on college faculties. Awardees later serve as role models and mentors for a new generation of scholars. CARLOS E. ARRECHE of the University of Chicago, a student in algebra, and ASHLEY N. CRUMP, a student in applications of mathematics at Princeton University, were awarded predoctoral fellowships of US$20,000 a year for up to three years. BIANCA L. VIRAY, a student in algebra at the University of California, Berkeley, received a dissertation fellowship of US$21,000 for one year of study.

—From a Ford Foundation announcement

Boleslaw Kacewicz Wins the 2010 Information-Based Complexity Prize

BOLESLAW KACEWICZ of AGH University of Science and Technology, Cracow, Poland, has been awarded the 2010 Prize in Information-Based Complexity. The prize consists of US$3,000 and a plaque. The award will be presented at the 2010 Ninth International Conference on Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing, Warsaw, Poland, in August 2010. This annual prize is given for outstanding contributions to information-based complexity.

—Joseph Traub, Columbia University

Royal Society of London Elections

The following mathematical scientists have been elected to the Royal Society of London: PHILIP CANDELAS, University of Oxford; DONALD A. DAWSON, Carleton University; GEORG GOTTLOB, University of Oxford and Vienna University of Technology; BEN J. GREEN, University of Cambridge; and ROBERT C. GRIFFITHS, University of Oxford. Elected as a foreign fellow was LUDWIG D. FADDEEV, Steklov Mathematical Institute.

—From a Royal Society announcement

Mary L. Boas (1917–2010)

Mary Elizabeth Layne Boas died on February 17, 2010. Born on March 10, 1917, in Prosser, Washington, she earned a bachelor's degree (1938) and master's degree (1940) in mathematics at the University of Washington. She did graduate work and taught at Duke University, where she met her future husband, Ralph P. Boas Jr. Ralph Boas, who died in 1992, was active in the AMS, serving on the Board of Trustees and the Council and as executive editor of *Mathematical Reviews.* Mary Boas went on to earn a Ph.D. in physics in 1948 at the Massachusetts Institute of Technology and taught physics at DePaul University in Chicago for thirty years. She is perhaps best known for her textbook *Mathematical Methods in the Physical Sciences*, the third edition of which appeared in 2005. The Boases had three children, one of whom is Harold Boas of Texas A&M University, who served as editor of the *Notices*, 2001–2003.

—Allyn Jackson

Leo Sario (1916–2009)

Leo Sario was born in Vyborg, Finland, in 1916. He was an accomplished ski jumper as a young man and served valorously in World War II.

Sario earned his Ph.D. under the direction of Rolf Nevanlinna in 1948. He soon played a key role in establishing the Finnish National Academy, and the statute for that purpose is named in his honor. He was later knighted by the country of Finland.

Leo's first jobs in the United States were at the Institute for Advanced Study, the Massachusetts Institute of Technology, Stanford University, and Harvard University. He settled at the University of California, Los Angeles, in 1955 and spent the remainder of his career there.

Leo Sario wrote 6 important books and 134 research papers. His books *Principal Functions* with Burton Rodin, *Riemann Surfaces* with Lars Ahlfors, and *Classification Theory of Riemann Surfaces* with Mitsuru Nakai still stand as classics. He mentored thirty-six Ph.D. students. Among his distinguished students were Kôtaro Oikawa and Burton Rodin. He was an active and prolific mathematician until he retired from UCLA, and from mathematics, in 1986.

Sario is credited with creating the theory of principal functions—a method of constructing harmonic functions on arbitrary Riemann surfaces. He was one of the ranking experts in Riemann surface theory, particularly in the classification theory of Riemann surfaces. He later extended these ideas to the classification theory of Riemannian manifolds.

Sario had many interests, including hiking, running, traveling, and reading. He loved films and was an active participant in the Los Angeles Museum Film Group. He once said that his favorite way to study mathematics was to sit on the beach at two o'clock in the morning. He would wear a child-carrier backward to hold his papers and a miner's helmet to illuminate his work. He used to run twenty miles barefoot on the beach every day.

Leo Sario's students remember him as vigorous, dynamic, and supportive. Many of his students became his collaborators, and they were all his friends. He had a large mathematical family.

—Steven G. Krantz, editor

Mathematics Opportunities

American Mathematical Society Centennial Fellowships

Invitation for Applications for Awards for 2011–2012
Deadline December 1, 2010

Description: The AMS Centennial Research Fellowship Program makes awards annually to outstanding mathematicians to help further their careers in research. The number of fellowships to be awarded is small and depends on the amount of money contributed to the program. The Society supplements contributions as needed. One fellowship will be awarded for the 2011–2012 academic year. A list of previous fellowship winners can be found at http://www.ams.org/profession/prizes-awards/ams-awards/centennial-fellow.

Eligibility: The eligibility rules are as follows. The primary selection criterion for the Centennial Fellowship is the excellence of the candidate's research. Preference will be given to candidates who have not had extensive fellowship support in the past. Recipients may not hold the Centennial Fellowship concurrently with another research fellowship such as a Sloan or NSF Postdoctoral Fellowship. Under normal circumstances, the fellowship cannot be deferred. A recipient of the fellowship shall have held his or her doctoral degree for at least three years and not more than twelve years at the inception of the award (that is, received between September 1, 1999, and September 1, 2008). Applications will be accepted from those currently holding a tenured, tenure-track, postdoctoral, or comparable (at the discretion of the selection committee) position at an institution in North America. Applications should include a cogent plan indicating how the fellowship will be used. The plan should include travel to at least one other institution and should demonstrate that the fellowship will be used for more than reductions of teaching at the candidate's home institution. The selection committee will consider the plan in addition to the quality of the candidate's research and will try to award the fellowship to those for whom the award would make a real difference in the development of their research careers. Work in all areas of mathematics, including interdisciplinary work, is eligible.

Grant amount: The stipend for fellowships awarded for 2010–2011 is expected to be US$79,000, with an additional expense allowance of about US$7,900. Acceptance of the fellowship cannot be postponed.

Deadline: The deadline for receipt of applications is **December 1, 2010**. Awards will be announced in February 2011 or earlier if possible.

Application information: Find Centennial information and the application form via the Internet at http://www.ams.org/ams-fellowships/. For paper copies of the form, write to the Membership and Programs Department, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294; prof-serv@ams.org; 401-455-4105.

—AMS announcement

Call for Papers for ICIAM 2011

The Seventh International Congress on Industrial and Applied Mathematics (ICIAM) will be held July 18–22, 2011, in Vancouver, British Columbia, Canada. ICIAM 2011 will highlight the most recent advances in the discipline and demonstrate their applicability to science, engineering, and industry. In addition to the traditional, strong focus on applied mathematics, the congress will emphasize industrial applications and computational science. An integrated program will highlight the many outstanding contributions of applied mathematics. ICIAM 2011 will also be an opportunity to demonstrate to young researchers and graduate students the vast potential of mathematics. The congress is being planned by the Canadian Applied and Industrial Mathematics Society (CAIMS), the Mathematics of Information Technology and Complex Systems (MITACS), and the Society for Industrial and Applied Mathematics (SIAM).

Proposals for minisymposia and for papers are sought. The deadline for submitting minisymposia proposals is **October 4, 2010**. The deadline for abstracts for contributed papers is **December 15, 2010**. The cochairs of the scientific program committee are Ivar Ekeland, University of British Columbia, and Jerrold Marsden, California Institute of Technology. For more details, see the website http://www.iciam2011.com/.

—From an ICIAM announcement

Call for Nominations for CRM-Fields-PIMS Prize

The Centre de Recherches Mathématiques (CRM), the Fields Institute, and the Pacific Institute for the Mathematical Sciences (PIMS) invite nominations for the joint CRM-Fields-PIMS prize, awarded in recognition of exceptional research achievement in the mathematical sciences. The prize recipient will be chosen on the basis of outstanding contributions to the advancement of the mathematical sciences, with excellence in research as the main selection criterion. The candidate's research should have been conducted primarily in Canada or in affiliation with a Canadian university. A monetary prize will be awarded, and the recipient will be asked to present a lecture at the CRM, the Fields Institute, and PIMS.

The deadline for nominations is **November 1, 2010**. Nominations should be submitted by at least two sponsors of recognized stature and must include the following: three supporting letters, curriculum vitae, list of publications, and up to four preprints. Nominations will remain active for two years. At most one prize will be awarded during any academic year. Submit nominations to crm-fields-pims-prize@fields.utoronto.ca. Only electronic submissions will be accepted.

The prize was established in 1994 as the CRM-Fields Prize. Renamed in 2005, all subsequent prizes have been awarded jointly by all three institutes. The selection committee is appointed by the three institutes and will select the prizewinner.

—From a CRM-Fields-PIMS announcement

NSF International Research Fellow Awards

The objective of the International Research Fellowship Program (IRFP) of the National Science Foundation (NSF) is to introduce scientists and engineers in the early stages of their careers to research opportunities abroad. The program provides support for postdoctoral and junior investigators to do research in basic science and engineering for nine to twenty-four months in any country in the world. The goal of the program is to establish productive, long-term relationships between U.S. and foreign science and engineering communities. Applicants must be U.S. citizens or permanent residents who have earned their doctoral degrees within two years before the date of application or who expect to receive their degrees by the date of the award.

The target date for full proposals is **September 14, 2010.** For further information contact the program officer, Susan Parris, 703-292-7225, sparris@nsf.gov; or visit the website http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5179&org=NSF.

—From an NSF announcement

AWM Travel Grants for Women

The National Science Foundation (NSF) and the Association for Women in Mathematics (AWM) sponsor travel grant programs for women mathematicians.

AWM Travel Grants enable women to attend research conferences in their fields, thereby providing scholars valuable opportunities to advance their research activities and their visibility in the research community. A Mathematics Travel Grant provides full or partial support for travel and subsistence for a meeting or conference in the grantee's field of specialization. The Mathematics Education Research Travel Grants provide full or partial support for travel and subsistence in math/math education research for mathematicians attending a math education research conference or math education researchers attending a math conference.

AWM Mentoring Travel Grants are designed to help junior women develop long-term working and mentoring relationships with senior mathematicians. A Mentoring Travel Grant funds travel, subsistence, and other expenses for an untenured woman mathematician to travel to an institute or a department to do research with a specified individual for one month.

The final deadline for the Travel Grants program for 2010 is **October 1, 2010**. The deadlines for 2011 are **February 1, 2011**; **May 1, 2011**; and **October 1, 2011**. For the Mentoring Travel Grants program the deadline is **February 1, 2011**. For further information and details on applying, see the AWM website http://www.awm-math.org/travelgrants.html#standard, telephone: 703-934-0163, or e-mail: awm@awm-math.org; or contact Association for Women in Mathematics, 11240 Waples Mill Road, Suite 200, Fairfax, VA 22030.

—From an AWM announcement

Call for Nominations for Clay Research Fellows

The Clay Mathematics Institute (CMI) solicits nominations for its competition for the 2011 Clay Research Fellowships. Fellows are appointed for a period of two to five years. They may conduct their research at whatever institution or combination of institutions best suits their research. In addition to a generous salary, the fellow receives support for travel, collaboration, and other research expenses.

The selection criteria are the quality of the candidate's research and promise to make contributions of the highest level. At the time of their selection, most recent appointees were graduating Ph.D. students. However, mathematicians within three years of the Ph.D. are sometimes appointed. Selection decisions are made by CMI's Scientific Advisory Board: Jim Carlson, Simon Donaldson, Gregory Margulis, Richard Melrose, Yum-Tong Siu, and Sir Andrew Wiles.

To nominate a candidate, please send the following items by **October 29, 2010**: (1) letter of nomination,

(2) names and contact information for two other references, (3) curriculum vitae for the nominee, and (4) publication list for the nominee.

Nominations should be sent to the attention of Alagi Patel, Clay Mathematics Institute, One Bow Street, Cambridge, MA 02138. Electronic submissions are also accepted at nominations@claymath.org.

Information about the Clay Research Fellows is available on the CMI website at http://www.claymath.org/research_fellows. Additional information may be obtained by calling Alagi Patel at 617-995-2602 or emailing her at patel@claymath.org.

Current and alumni Clay Research Fellows are Mohammed Abouzaid, Spyridon Alexakis, Timothy Austin, Artur Avila, Roman Bezrukavnikov, Manjul Bhargava, Daniel Biss, Alexei Borodin, Maria Chudnovsky, Dennis Gaitsgory, Soren Galatius, Daniel Gottesman, Ben Green, Sergei Gukov, Adrian Ioana, Bo'az Klartag, Elon Lindenstrauss, Ciprian Manolescu, Davesh Maulik, Maryam Mirzakhani, Sophie Morel, Mircea Mustata, Sam Payne, Igor Rodnianski, Sucharit Sarkar, David Speyer, Terence Tao, Andras Vasy, Akshay Venkatesh, Teruyoshi Yoshida, and Xinyi Yuan.

—Clay Mathematics Institute announcement

Graduate Student Travel Grants to 2011 JMM

The AMS, with funding from a private gift, is accepting applications for partial travel support for graduate students attending the Joint Mathematics Meetings in New Orleans, LA, January 6–9, 2011. The awards, not to exceed US$500, must be matched by travel funds from the student's institution. Applications will be accepted ONLY from doctoral students in mathematics who are in their last year of study; i.e., applicants must not have received their doctoral degrees before the travel takes place but must expect to receive them no later than August of the upcoming year. No student shall receive a grant more than once.

It is expected that awards will be made late in November 2010. Funding is provided on a reimbursement basis. The deadline for submitting applications is **October 28, 2010**. Awards or decline notifications will be made by email in late November 2010. Information may be found at http://www.ams.org/travel-grants/. This travel grant program is being administered by the AMS Membership and Programs Department. You can reach the department at student-JMM@ams.org or at 800-321-4267, ext. 4060, or 401-455-4060.

—AMS announcement

PIMS Postdoctoral Fellowships

The Pacific Institute for the Mathematical Sciences (PIMS) invites nominations of outstanding young researchers in the mathematical sciences for postdoctoral fellowships for the year 2011–2012. Candidates must be nominated by one or more scientists affiliated with PIMS or by a department or departments affiliated with PIMS. The fellowships are intended to supplement support provided by the sponsor and are tenable at any of its Canadian member universities: Simon Fraser University, University of Alberta, University of British Columbia, University of Calgary, University of Victoria, University of Regina, and University of Saskatchewan, as well as at the University of Lethbridge (a PIMS affiliate).

For the 2011–2012 competition, held in January of 2011, the amount of the award will be CA$20,000 (approximately US$19,500), and the sponsor(s) is (are) required to provide additional funds to finance a minimum total stipend of CA$40,000 (approximately US$39,000).

Rankings of the candidates are made by the PIMS PDF Review Panel based on the qualifications of the candidate, potential for participation in PIMS programs, and potential involvement with PIMS partners. PIMS Postdoctoral Fellows will be expected to participate in all PIMS activities related to the fellow's area of expertise and will be encouraged to spend time at more than one site. To ensure that PIMS Postdoctoral Fellows are able to participate fully in institute activities, they may not teach more than two single-term courses per year.

Nominees must have a Ph.D. or equivalent (or expect to receive a Ph.D. by December 31, 2011) and must be within three years of the Ph.D. at the time of the nomination (i.e., the candidate must have received her or his Ph.D. on or after January 1, 2008). The fellowship may be taken up at any time between September 1, 2011, and January 1, 2012. The fellowship is for one year and is renewable for at most one additional year.

The PIMS PDF nomination/application process takes place entirely online, utilizing the MathJobs service provided by the American Mathematical Society (AMS). Having selected their nominees, sponsors direct them to apply online at mathjobs.org/jobs/PIMS. Nominees are required to upload two letters of reference, a curriculum vitae, and a statement of research interests. Sponsors must also upload their own reference letters (these are in addition to the two reference letters mentioned just above) and statements of anticipated support. They will receive instructions as to how to proceed from their nominees via email from MathJobs. Detailed instructions regarding all aspects of the MathJobs application procedure may be found in the online MathJobs user guides. Please note that application is **by nomination only**; unsolicited applications will not be considered.

Complete applications must be uploaded to MathJobs by **December 15, 2010**. For further information, visit the website http://www.pims.math.ca/scientific/postdoctoral.

—PIMS announcement

News from the Fields Institute

The Fields Institute has recently implemented a new program, Research Immersion Fellowships, which provides financial support to individuals with high potential to reenter an active research career after an interruption for family responsibilities by participating in a thematic program. There are no restrictions on the nationality or country of employment of candidates for an Immersion Fellowship. For more information, see www.fields.utoronto.ca/proposals/research_immersion.html.

The thematic program for the fall of 2010 is *Asymptotic Geometric Analysis*. Three workshops will be held: *Asymptotic Geometric Analysis and Convexity*, September 13–17; *Concentration Phenomenon, Transformation Groups, and Ramsey Theory*, October 12–16; and *Geometric Probability and Optimal Transportation*, November 1–5.

Avi Wigderson (Institute for Advanced Study) will deliver the Distinguished Lecture Series during the week of September 13, and Shiri Artstein-Avidan (Tel-Aviv University) will deliver the Coxeter Lecture Series during the month of September.

More (and up-to-date) information can be found at www.fields.utoronto.ca/programs/scientific/10-11/asymptotic/.

Future thematic programs include the following:
Winter/Spring 2011: Dynamics and Transport in Disordered Systems
Summer 2011: Constraint Satisfaction Problem
Fall 2011: Discrete Geometry and Applications
Winter/Spring 2012: Galois Representations
Fall 2012: Forcing and Its Applications

A conference on Homotopy Theory and Derived Algebraic Geometry is scheduled for August 30–September 3, 2010.

One of the objectives of the Fields Institute is to increase the diversity of participants in all of its mathematical activities. Organizers of Fields-supported events are required to keep this goal in mind when selecting participants.

See www.fields.utoronto.ca/programs/scientific/ for more information on these programs and on all other activities at the institute.

—Fields Institute announcement

AIM Workshops

The American Institute of Mathematics (AIM) seeks proposals for workshops and SQuaREs. Workshops are held in all areas of the mathematical sciences. Funding is provided for full support (travel, hotel, meals) of twenty-eight participants for a 5-day workshop in Palo Alto, California.

Proposals for workshops (to run sometime between June 2011 and October 2012) and SQuaREs may be submitted online at www.aimath.org by **November 1**, and decisions will be made by December 15. The AIM workshop format is designed to encourage new collaborations to make plans or progress toward a research goal: there are two talks each morning of the workshop and structured group activities each afternoon, including research in small groups.

SQuaREs are for collaborative efforts by four to six researchers for multiple-week-long visits to AIM. SQuaREs groups are encouraged to make ambitious research plans to attack a long-term goal.

AIM reserves seven spots at each workshop for participants selected from a pool of applicants who apply online to attend an AIM workshop. The deadline is usually four months before the workshop. Interested researchers are invited to browse our list of upcoming workshops at www.aimath.org and apply for funding to attend a workshop of interest.

—AIM announcement

News from BIRS

The Banff International Research Station for Mathematical Innovation and Discovery (BIRS) is now accepting proposals for its 2012 program. The station provides an environment for creative interaction and the exchange of ideas, knowledge, and methods within the mathematical, statistical, and computing sciences, and with related disciplines and industrial sectors.

Full information, guidelines, and online forms are available at the new BIRS website: http://www.birs.ca/.

BIRS is hosting a 49-week scientific program in 2012. Each week, the station will be running either a full workshop (42 people for 5 days) or two half-workshops (each with 21 people for 5 days). As usual, BIRS provides full accommodation, board, and research facilities at no cost to the invited participants, in a setting conducive to research and collaboration.

The deadline for 5-day Workshop and Summer School proposals is **September 27, 2010**.

In addition BIRS will operate its Research in Teams and Focused Research Groups programs, which allow smaller groups of researchers to get together for several weeks of uninterrupted work at the station. **September 27, 2010**, is also the preferred date to apply for these programs. However, proposals for projects involving Research in Teams or Focused Research Groups can be submitted at any time—subject to availability—and they must be received at least 4 months before their requested start date.

Proposal submissions should be made using the online submission form. Please use: https://www.birs.ca/proposals.

—BIRS Announcement

Inside the AMS

AMS Research Journals Archive Is Digitized

The American Mathematical Society (AMS) has established a complete digital archive of its mathematical research journals. Over 34,000 articles are available from more than one hundred years of high-quality mathematical research in *Journal of the AMS*, *Mathematics of Computation*, *Proceedings of the AMS*, *Transactions of the AMS*, and *Bulletin of the AMS*. All back issues, starting with each journal's inaugural issue through 2005, are now freely available in electronic format.

Researchers can browse the contents of each journal to find articles and authors in each volume and issue and can search across the entire archive by journal *or group of journals* at `http://www.ams.org/joursearch/`.

View the abstract, references (with links to MathSciNet), bibliographic information, and Mathematics Subject Classifications for each article or view a PDF of the full article.

Each journal is unique in its offering of articles, book reviews, and reports. AMS journals have consistently been managed by editors highly prominent in their fields. *Journal of the AMS*, founded in 1988 in celebration of the AMS Centennial, maintains the highest standards in mathematical research. Its first editors, Michael Artin, H. Blaine Lawson Jr., Richard Melrose, Wilfried Schmid, and Robert E. Tarjan, along with a distinguished group of associate editors, launched one of the most respected and valued research journals in mathematics.

Mathematics of Computation was founded in 1943 to serve as a clearinghouse for information concerning mathematical tables and other aids to computation. The journal continues to focus on research articles of the highest quality in computational mathematics. Areas covered include numerical analysis; computational discrete mathematics, including number theory, algebra, and combinatorics; and related fields such as stochastic numerical methods. The journal also includes reviews of books in related areas.

Proceedings of the AMS is devoted to research in all areas of pure and applied mathematics and contains significant and peer-reviewed research of interest to mathematicians across many specialties. The entire archive of 18,295 articles, dating from 1950, has been digitized.

Transactions of the AMS, founded in 1900 originally to foster the work of American mathematicians, includes significant and peer-reviewed research—generally lengthier papers—in pure and applied mathematics.

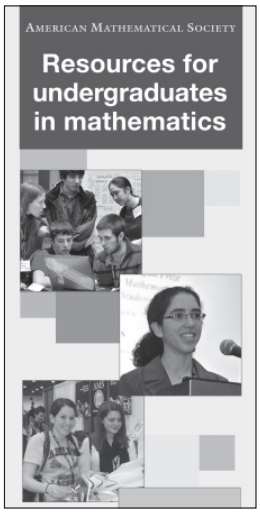
The AMS makes the digitized archive of these important research journals freely available to all mathematicians through the generosity of an anonymous donor.

—Annette Emerson, AMS Public Awareness Officer

From the Public Awareness Office

Resources for Undergraduates in Mathematics

The revised brochure for undergraduate students in mathematics and their advisors points to websites that explore mathematics and provide information on graduate programs and career choices. Individuals, mathematics departments, and math clubs may email `prof-serv@ams.org` to request a maximum of one hundred copies.



Feature Column

Recent columns include "How Did Escher Do It?", by Bill Casselman; "From Pascal's Triangle to the Bell-Shaped Curve", by Tony Phillips; "Mathematics and Sports", by Joe Malkevitch; and "Moving Remy in Harmony: Pixar's Use of Harmonic Functions", by David Austin. The archive and monthly columns are posted at `www.ams.org/featurecolumn`.

—Annette Emerson and Mike Breen
AMS Public Awareness Officers
`paoffice@ams.org`

Deaths of AMS Members

S. F. BARBER, from Southbury, CT, died on July 4, 2010. Born on October 25, 1907, he was a member of the Society for 76 years.

JOHN A. BERTON, of Ottawa, Kansas, died on March 23, 2010. Born on June 22, 1930, he was a member of the Society for 51 years.

IRVING GERST, professor emeritus, SUNY at Stony Brook, died on May 21, 1995. Born on May 30, 1912, he was a member of the Society for 50 years.

JAMES A. HUMMEL, of Silver Spring, Maryland, died on June 23, 2010. Born on December 14, 1927, he was a member of the Society for 56 years.

ALAN JEFFREY, of Newcastle upon Tyne, England, died on June 6, 2010. Born on July 16, 1929, he was a member of the Society for 40 years.

SVETOZAR KUREPA, professor emeritus, College of Sciences at the University of Zagreb, died on February 2, 2010. Born on May 25, 1929, she was a member of the Society for 49 years.

BENOY KUMAR LAHIRI, of West Bengal, India, died on May 26, 2010. Born on June 1, 1932, he was a member of the Society for 17 years.

WILLIAM F. LUCAS, emeritus professor at the Claremont Graduate University, died on June 7, 2010. Born on April 21, 1933, he was a member of the Society for 47 years.

PAUL MALLIAVIN, professor emeritus, The Pierre and Marie Curie University, died on June 3, 2010. Born on September 10, 1925, he was a member of the Society for 16 years.

ANDRZEJ PELCZAR, of Cracow, Poland, died on May 18, 2010. Born on April 12, 1937, he was a member of the Society for 27 years.

NORMAN S. ROSENFELD, former dean of Yeshiva College and current incumbent of the Jekuthiel Ginsberg Professor of Mathematics chair, died on January 15, 2010. Born on July 21, 1934, he was a member of the Society for 54 years.

LEO J. SCHNEIDER, professor from John Carroll University, died on June 6, 2010. Born on December 1, 1937, he was a member of the Society for 40 years.

RICHARD P. STAUDUHAR, from Kailua Kona, Hawaii, died on March 24, 2010. Born on May 28, 1940, he was a member of the Society for 4 years.

ERIC A. STURLEY, of Edwardsville, Illinois, died on March 23, 2010. He was a member of the Society for 72 years.

LAKEY TOLBERT, of Birmingham, Alabama, died on June 10, 2010. He was a member of the Society for 5 years.

BARRY YOUNG, professor, from Las Cruces, New Mexico, died on May 24, 2010. Born on December 19, 1948, he was a member of the Society for 26 years.

HIDEKAZU WADA, from Sendai, Japan, died on October 26, 2009. Born on February 24, 1924, he was a member of the Society for 48 years.

JOSEPH A. ZILBER, of Moss Beach, California, died on October 4, 2009. Born on July 27, 1923, he was a member of the Society for 65 years.

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.wustl.edu in the case of the editor and notices@ams.org in the case of the managing editor. The fax numbers are 314-935-6839 for the editor and 401-331-3842 for the managing editor. Postal addresses may be found in the masthead.

Upcoming Deadlines

August 15, 2010: Nominations for SASTRA Ramanujan Prize. Email sastraprize@math.ufl.edu or see the website http://www.math.ufl.edu/sastra-prize/nominations-2008.html.

August 20, 2010: Letter of intent for NSF Focused Research Groups. See http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5671.

August 25, 2010: Full proposals for REU sites. See http://www.nsf.gov/pubs/2009/nsf09598/nsf09598.htm.

September 14, 2010: Full proposals for NSF International Research Fellow awards. See "Mathematics Opportunities" in this issue.

September 15, 2010: Nominations for Sloan Fellowships. See http://www.sloan.org/fellowships.

September 17, 2010: Full proposals for NSF Focused Research Groups. See http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5671.

September 30, 2010: Nominations for ICTP Ramanujan Prize. See http://prizes.ictp.it/Ramanujan/.

September 30, 2010: Nominations for 2010 Sacks Prize. See http://www.aslonline.org/Sacks_nominations.html.

September 30, 2010: Full proposals for NSF Integrative Graduate Education and Research Training (IGERT) program; by invitation only. See http://www.nsf.gov/pubs/2010/nsf10523/nsf10523.htm?WT.mc_id=USNSF_25.

October 1, 2010: Applications for AWM Travel Grants. See "Mathematics Opportunities" in this issue.

October 4, 2010: Proposals for minisymposia for ICIAM 2011. See "Mathematics Opportunities" in this issue.

October 15, 2010: Proposals for NSA Grants for Research in Mathematics. See http://www.nsa.gov/research/math_research/index.shtml.

October 20, 2010: Applications for NSF Mathematical Sciences Postdoctoral Research Fellowships. See

Where to Find It

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

AMS Bylaws—*November 2009, p. 1320*

AMS Email Addresses—*February 2010, p. 268*

AMS Ethical Guidelines—*June/July 2006, p. 701*

AMS Officers 2008 and 2009 Updates—*May 2010, p. 670*

AMS Officers and Committee Members—*October 2009, p. 1133*

Conference Board of the Mathematical Sciences—*September 2010, p. 1009*

IMU Executive Committee—*December 2009, p. 1465*

Information for *Notices* Authors—*June/July 2009, p. 749*

Mathematics Research Institutes Contact Information—*August 2009, p. 854*

National Science Board—*January 2010, p. 68*

New Journals for 2008—*June/July 2009, p. 751*

NRC Board on Mathematical Sciences and Their Applications—*March 2010, p. 423*

NRC Mathematical Sciences Education Board—*April 2010, p. 541*

NSF Mathematical and Physical Sciences Advisory Committee—*February 2010, p. 272*

Program Officers for Federal Funding Agencies—*October 2009, p. 1126 (DoD, DoE); December 2007, p. 1359 (NSF); December 2009, p. 1464 (NSF Mathematics Education)*

Program Officers for NSF Division of Mathematical Sciences—*November 2009, p. 1313*

http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5301.

October 30, 2010: Nominations for Clay Research Fellowships. See "Mathematics Opportunities" in this issue.

November 1, 2010: Nominations for CRM-Fields-PIMS Prize. See "Mathematics Opportunities" in this issue.

November 1, 2010: Applications for November review for National Academies Postdoctoral and Senior Research Associateship Program. See http://sites.nationalacademies.org/PGA/RAP/PGA_050491 or contact Research Associateship Programs, National Research Council, Keck 568, 500 Fifth Street, NW, Washington, DC 20001; telephone 202-334-2760; fax 202-334-2759; email rap@nas.edu.

November 19, 2010: Proposals for research programs at CRM. See http://www.crm.cat/RPapplication.

December 1, 2010: Letters of intent for proposals for thematic programs at the Bernoulli Center. See the website http://bernoulli.epfl.ch/new/index.php.

December 3, 2010: Entries for Ferran Sunyer i Balaguer Prize. See http://ffsb.iec.cat.

December 15, 2010: Abstracts for contributed papers for ICIAM. See "Mathematics Opportunities" in this issue.

December 15, 2010: Applications for PIMS Postdoctoral Fellowships. See "Mathematics Opportunities" in this issue.

February 1, 2011: Applications for AWM Mentoring Travel Grants. See "Mathematics Opportunities" in this issue.

February 1, 2011: Applications for AWM Travel Grants. See "Mathematics Opportunities" in this issue.

May 1, 2011: Applications for AWM Travel Grants. See "Mathematics Opportunities" in this issue.

October 1, 2011: Applications for AWM Travel Grants. See "Mathematics Opportunities" in this issue.

October 1, 2011: Nominations for the 2012 Emanuel and Carol Parzen Prize. Contact Thomas Wehrly, Department of Statistics, 3143 TAMU, Texas A&M University, College Station, TX 77843-3143.

Conference Board of the Mathematical Sciences

1529 Eighteenth Street, NW
Washington, DC 20036
202-293-1170
http://www.cbmsweb.org/

Ronald C. Rosier
Director
202-293-1170
410-730-1426 (home—try this first)
Fax: 202-293-3412

Lisa R. Kolbe
Administrative Coordinator
202-293-1170
Fax: 202-293-3412

Member Societies:

American Mathematical Association of Two-Year Colleges (AMATYC)
American Mathematical Society (AMS)
Association of Mathematics Teacher Educators (AMTE)
American Statistical Association (ASA)
Association for Symbolic Logic (ASL)
Association for Women in Mathematics (AWM)
Association of State Supervisors of Mathematics (ASSM)
Benjamin Banneker Association (BBA)
Institute for Operations Research and the Management Sciences (INFORMS)
Institute of Mathematical Statistics (IMS)
Mathematical Association of America (MAA)
National Association of Mathematicians (NAM)
National Council of Supervisors of Mathematics (NCSM)
National Council of Teachers of Mathematics (NCTM)
Society for Industrial and Applied Mathematics (SIAM)
Society of Actuaries (SOA)
TODOS: Mathematics for ALL

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.

The Archimedes Codex: How a Medieval Prayer Book Is Revealing the True Genius of Antiquity's Greatest Scientist, by Reviel Netz and William Noel. Da Capo Press, October 2007. ISBN-13: 978-03068-1580-5. (Reviewed September 2008.)

Bright Boys: The Making of Information Technology, by Tom Green. A K Peters, April 2010. ISBN-13: 978-1-56881-476-6.

The Calculus of Friendship: What a Teacher and Student Learned about Life While Corresponding about Math, by Steven Strogatz. Princeton University Press, August 2009. ISBN-13: 978-0-691-13493-2. (Reviewed June/July 2010.)

**The Cult of Statistical Significance: How the Standard Error Costs Us Jobs, Justice, and Lives*, by Stephen T. Ziliak and Deirdre N. McCloskey, University of Michigan Press, February 2008. ISBN-13: 978-04720-500-79.

Duel at Dawn: Heroes, Martyrs, and the Rise of Modern Mathematics, by Amir Alexander. Harvard University Press, April 2010. ISBN-13: 978-06740-466-10.

Here's Looking at Euclid: A Surprising Excursion through the Astonishing World of Math, by Alex Bellos. Free Press, June 2010. ISBN-13: 978-14165-882-52.

The Housekeeper and the Professor, by Yoko Ogawa. Picador, February 2009. ISBN-13: 978-03124-278-01. (Reviewed May 2010.)

How to Read Historical Mathematics, by Benjamin Wardhaugh. Princeton University Press, March 2010. ISBN-13: 978-06911-401-48.

Isaac Newton on Mathematical Certainty and Method, by Niccolò Guicciardini. MIT Press, October 2009. ISBN-13: 978-02620-131-78.

Logicomix: An Epic Search for Truth, by Apostolos Doxiadis and Christos

Papadimitriou. Bloomsbury USA, September 2009. ISBN-13: 978-15969-145-20.

Logic's Lost Genius: The Life of Gerhard Gentzen, by Eckart Menzler-Trott, Craig Smorynski (translator), Edward R. Griffor (translator). AMS-LMS, November 2007. ISBN-13: 978-0-8218-3550-0.

The Mathematical Mechanic: Using Physical Reason to Solve Problems, by Mark Levi. Princeton University Press, 2009. ISBN-13: 978-0691140209.

Mathematicians: An Outer View of the Inner World, by Mariana Cook. Princeton University Press, June 2009. ISBN-13: 978-0-691-13951-7. (Reviewed August 2010.)

Mathematicians Fleeing from Nazi Germany: Individual Fates and Global Impact, by Reinhard Siegmund-Schultze. Princeton University Press, July 2009. ISBN-13: 978-0-691-14041-4.

Mathematics in Ancient Iraq: A Social History, by Eleanor Robson. Princeton University Press, August 2008. ISBN-13: 978-06910-918-22. (Reviewed March 2010.)

Mathematics in India, by Kim Plofker. Princeton University Press, January 2009. ISBN-13: 978-06911-206-76. (Reviewed March 2010.)

The Mathematics of Egypt, Mesopotamia, China, India, and Islam: A Sourcebook, by Victor J. Katz et al. Princeton University Press, July 2007. ISBN-13: 978-0-6911-2745-3.

The Millennium Prize Problems, edited by James Carlson, Arthur Jaffe, and Andrew Wiles. AMS, June 2006. ISBN-13: 978-08218-3679-8. (Reviewed December 2009.)

More Mathematical Astronomy Morsels, by Jean Meeus. Willmann-Bell, 2002. ISBN 0-943396743.

Mrs. Perkins's Electric Quilt: And Other Intriguing Stories of Mathematical Physics, Paul J. Nahin, Princeton University Press, August 2009. ISBN-13: 978-06911-354-03.

Naming Infinity: A True Story of Religious Mysticism and Mathematical Creativity, by Loren Graham and Jean-Michel Kantor. Belknap Press of Harvard University Press, March 2009. ISBN-13: 978-06740-329-34.

Numbers Rule: The Vexing Mathematics of Democracy, from Plato to the Present, by George G. Szpiro. Princeton University Press, April 2010. ISBN-13: 978-06911-399-44.

The Numerati, by Stephen Baker. Houghton Mifflin, August 2008. ISBN-13: 978-06187-846-08. (Reviewed October 2009.)

Our Days Are Numbered: How Mathematics Orders Our Lives, by Jason Brown. Emblem Editions, April 2010. ISBN-13: 978-07710-169-74.

A Passion for Discovery, by Peter Freund. World Scientific, August 2007. ISBN-13: 978-9-8127-7214-5

Perfect Rigor: A Genius and the Mathematical Breakthrough of the Century, by Masha Gessen. Houghton Mifflin Harcourt, November 2009. ISBN-13: 978-01510-140-64.

Pioneering Women in American Mathematics: The Pre-1940 Ph.D.'s, by Judy Green and Jeanne LaDuke. AMS, December 2008. ISBN-13:978-08218-4376-5.

Plato's Ghost: The Modernist Transformation of Mathematics, by Jeremy Gray. Princeton University Press, September 2008. ISBN-13: 978-06911-361-03. (Reviewed February 2010.)

The Princeton Companion to Mathematics, edited by Timothy Gowers (June Barrow-Green and Imre Leader, associate editors). Princeton University Press, November 2008. ISBN-13: 978-06911-188-02. (Reviewed November 2009.)

Probabilities: The Little Numbers That Rule Our Lives, by Peter Olofsson. Wiley, March 2010. ISBN-13: 978-04706-244-56.

Proofs from THE BOOK, by Martin Aigner and Günter Ziegler. Expanded fourth edition, Springer, October 2009. ISBN-13: 978-3-642-00855-9

Pythagoras' Revenge: A Mathematical Mystery, by Arturo Sangalli. Princeton University Press, May 2009. ISBN-13: 978-06910-495-57. (Reviewed May 2010.)

Recountings: Conversations with MIT Mathematicians, edited by Joel Segel. A K Peters, January 2009. ISBN-13: 978-15688-144-90.

Roger Boscovich, by Radoslav Dimitric (Serbian). Helios Publishing Company, September 2006. ISBN-13: 978-09788-256-21.

Sacred Mathematics: Japanese Temple Geometry, by Fukagawa Hidetoshi and Tony Rothman. Princeton University Press, July 2008. ISBN-13: 978-0-6911-2745-3.

The Solitude of Prime Numbers, by Paolo Giordano. Pamela Dorman Books, March 2010. ISBN-13: 978-06700-214-82. (Reviewed in this issue.)

Solving Mathematical Problems: A Personal Perspective, by Terence Tao. Oxford University Press, September 2006. ISBN-13: 978-0-199-20560-8. (Reviewed February 2010.)

Sphere Packing, Lewis Carroll, and Reversi, by Martin Gardner. Cambridge University Press, July 2009. ISBN-13: 978-0521756075.

The Strangest Man, by Graham Farmelo. Basic Books, August 2009. ISBN-13: 978-04650-182-77.

Street-Fighting Mathematics: The Art of Educated Guessing and Opportunistic Problem Solving, by Sanjoy Mahajan. MIT Press, March 2010. ISBN-13: 978-0-262-51429-3.

Symmetry in Chaos: A Search for Pattern in Mathematics, Art, and Nature, by Michael Field and Martin Golubitsky. Society for Industrial and Applied Mathematics, second revised edition, May 2009. ISBN-13: 978-08987-167-26.

Teaching Statistics Using Baseball, by James Albert. Mathematical Association of America, July 2003. ISBN-13: 978-08838-572-74. (Reviewed April 2010.)

Tools of American Math Teaching, 1800–2000, by Peggy Aldrich Kidwell, Amy Ackerberg-Hastings, and David Lindsay Roberts. Johns Hopkins University Press, July 2008. ISBN-13: 978-0801888144. (Reviewed January 2010.)

The Unfinished Game: Pascal, Fermat, and the Seventeenth-Century Letter That Made the World Modern, by Keith Devlin. Basic Books, September 2008. ISBN-13: 978-0-4650-0910-7.

Zeno's Paradox: Unraveling the Ancient Mystery behind the Science of Space and Time, by Joseph Mazur. Plume, March 2008 (reprint edition). ISBN-13: 978-0-4522-8917-8.

SPECIAL SECTION

2010 American Mathematical Society Election

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2010 AMS Elections

Special Section

List of Candidates–2010 Election

Vice President
(one to be elected)

Anthony Michael Bloch
Barbara Lee Keyfitz

Board of Trustees
(one to be elected)

Avner Friedman
William H. Jaco

Member at Large of the Council
(five to be elected)

Adebisi Agboola
Matthew Ando
Estelle Basor
Wilfrid Gangbo
Ira M. Gessel
Lawrence F. Gray
Patricia Hersh
Tara S. Holm
Alice Silverberg
T. Christine Stevens

Nominating Committee
(three to be elected)

Richard A. Brualdi
Beverly Diamond
Judy Anita Kennedy
Joshua D. Laison
Donal O'Shea
Gunther Uhlmann

Editorial Boards Committee
(two to be elected)

Krishnaswami Alladi
Edward B. Saff
John R. Stembridge
Sergei S. Suslov

Ballots

AMS members will receive email with instructions for voting online by August 24, or a paper ballot by September 20. If you do not receive this information by that date, please contact the AMS (preferably before October 1) to request a ballot. Send email to `ballot@ams.org` or call the AMS at 800-321-4267 (within the U.S. or Canada) or 401-455-4000 (worldwide) and ask to speak with Member Services. The deadline for receipt of ballots is November 5, 2010.

Write-in Votes

It is suggested that names for write-in votes be given in exactly the form that the name occurs in the *Combined Membership List* (`www.ams.org/cml`). Otherwise the identity of the individual for whom the vote is cast may be in doubt and the vote may not be properly credited.

Replacement Ballots

For a paper ballot, the following replacement procedure has been devised: A member who has not received a ballot by September 20, 2010, or who has received a ballot but has accidentally spoiled it, may write to `ballot@ams.org` or Secretary of the AMS, 201 Charles Street, Providence, RI 02904-2294, USA, asking for a second ballot. The request should include the individual's member code and the address to which the replacement ballot should be sent. Immediately upon receipt of the request in the Providence office, a second ballot, which will be indistinguishable from the original, will be sent by first class or airmail. Although a second ballot will be supplied on request and will be sent by first class or airmail, the deadline for receipt of ballots cannot be extended to accommodate these special cases.

Biographies of Candidates

The next several pages contain biographical information about all candidates. All candidates were given the opportunity to provide a statement of not more than 200 words to appear at the end of their biographical information.

Description of Offices

The **vice president** and the **members at large of the AMS Council** serve for three years on the Council. That body determines all scientific policy of the Society, creates and oversees numerous committees, appoints the treasurers and members of the Secretariat, makes nominations of candidates for future elections, and determines the chief editors of several key editorial boards. Typically, each of these new members of the Council also will serve on one of the Society's five policy committees.

The **Board of Trustees**, of whom you will be electing one member for a five-year term, has complete fiduciary responsibility for the Society. Among other activities, the trustees determine the annual budget of the Society, prices of journals, salaries of employees, dues (in cooperation with the Council), registration fees for meetings, and investment policy for the Society's reserves. The person you select will serve as chair of the Board of Trustees during the fourth year of the term.

The candidates for vice president, members at large, and trustee were suggested to the Council either by the

Nominating Committee or by petition from members. While the Council has the final nominating responsibility, the groundwork is laid by the **Nominating Committee**. The candidates for election to the Nominating Committee were nominated by the current president, George E. Andrews. The three elected will serve three-year terms. The main work of the Nominating Committee takes place during the annual meeting of the Society, during which it has four sessions of face-to-face meetings, each lasting about three hours. The Committee then reports its suggestions to the spring Council, which makes the final nominations.

The **Editorial Boards Committee** is responsible for the staffing of the editorial boards of the Society. Members are elected for three-year terms from a list of candidates named by the president. The Editorial Boards Committee makes recommendations for almost all editorial boards of the Society. Managing editors of *Journal of the AMS*, *Mathematics of Computation*, *Proceedings of the AMS*, and *Transactions of the AMS*; and Chairs of the *Collquium*, *Mathematical Surveys and Monographs*, and *Mathematical Reviews* editorial committees are officially appointed by the Council upon recommendation by the Editorial Boards Committee. In virtually all other cases, the editors are appointed by the president, again upon recommendation by the Editorial Boards Committee.

Elections to the **Nominating Committee** and the **Editorial Boards Committee** are conducted by the method of approval voting. In the approval voting method, you can vote for as many or as few of the candidates as you wish. The candidates with the greatest number of the votes win the election.

A Note from AMS Secretary Robert J. Daverman

The choices you make in these elections directly affect the direction the Society takes. If the past election serves as a reliable measure, about 13 percent of you will vote in the coming election, which is comparable with voter participation in other professional organizations which allow an online voting option. This is not mentioned as encouragement for you to throw the ballot in the trash; instead, the other officers and Council members join me in urging you to take a few minutes to review the election material, fill out your ballot, and submit it. The Society belongs to its members. You can influence the policy and direction it takes by voting.

Also, let me urge you to consider other ways of participating in Society activities. The Nominating Committee, the Editorial Boards Committee, and the Committee on Committees are always interested in learning of members who are willing to serve the Society in various capacities. Names are always welcome, particularly when accompanied by a few words detailing the person's background and interests. Self-nominations are probably the most useful. Recommendations can be transmitted through an online form (`www.ams.org/committee-nominate`) or sent directly to the secretary (`secretary@ams.org`) or Office of the Secretary, American Mathematical Society, Department of Mathematics, 302C Aconda Court, University of Tennessee, 1534 Cumberland Avenue, Knoxville, TN 37996-0612.

PLEASE VOTE.

Biographies of Candidates 2010

Biographical information about the candidates has been supplied and verified by the candidates.

Candidates have had the opportunity to make a statement of not more than 200 words (400 words for presidential candidates) on any subject matter without restriction and to list up to five of their research papers.

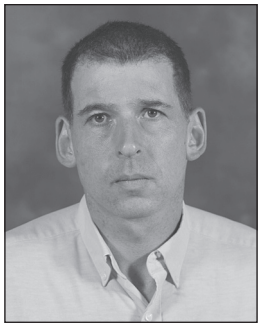
Candidates have had the opportunity to supply a photograph to accompany their biographical information.

Candidates with an asterisk (*) beside their names were nominated in response to a petition.

Abbreviations: American Association for the Advancement of Science (AAAS); American Mathematical Society (AMS); American Statistical Association (ASA); Association for Computing Machinery (ACM); Association for Symbolic Logic (ASL); Association for Women in Mathematics (AWM); Canadian Mathematical Society, Société Mathématique du Canada (CMS); Conference Board of the Mathematical Sciences (CBMS); Institute for Advanced Study (IAS), Institute of Mathematical Statistics (IMS); International Mathematical Union (IMU); London Mathematical Society (LMS); Mathematical Association of America (MAA); Mathematical Sciences Research Institute (MSRI); National Academy of Sciences (NAS); National Academy of Sciences/National Research Council (NAS/NRC); National Aeronautics and Space Administration (NASA); National Council of Teachers of Mathematics (NCTM); National Science Foundation (NSF); Society for Industrial and Applied Mathematics (SIAM).

Vice-President

Anthony Michael Bloch



Alexander Ziwet Collegiate Professor of Mathematics, Department of Mathematics, University of Michigan.

Born: February 28, 1955, Johannesburg, South Africa.

Ph.D.: Harvard University, 1985.

Selected Addresses: Plenary Address, SIAM National Meeting, Kansas City, 1996; Invited Series of Lectures in IIIe Cycle, Romand de Mathématiques, Les Diablerets, Switzerland, 2000; Plenary Address, XV International Workshop on Geometry and Physics, Tenerife, Spain, 2006; Invited Address, AMS meeting, Huntsville, Alabama, October, 2008; Invited series of lectures, International Summer School on Geometry, Mechanics and Control, Amettla Del Mar, Spain, 2009.

Additional Information: Presidential Young Investigator Award, 1991; Guggenheim Fellowship, 1996; Member, Institute for Advanced Study, 1997; Fellow of the IEEE, 2003; Chair, Department of Mathematics, University of Michigan, 2005–2008; Senior Fellow, Michigan Society of Fellows, 2010–; Editorial Boards include: *SIAM Journal on Control and Optimization*, 1993–1999, *Journal of Nonlinear Science*, 2001–, *Dynamical Systems*, 2002–, *Journal of Geometric Mechanics*, 2009–; Participating Institutions Council, Institute for Mathematics and its Applications, 2005–2008.

Selected Publications: 1. with R. W. Brockett and T. S. Ratiu, A new formulation of the generalized Toda lattice equations and their fixed point analysis via the momentum map, *Bull. Amer. Math. Soc. (N.S.)*, **23** (1990), No. 2, 477–485. MR**1027895 (91e:58067)**; 2. with H. Flaschka and T. S. Ratiu, A Schur-Horn-Kostant convexity theorem for the diffeomorphism group of the annulus, *Invent. Math.*, **113** (1993), No. 3, 511–529. MR**1231835 (94i:58063)**; 3. with D. Zenkov, Invariant measures of nonholonomic flows with internal degrees of freedom, *Nonlinearity*, **16** (2003), No. 5, 1793–1807. MR**1999579 (2004e:37100)**; 4. with F. Adams, Hill's equation with random forcing terms, *SIAM J. Appl. Math.*, **68** (2008), No. 4, 947–980. MR**2390975 (2008m:34064)**; 5. with V. Brinzanescu, A. Iserles, J. E. Marsden and T. S. Ratiu, A class of integrable flows on the space of symmetric matrices, *Comm. Math. Phys.*, **290** (2009), No. 2, 399–435. MR**2525626**.

Statement: It would be an honor to foster, support and extend the role that the American Mathematical Society plays in mathematical research, education, and outreach. It is important for the AMS to encourage research in pure and applied areas, to offer support for education at all levels, and to convey the vitality of mathematics to the academic and research community at large, and to the wider public. Mathematics is a wonderful intellectual endeavor which plays a key role in science and technology and everyday life. My goal would be to continue and extend the fine contributions that the AMS makes to the development of mathematics in all these areas.

Barbara Lee Keyfitz

Dr. Charles Saltzer Professor of Mathematics, The Ohio State University, Columbus, OH.

Born: November 7, 1944.

Ph.D.: New York University, 1970.

AMS Committees: Co-chair, organizing committee, Joint Summer Research Conference on Current Progress in Hyperbolic Systems: Riemann Problems and Computations, Bowdoin, Maine, July, 1988; Editorial Board, *Proc. Amer.*

Math. Soc., 1988–1992; Committee on Summer Institutes and Special Symposia, 1989–1992; Nominating Committee, 1990–1992 (Chair, 1991); Ad Hoc Committee on the Applications of Mathematics, 1990–1992; Coordinating Editor, *Proc. Amer. Math. Soc.*, 1992–1994; Task Force on Excellence in Mathematics Scholarship, 1992–1999; AMS Representative to AMS-SIAM-IMS Committee on Joint Summer Research Conferences, 1994–1997 (Chair, 1996–1997), SIAM Representative, 1998–2003; Committee on Centennial Fellowships, 1995–1997; Editorial Board, *Trans. Amer. Math. Soc.*, 1998–2002; Co-organizer, with Kevin Payne, of Special Session on Partial Differential Equations of Mixed Elliptic-Hyperbolic Type and Applications, AMS Sectional Meeting, Penn State University, 2009; Member, Committee to Select the Winner of the Steele Prize, 2010–2013; *Mathematical Reviews* Editorial Committee, 2010–2014.

Selected Addresses: Krieger-Nelson Prize Lecture, CMS Summer Meeting, Waterloo, 2005; Invited Speaker, Conference on Advances in PDE in honor of the eightieth birthdays of Peter Lax and Louis Nirenberg, Toledo, Spain, 2006; Invited Speaker, International Congress on Industrial and Applied Mathematics, Zurich, 2007; Karen Ames Lecture Series talk, University of Alabama, Huntsville, 2009; Plenary Speaker, EWM Conference, Novi Sad, 2009.

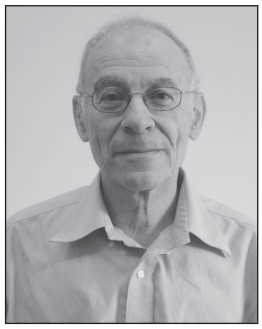
Additional Information: Fellow of AAAS, 1992; Krieger-Nelson Prize, Canadian Mathematical Society, 2005; Esther Farfel Award, University of Houston, 2006; Honorary Doctor of Mathematics Degree, University of Waterloo, 2010; SIAM Fellow, 2010.

Selected Publications: 1. Solutions with shocks, an example of an L^1-contractive semi-group, *Comm. Pure Appl. Math.*, **24** (1971), 125–132. MR**0271545 (42 #6428)**; 2. with H. C. Kranzer, A system of nonstrictly hyperbolic conservation laws arising in elasticity theory, *Arch. Rational Mech. Anal.*, **72** (1979/1980), No. 3, 219–241. MR**0549642 (80k:35050)**; 3. with M. Golubitsky, A qualitative study of the steady-state solutions for a continuous flow stirred tank chemical reactor, *SIAM J. Math. Anal.*, **11** (1980), No. 2, 316–339. MR**0559872 (82i:80010)**; 4. with G. M. Lieberman and S. Ĉanić, A proof of existence of perturbed steady transonic shocks via a free boundary problem, *Comm. Pure Appl. Math.*, **53** (2000), No. 4, 484–511. MR**1733695 (2001m:76056)**; 5. with E. H. Kim and S. Ĉanić, A free boundary problem for a quasi-linear degenerate elliptic equation: regular reflection of weak shocks, *Comm. Pure Appl. Math.*, **55** (2002), No. 1, 71–92. MR**1857880 (2003a:35206)**.

Statement: It is an honor to be asked to run for the position of Vice President. I hope to be able to contribute by listening carefully, making fair decisions, and working towards inclusiveness and excellence.

Trustee

Avner Friedman



Distinguished University Professor, Department of Mathematics, Ohio State University.

Born: November 19, 1932.

Ph.D.: Hebrew University, 1956.

AMS Committees: Member at Large of the Council, 1968–1969.

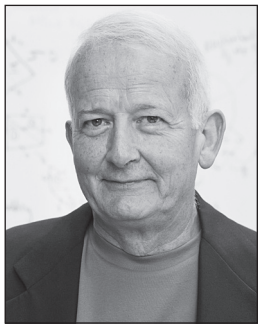
Selected Addresses: AMS/Canada Summer Conference, Vancouver, 1993; International Congress on Industrial and Applied Mathematics (ICIAM), Edinburgh, 1999; Petrowski Conference, Moscow, 2004; Annual British Joint Mathematics-Applied Mathematics Conference, Liverpool, 2005; Joint Society for Mathematical Biology and Chinese Society for Mathematical Biology (SMB/CSMB) International Conference, Hangzhou, China, 2009.

Additional Information: Sloan Fellowship, 1962–1965; Guggenheim Fellowship, 1966–1967; NSF Special Creativity Award, 1983–1985, 1991–1993. Elected to American Academy of Arts and Sciences, 1987– ; National Academy of Science, 1993– ; Spain Academy of Science, 1998–.

Selected Publications: 1. Fundamental solutions for degenerate parabolic equations, *Acta Math.*, **133** (1974), 171–217. MR**0481551 (58 #1665)**; 2. On the free boundary of a quasivariational inequality arising in a problem of quality control, *Trans. Amer. Math. Soc.*, **246** (1978), 95–110. MR**0515531 (80f:93086c)**; 3. with E. DiBenedetto, The ill-posed Hele-Shaw model and the Stefan problem for supercooled water, *Trans. Amer. Math. Soc.*, **282** (1984), No. 1, 183–204. MR**0728709 (85g:35121)**; 4. with F. Reitich, Quasi-static motion of a capillary drop. II. The three-dimensional case, *J. Differential Equations*, **186** (2002), No. 2, 509–557. MR**1942220 (2003m:35197)**; 5. with B. Hu, Stability and instability of Liapunov-Schmidt and Hopf bifurcation for a free boundary problem arising in a tumor model, *Trans. Amer. Math. Soc.*, **360** (2008), No. 10, 5291–5342. MR**2415075 (2009d:35353)**.

Statement: The Board of Trustees manages the business affairs and sets the fiscal policy of the Society. But it also needs to look for new resources, especially at current times of economic stress. I believe I can contribute to the mission of the Board, with my experience which includes serving on the Board of Trustees of SIAM (1990–1995), serving as Director of two mathematical institutes, the Institute of Mathematics and its Applications (1987–1997), and the Mathematical Biosciences Institute (2001–2008); Chair of the Board of Mathematical Sciences (1994–1997); and President of SIAM (1993–1995) and of the Society of Mathematical Biology (2007–2009). These experiences involved balancing budgets with attention to scientific and scholar priorities, but also identifying new resources in government, foundations, and industry.

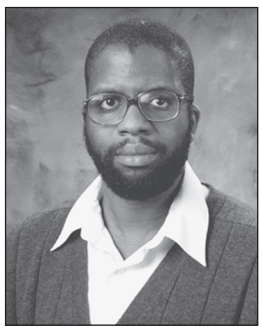
William H. Jaco



Regents Professor and Grayce B. Kerr Chair, Department of Mathematics, Oklahoma State University.
Born: July 14, 1940.
Ph.D.: University of Wisconsin-Madison, 1968.
AMS Committees: Committee to Select Hour Speakers (Midwest Section), 1978–1980 (Chair, 1979–1980); Committee on Committees, 1985–1989 (Chair, 1987–1989); Joint Meetings Committee, 1988–1995 (Ex-officio); Long Range Planning Committee, 1988–1995 (Ex-officio); Committee to Monitor Problems in Communication, 1988–1993 (Ex-officio); Committee on Science Policy, 1988–1998; Committee on Education, 1990–1995 (Ex-officio); Committee on Meetings and Conferences, 1993–1995 (Ex-officio); Committee on the Profession, 1993–1995 (Ex-officio); Committee on Publications, 1993–1995 (Ex-officio); Federal Policy Committee, 1995–1997 (Chair); Subcommittee on Professional Development of Graduate Students, 1996–1999; Committee on Graduate/Postdoctoral Education, 1996–1999; Committee on Fellows, 2003–2004; Liaison Committee with AAAS, 2003–2010 (Chair, 2009–2010); Task Force on Prizes, 2009–2010 (Chair).
Selected Addresses: AMS Invited One-Hour Address, Blacksburg, VA, 1975; CBMS Regional Research Conference (Principle Lecturer), Blacksburg, VA, 1977; International Mathematical Union Lectures (6 lectures), University of Geneva (Switzerland), 1981; Summer School (10 lectures), University of Peking, Beijing, China, 2004; AMS Invited One-Hour Address, Tallahassee, FL, 2004.
Additional Information: National Science Foundation Graduate Fellowship, 1964–1967; National Science Foundation Postdoctoral Fellowship, 1971–1972; Member, Board on Mathematical Sciences, National Research Council, National Academy of Sciences, 1987–1990; Executive Director, AMS, 1988–1995; Member, American Institute of Mathematics Advisory Board, 1994–2010; Fellow, AAAS, 1998–; AAAS Steering Committee, Section A. Mathematics, 2007–2010 (Chair, 2008–2009); Regents Professor, Oklahoma State University, 2008–; AAAS Council Member, 2009–2010.
Selected Publications: 1. Finitely presented subgroups of 3-manifold groups, *Invent. Math.,* **13** (1971), 335–346. MR**0300279 (45 #9325)**; 2. with J. Hempel, Fundamental groups of 3-manifolds which are extensions, *Ann. of Math. (2),* **95** (1972), 86–98. MR**0287550 (44 #4754)**; 3. with P. Shalen, Seifert fibered spaces in 3-manifolds, *Mem. Amer. Math. Soc.*, **21** (1979), No. 220, viii+192 pp. MR**539411 (81c:57010)**; 4. with U. Oertel, An algorithm to decide if a 3-manifold is a Haken manifold, *Topology*, **23** (1984), No. 2, 195–209. MR**0744850 (85j:57014)**; 5. with J. H. Rubinstein, 0-efficient triangulations of 3-manifolds, *J. Differential Geom.*, **65** (2003), No. 1, 61–168. MR**2057531 (2005d:57034)**.
Statement: The Trustees of the AMS have the responsibility to oversee the business and financial affairs of the Society. As Executive Director of the Society (1988–1995), I had the primary executive responsibility for the business and finances of the Society. This experience gives me unique familiarity with those aspects of the Society that fall under the responsibility of a Trustee. During my tenure as Executive Director, *Mathematical Reviews* joined the central administrative structure under the Executive Director and began its successful electronic delivery of *Mathematical Reviews* (MathSci Net), the AMS held its first long-range planning, establishing the five standing policy committees (Science, Education, Profession, Publications, and Meetings), the Washington Office was founded, which today plays a central role in Federal Science Policy, and the Society lead a campaign for support of Russian mathematics and mathematicians during the breakup of the former Soviet Union. I am pleased that the member and staff leadership of the Society continue to support and strengthen these initiatives. As a Trustee I would strive to protect the financial stability of the Society while continuing its enviable record of support to mathematical research and scholarship and to the mathematics profession. I greatly enjoyed my tenure as Executive Director and am honored with the opportunity to stand for election as a Trustee and to have the chance to serve the Society in this capacity.

Member at Large

Adebisi Agboola



Professor of Mathematics, University of California, Santa Barbara.
Born: August 11, 1964, Ogbomoso, Nigeria.
Ph.D.: Columbia University, 1991.
AMS Committees: Centennial Fellowship Committee, 2009–2010.
Selected Addresses: Conference on "Integral Galois structures", Irsee, Germany, 1993; Conference on "p-adic representations in arithmetic", Anogia, Greece, 1998; Conference on "Stark's conjectures and related topics", Baltimore, 2002; Conference on "Open questions and recent developments in Iwasawa theory, in honor of Ralph Greenberg's 60th birthday", Boston, 2005; Conference "Iwasawa 2010", Toronto, 2010.

Additional Information: NSF Postdoctoral Research Fellow, 1991–1994. Member: MSRI, 1991–1992; Institute for Advanced Study, 1995–1996; CIRM Montreal, Fall, 2005.

Selected Publications: 1. with M. J. Taylor, Class invariants of Mordell-Weil groups, *J. Reine Angew. Math.*, **447** (1994), 23–61. MR**1263168 (95k:11142)**; 2. Torsion points on elliptic curves and Galois module structure, *Invent. Math.*, **123** (1996), No. 1, 105–122. MR**1376248 (97a:11178)**; 3. On primitive and realisable classes, *Compositio Math.*, **126** (2001), No. 1, 113–122. MR**1827865 (2002a:11125)**; 4. with B. Howard (and with an appendix by K. Rubin), Anticyclotomic Iwasawa theory of CM elliptic curves, *Ann. Inst. Fourier*, **56** (2006), No. 4, 1001–1048. MR**2266884 (2009b:11098)**; 5. On Rubin's variant of the p-adic Birch and Swinnerton-Dyer conjecture, *Compositio Math.*, **143** (2007), No. 6, 1374–1398. MR**2371373 (2009d:11101)**.

Statement: The primary purpose of the AMS is to foster the development of mathematics by promoting the professional interests of mathematicians. I would be honored to be able to make a contribution to the Society by serving as a Member at Large of the Council.

Matthew Ando

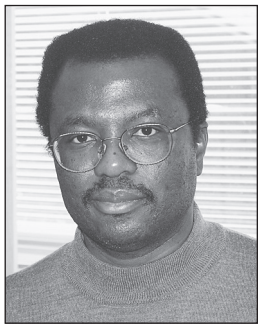
Associate Professor, Department of Mathematics, University of Illinois at Urbana-Champaign.
Born: April 3, 1968, Philadelphia, PA, USA.
Ph.D.: Massachusetts Institute of Technology, 1992.
Selected Addresses: International Conference on algebraic topology, Gdansk, Poland, 2001; International Conference on algebraic geometry and topology, Canberra, Australia, 2003; Abel Symposium, Oslo, 2007.
Additional Information: Invited long-stay visitor, Isaac Newton Institute, Cambridge, 2002; Invited organizer, conference on elliptic cohomology, Fields Institute, Toronto, 2004; Invited visitor, MSRI, 2006.
Selected Publications: 1. with M. Hopkins and N. Strickland, Elliptic spectra, the Witten genus, and the theorem of the cube, *Invent. Math.*, **146** (2001), No. 3, 595–687. MR**1869850 (2002g:55009)**; 2. The sigma orientation for analytic circle-equivariant elliptic cohomology, *Geom. Topol.*, **7** (2004), 91–153. MR**1988282 (2004d:55006)**; 3. with N. Ganter and C. French, The Jacobi orientation and the two-variable elliptic genus, *Algebr. Geom. Topol.*, **8** (2008), No. 1, 493–539. MR**2443236 (2009g:55006)**; 4. with A. Blumberg and D. Gepner, Twists of *K*-theory and TMF, to appear in *Proc. Symp. Pure Math.*

Statement: Two striking features of mathematics, compared to lab sciences, are the breadth of the research community and the relatively low cost of the typical mathematician's research program. These features should be a source of strength in the current difficult economic climate, but they are not automatically so. Institutions of higher education—particularly public institutions—face simultaneously increasing enrollment and declining public investment, resulting in substantial pressure to focus precious limited resources on superstars and adjuncts. Funding agencies such as the NSF have helped with postdocs, but have not directly affected tenure-track positions. The AMS should support our historical breadth, for example by articulating its importance to decision-makers at all levels. A primary goal should be to promote the hiring of tenure-track faculty in mathematics and to support the careers of those tenure-track faculty. Broad-based intellectual foment is the habitat in which great mathematical discoveries have emerged for decades. In addition, our breadth plays an important role in the renewal of our community, and in the recruitment of the next generation of scientists and engineers. As research and teaching go hand in hand, so hiring tenure-track research mathematicians has a salutary effect not only on research but also on instruction and recruitment.

Estelle Basor

Deputy Director, American Institute of Mathematics, Palo Alto, CA.
Born: October 23, 1947, Watsonville, CA, USA.
Ph.D.: University of California, Santa Cruz, 1975.
Selected Addresses: Invited Talk, International Conference on Toeplitz Matrices, Pobershau, Germany, 2001; Three Lectures, Random Matrix Approaches in Number Theory, Newton Institute, Cambridge, 2004; Plenary Talk, International Workshop on Operator Theory, Williamsburg, VA, 2008; Invited Talk, Northern California, Nevada, and Hawaii Section of the MAA, San Francisco, CA, 2010.
Additional Information: Professor Emeritus, California Polytechnic State University, San Luis Obispo, 1976–2008; Member of the AWM, 1976–; Selection Committee for AWM-NSF Travel Grants, 1996–1999; Member of MSRI, 1999; Member of the Newton Institute, 2004; Member of the SAMSI scientific committee for Program on High Dimensional Inference and Random Matrices, 2006–2007; Co-Organizer Special Session, AMS regional meeting, Recent Developments in Random Matrix Theory, Tucson, Arizona, 2007; Co-Organizer for the workshop Random Matrices, Related Topics and Applications, Parent program: Probabilistic Methods in Mathematical Physics CRM, Montreal, 2008.
Selected Publications: 1. A localization theorem for Toeplitz determinants, *Indiana Univ. Math. J.*, **28** (1979), 975–983. MR**0551161 (81e:47029)**; 2. Distribution functions for random variables for ensembles of positive Hermitian matrices, *Comm. Math. Phys.*, **188** (1997), 327–350. MR**1471817 (99b:82046)**; 3. with T. Ehrhardt, Asymptotic formulas for the determinants of symmetric Toeplitz plus Hankel matrices, *Toeplitz Matrices and Singular Integral Equations* (Pobershau, 2001), 61–90, *Oper. Theory Adv. Appl.*, **135**, Birkhäuser, Basel, 2002. MR**1935758 (2003h:47049)**; 4. with H. Widom, Wiener-Hopf determinants with Fisher-Hartwig symbols, *Oper. Theory Adv. Appl.*, **147** (2004), 131–149. MR**2053687 (2005c:47031)**; 5. with T. Ehrhardt, Asymptotics of block Toeplitz determinants and the classical dimer model, *Comm. Math. Phys.*, **274** (2007), No. 2, 427–455. MR**2322911 (2008j:47067)**.
Statement: The strength of the AMS has always been its ability to promote the highest quality research. As a Member at Large I will work to maintain and promote excellence in research and in all other areas important to the health of the mathematical community. These areas include the teaching of mathematics, making mathematics an inclusive activity, and promoting mathematical outreach activities. It is especially important given the current financial crisis that the AMS provide assistance to graduate students seeking employment, provide affordable journals and books, and continue to encourage the public awareness of the importance of mathematics.

Wilfrid Gangbo

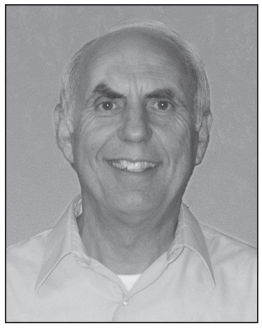


Professor of Mathematics, School of Mathematics, Georgia Institute of Technology, Atlanta, Georgia.
Born: May 11, 1961, Porto-Novo, Benin.
Ph.D.: École Polytechniques Fédérales de Lausanne, Switzerland, 1992.
AMS Committees: Committee on Human Rights of Mathematicians, 2009–2011; SIAG/Activity Group on Analysis of PDEs, 2009–2011.
Selected Addresses: Plenary Address, AMS meeting, New York University, 2003; Plenary Address, SIAM Conference on Analysis of PDEs, Houston, 2004; ICMS, Edinburgh, UK, 2007; Variational Methods for Nonlinear PDE, Technion, Israel, 2008; Pacific NorthWest Seminar, Vancouver, Canada, 2009.
Additional Information: National Academy of Sciences, 11th Annual Frontiers of Science Symposium, 1999; Membership: MSRI, 1994–1995, 2005; IPAM, 2008; CNRS-visiting Professor at ENS-Paris, ENS-Lyon, Paris Dauphine, 2002; Program Organized: IPAM, Spring 2008; Editorial Boards: *Communication in Mathematical Sciences*, 2007–, *Journal on Mathematical Analysis*, 2008–, *Network and Heterogeneous Media*, 2008–, *European Series in Applied and Industrial Mathematics: Control, Optimisation and Calculus of Variations*, 2009–; Selected Conferences Organized: "Optimal Mass Transport and its Applications", MSRI, 2005, "SIAM Conference on Analysis of PDEs", Miami FL, 2009.
Selected Publications: 1. with R. McCann, The geometry of optimal transportation, *Acta Math.*, **177** (1996), No. 2, 113–161. MR**1440931 (98e:49102)**; 2. with L. C. Evans, Differential equations methods for the Monge-Kantorovich mass transfer problem, *Mem. Amer. Math. Soc.*, **137** (1999), No. 653, 1–66. MR**1464149 (99g:35132)**; 3. with E. Carlen, Constrained steepest descent in the 2–Wasserstein metric, *Ann. of Math. (2)*, **157** (2003), No. 3, 807–846. MR**1983782 (2004c:49027)**; 4. with M. Cullen and G. Pisante, Semigeostrophic equations discretized in reference and dual variables, *Arch. Ration. Mech. Anal.*, **185 (**2007), No. 2, 341–363. MR**2317792 (2009a:76037)**; 5. with L. Ambrosio, Hamiltonian ODEs in the Wasserstein space of probability measures, *Comm. Pure Appl. Math.*, **61** (2008), No. 1, 18–53. MR**2361303 (2009b:37101)**.
Statement: Mathematics is recognized as a vital part of science. However, it seems that its current funding level leaves out a group of people worth supporting. It seems that the European funding level is catching up very fast to the American one and may surpass it soon. How far are we from the point where this could have a long–term impact on research and education? Could AMS play a role and propose remedies? It will be an honor to serve as an AMS Member at Large and be involved in such issues.

Ira M. Gessel

Professor and Chair, Department of Mathematics, Brandeis University.
Born: April 9, 1951, Philadelphia, PA, USA.
Ph.D.: Massachusetts Institute of Technology, 1977.
Selected Addresses: AMS Joint Summer Research Conference on *q*-Series, Combinatorics and Computer Algebra, Mount Holyoke College, 1998; 50th Séminaire Lotharingien de Combinatoire, 2003; CombinaTexas, Texas A&M University, 2004; Diagonally Symmetric Polynomials and Applications, Centro Internacional de Encuentros Matemáticos, Castro-Urdiales, Spain, 2007; Canadian Mathematical Society, Ottawa, 2008.
Selected Publications: 1. Multipartite *P*-partitions and inner products of skew Schur functions, in *Combinatorics and Algebra* (Boulder, Colo., 1983), *Contemp. Math.*, vol. 34, Amer. Math. Soc., Providence, RI, 1984. pp. 289–317. MR**0777705 (86k:05007)**; 2. with G. Viennot, Binomial determinants, paths and hook length formulae, *Adv. Math.*, **58** (1985), No. 3, 300–321. MR**0815360 (87e:05008)**; 3. Symmetric functions and *P*-recursiveness, *J. Combin. Theory Ser. A*, **53** (1990), 257–285. MR**1041448 (91c:05190)**; 4. with C. Reutenauer, Counting permutations with given cycle structure and descent set, *J. Combin. Theory Ser. A*, **64** (1993), No. 2, 189–215. MR**1245159 (95g:05006)**; 5. Applications of the classical umbral calculus, *Algebra Universalis*, **49** (2003), no. 4, 397–434. MR**2022347 (2004k:05029)**.
Statement: The AMS supports the mathematics profession in many ways: with publishing, organizing meetings, advocacy for mathematics funding, and informing the public of the importance of mathematics in our society. In these financially challenging times, with a tight job market and diminished resources at colleges and universities, the role of the AMS in our profession is more important than ever. As a Member at Large of the Council, I would do my best to support the good work that the AMS does.

Lawrence F. Gray



Professor, School of Mathematics, University of Minnesota.
Born: May 25, 1949, Santa Monica, California, USA.
Ph.D.: Cornell University, 1977.
AMS Committees: Committee on Education, 2007– (Chair, 2009); Committee on Science Policy, 2009–; Liaison Committee with AAAS, 2010–.
Selected Addresses: "Rigorous techniques for analyzing CA traffic models", ICIAM, 2007, Zurich; "A new coupling for particle jump models", IMS, 2010, Gothenburg.
Additional Information: Honored Fellow of the Institute of Mathematical Statistics.

Selected Publications: 1. with B. Fristedt, *A Modern Approach to Probability Theory*, Birkhäuser Boston Inc., Boston, MA, 1997. MR**1422917 (98e:60002)**; 2. with D. Griffeath, The ergodic theory of traffic jams, *J. Statist. Phys.*, **105** (2001), No. 3–4, 413–452. MR**1871652 (2002j:60169)**; 3. A mathematician looks at Wolfram's new kind of science, *Notices Amer. Math. Soc.*, **50** (2003), No. 2, 200–211. MR**1951106**.

Statement: The world of mathematics that we all know and love as members of the AMS is naturally dominated by research and other scholarly activities. But beyond these vital pursuits, there is much else of value that we have to offer to the rest of the world, due to our unique perspectives as mathematicians. In recent years, much of my energy has been directed towards reaching out to and working with those that are concerned with K–12 mathematics including public school teachers, mathematics education researchers, state education departments, and state legislators. There are other forms of outreach as well, and I believe these should be priorities for the AMS.

Patricia Hersh

Associate Professor of Mathematics, North Carolina State University.

Born: May 24, 1973, Saginaw, Michigan, USA.

Ph.D.: Massachusetts Institute of Technology, 1999.

Selected Addresses: Plenary Talk, Trends in Topological Combinatorics Conference, KTH-Stockholm, Sweden, 2005; Plenary Talk, CombinaTexas Conference, El Paso, Texas, 2008; Virginia Tech Math Departmental Colloquium, Blacksburg, Virginia, 2009; UBC Math Departmental Colloquium, Vancouver, Canada, 2010; Plenary Talk, Southeast Lie Theory Conference, Athens, Georgia, 2010.

Additional Information: 1994 Alice T. Schafer Prize runner-up; NSF Postdoctoral Research Fellowship, 2001–2004; Ruth I. Michler Memorial Prize winner, 2010–2011; AWM Mentoring Travel Grant Selection Committee; Triangle Lectures in Combinatorics (TLC) Regional Conference Series Organizing Committee; FPSAC Conference Program Committees for 21st and 24th annual conferences; 5 AMS special sessions co-organized; postdoctoral positions at the University of Washington, 1999–2001, the University of Michigan, 2001–2004, and MSRI, Fall, 2004; faculty member at Indiana University–Bloomington, 2004–2009; Institute for Math and its Applications (IMA), long-term visitor, Spring, 2007.

Selected Publications: 1. Chain decomposition and the flag f-vector, *J. Combin. Theory Ser. A*, **103** (2003), No. 1, 27–52. MR**1986829 (2004e:06003)**; 2. with P. Hanlon, Multiplicity of the trivial representation in rank-selected homology of the partition lattice, *J. Algebra*, **266** (2003), No. 2, 521–538. MR**1995126 (2004e:05206)**; 3. with E. Babson, Discrete Morse functions from lexicographic orders, *Trans. Amer. Math. Soc.*, **357** (2005), 509–537. MR**2095621 (2006d:05185)**; 4. with S. Hsiao, Random walks on quasi-symmetric functions, *Adv. Math.*, **222** (2009), No. 3, 782–808. MR**2553370**; 5. Shelling Coxeter-like complexes and sorting on trees, *Adv. Math.*, **221** (2009), No. 3, 812–829. MR**2511039**.

Statement: The AMS is well-positioned to help the mathematics community grapple with changing economic conditions through the thoughtful creation of new programs. Of utmost importance is the health of the mathematical pipeline. Also very important is travel. The careers of many well-deserving individuals and the continued vitality of mathematical research depend on these. I believe the AMS council should focus considerable energy right now on these priorities. Increased NSF support for regional conferences and/or a more extensive AMS travel grants program could help at a time when many schools are cutting travel funding.

I've had the opportunity to spend time at several research universities and institutes. I see real differences in how they are run—from the structure of graduate programs to the role of lecturers in teaching classes. Now is a critical time for good ideas to be devised and shared. I would welcome the opportunity to participate in this process.

Tara S. Holm

Associate Professor of Mathematics, Cornell University.

Born: Pittsburgh, PA, USA.

Ph.D.: Massachusetts Institute of Technology, 2002.

Selected Addresses: "Act globally, compute locally: Localization in symplectic geometry", Plenary Address, AMS Eastern Sectional Meeting, 2007; "Dance of the Astonished Topologist", Women in Math Celebration, MIT, 2008; "The K-theory of symplectic orbifolds", Combinatorial, Enumerative and Toric Geometry workshop, MSRI, 2009; "Symplectic reduction in stages and orbifold invariants", Colloque Paulette Libermann, Institut Henri Poincaré, 2009; "Moment polytopes and the connections between symplectic and discrete geometry", Formal Power Series and Algebraic Combinatorics, 2010.

Additional Information: NSF Postdoctoral Fellowship, 2002–2005; AIM Project NExT Fellow, 2006–2007; Co-organizer for Cornell Topology Festival, 2006–; NSF Disciplinary Grant in Geometric Analysis, 2006–2010; NSF Conference grant in Topology and Geometric Analysis, 2008–2009; NSF Conference grant in Topology, 2009–2012; Local co-organizer for upcoming AMS Eastern Sectional Meeting at Cornell University, 2011; (Co)organizer of 8 conferences and workshops in symplectic geometry.

Selected Publications: 1. with R. Goldin and L. Jeffrey, Distinguishing the chambers of the moment polytope, *J. Symplectic Geom.*, **2** (2003), No. 1, 109–131. MR**2128390 (2005j:53093)**; 2. with J.-Cl. Hausmann and V. Puppe, Conjugation spaces, *Algebr. Geom. Topol.*, **5** (2005), 923–964. MR**2171799 (2006e:55008)**; 3. with M. Harada and A. Henriques, Computation of generalized

equivariant cohomologies of Kac-Moody flag varieties, *Adv. Math.*, **197** (2005), No. 1, 198–221. MR**2166181 (2006h:53086)**; 4. with R. Goldin and A. Knutson, Orbifold cohomology of torus quotients, *Duke Math. J.*, **139** (2007), No. 1, 89–139. MR**2322677 (2008h:53144)**; 5. with R. Sjamaar, Torsion and abelianization in equivariant cohomology, *Transform. Groups*, **13** (2008), No. 3-4, 585–615. MR**2452608 (2009j:57041)**.

Statement: The AMS plays several vital roles in the support of mathematics research and education. As mathematicians, we frequently see the Society's influence in terms of publishing mathematical research and reviews of mathematical research. Perhaps more important, though, is its role as advocate for mathematics, to the government, to funding agencies and to the public at large. If elected to the Council, I pledge to do my utmost for the mathematics community, with particular attention to 1. advocating and lobbying for governmental and non-governmental funding for mathematics, from research to education at all levels; 2. employment and funding opportunities for recipients of new and recent Ph.D.s in mathematics; 3. promoting diversity in the mathematics community, broadly defined to include students and mathematicians outside of academia; 4. encouraging all talented students to pursue mathematics, and ensuring opportunities for all; and 5. dissemination and publication of mathematical research on the arXiv, on the Internet and in journals, at a reasonable cost.

Alice Silverberg

Professor, University of California, Irvine.

Born: October 6, 1958, New York, New York, USA.

Ph.D.: Princeton University, 1984.

AMS Offices: Member at Large of the Council, 1995–1998.

AMS Committees: Centennial Fellowship Committee, 1993–1995 (Chair, 1994–1995); Committee on Meetings and Conferences, 1995–1996; Committee on Publications, 1996–1998; Travel Grants Evaluation Panel, 2000; Committee on Committees, 2000–2003; Program Committee for National Meetings, 2005–2008; Program Committee for the AMS-MAA Joint Mathematics Meetings, 2005–2006, 2007–2008; Cole Prize Committee, 2007–2008.

Selected Addresses: Plenary Address, Australian Mathematical Society Annual Meeting, Sydney, Australia, 1989; I. A. and Fannie R. Barnett Lecture, University of Cincinnati, 1995; Invited Hour Address, AMS meeting, Kent, Ohio, 1995; Invited Hour Address, AMS meeting, Annandale-on-Hudson, NY, 2005; Invited Address, MAA MathFest, 2009.

Selected Publications: 1. Mordell-Weil groups of generic abelian varieties, *Invent. Math.*, **81** (1985), No. 1, 71–106. MR**0796192 (87b:11046)**; 2. with K. Rubin, A report on Wiles' Cambridge lectures, *Bull. Amer. Math. Soc. (N.S.)*, **31** (1994), No. 1, 15–38. MR**1256978 (94k:11062)**; 3. with Yu. G. Zarhin, Polarizations on abelian varieties and self-dual l-adic representations of inertia groups, *Compositio Math.*, **126** (2001), No. 1, 25–45. MR**1827860 (2002f:11066)**; 4. with K. Rubin, Ranks of elliptic curves, *Bull. Amer. Math. Soc. (N.S.)*, **39** (2002), No. 4, 455–474. MR**1920278 (2003f:11080)**; 5. with K. Rubin, Compression in finite fields and torus-based cryptography, *SIAM J. Comput.*, **37** (2008), No. 5, 1401–1428. MR**2386274 (2009d:94101).**

Statement: If elected to the Council, my primary interests would be to work towards equal opportunity, fairness, and openness in our profession, and making information widely accessible, in order to fulfill the AMS's mission of furthering mathematical research and scholarship.

T. Christine Stevens

Professor of Mathematics and Computer Science, Saint Louis University, Saint Louis, MO.

Born: December 1, 1948, Hagerstown, Maryland, USA.

Ph.D.: Harvard University, 1978.

Selected Addresses: Special Session on the History of Mathematics, Phoenix, Arizona, 2004; Plenary Address, KAIST International Symposium on Enhancing University Mathematics Teaching, Daejeon, South Korea, 2005; Keynote Address, Canadian Mathematics Education Study Group, Fredericton, New Brunswick, 2007; James R. C. Leitzel Lecture, MAA Mathfest, Madison, Wisconsin, 2008.

Additional Information: AMS/MAA/SIAM Congressional Science Fellow, 1984–1985; NSF program officer in teacher enhancement, 1987–1989; Co-director (1994–1998) and Director (1998–2009) of Project NExT (MAA); Fellow of AAAS, 2005; current and past service on committees of AAAS, AWM, MAA, and SIAM, including MAA Science Policy Committee, SIAM Education Committee, and MAA Committee on Minority Participation in Mathematics.

Selected Publications: 1. Weakening the topology of a Lie group, *Trans. Amer. Math. Soc.*, **276** (1983), No. 2, 541–549. MR**0688961 (84e:22010)**; 2. Connectedness of complete metric groups, *Colloq. Math.*, **50** (1986), No. 2, 233–240. MR**0857858 (88h:54056)**; 3. with J. Gallian and A. Higgins, Project NExT, *Notices Amer. Math. Soc.*, **47** (2000), No. 2, 217–220. 4. with J. W. Short, Weakened Lie groups and their locally isometric completions, *Topology Appl.*, **135** (2004), No. 1–3, 47–61. MR**2024945 (2005b:22005)**; 5. Helping new faculty to develop into successful teachers and scholars, *CBMS Issues in Mathematics Education*, **14** (2007), 33–41.

Statement: For sixteen years, I led Project NExT (New Experiences in Teaching), a professional development program of the MAA that helps new Ph.D.s in the mathematical sciences to make the transition from graduate student to faculty member. It addresses all aspects of an academic career: teaching, research, and service. Thus far, almost 1200 new faculty members have participated in this program, which the AMS has helped to support since 2001. My work with Project NExT has given me a unique perspective not only on the challenges faced by new members of our profession, but also on the opportunities that they will

have to advance mathematics and shape its future. One of my goals as a member of the Council would be to help the AMS serve the needs of new mathematicians and tap their creativity and enthusiasm in addressing some of the issues confronting our profession, such as attracting a diverse group of talented people into mathematics, improving mathematical education at all levels, fostering public appreciation of mathematics, and securing support for mathematics education and research. My activities in other professional organizations and my work at the NSF have taught me the importance of collaborating with other groups in these efforts.

Editorial Boards Committee

Krishnaswami Alladi

Professor, University of Florida, Gainesville, Florida.
Born: October 5, 1955, Trivandrum, India.
Ph.D.: University of California, Los Angeles, 1978.
AMS Committees: Program Committee, Southeastern Section, 2002–2003 (Chair, 2003); Committee on Committees, 2009–2011.
Selected Addresses: One-hour Address, Conference on Special Functions, q-series and Related Topics, Fields Institute, Toronto, 1995; Weissmann Public Lecture, City University of New York, 2002; Srinivasa Ramanujan Commemoration Lecture, International Conference on Fourier Analysis and Number Theory, SASTRA University, Kumbakonam, India, 2004; Public Lecture, Royal Spanish Academy of Sciences, Madrid, Spain, 2006; One-hour Address, Combinatory Analysis 2008, Conference in honor of George Andrews, Pennsylvania State University, 2008.
Additional Information: Chair, SASTRA Ramanujan Prize Committee, 2005–; Editorial Boards: Editor-in-Chief, *The Ramanujan Journal* (Springer), 1997–; Editor, *Developments in Mathematics* (Springer Book Series), 1998–; Associate Editor, *Notices Amer. Math. Soc.*, 2009–2012.

Selected Publications: 1. Some new observations on the Göllnitz-Gordon and Rogers-Ramanujan identities, *Trans. Amer. Math. Soc.*, **347** (1995), No. 3, 897–914. MR**1284910 (95h:11109)**; 2. with G. E. Andrews and B. Gordon, Generalizations and refinements of a partition theorem of Göllnitz, *J. Reine Angew. Math.,* **460** (1995), 165–188. MR**1316576 (96c:11119)**; 3. with G. E. Andrews and B. Gordon, Refinements and generalizations of Capparelli's conjecture on partitions, *J. Algebra*, **174** (1995), 636–658. MR**1334229 (96b:11136)**; 4. Partition identities involving gaps and weights, *Trans. Amer. Math. Soc.*, **349** (1997), 2721–2735. MR**1401759 (98c:05102)**; 5. with G. E. Andrews and A. Berkovich, A new four parameter q-series identity and its partition implications, *Invent. Math.*, **153** (2003), 231–260. MR**1992013 (2004g:05018)**.

Statement: Any leading professional society should play a major role in the dissemination of knowledge in its discipline and one of the principal ways to do this is through scholarly publications. The AMS has a fine collection of journals and book series with a broad range and scope. Many leaders of our discipline are involved in the editing of these publications to ensure that the highest quality is maintained, that new and important ideas are chronicled properly and communicated effectively through the Society's publications. This is especially important now because of the increasing awareness the world over of the central role of mathematics in a variety of fields. I will work enthusiastically to continue to engage the leaders of our discipline in the editorial process of our publications and help the AMS maintain its role as one of the world's major publishers.

Edward B. Saff

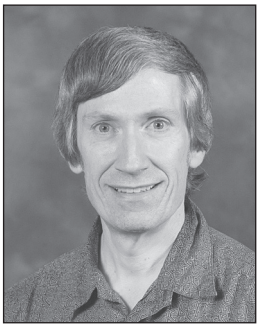
Professor and Director, Center for Constructive Approximation, Department of Mathematics, Vanderbilt University.
Born: January 2, 1944, New York City, NY, USA.
Ph.D.: University of Maryland, 1968.
Selected Addresses: Invited Address, AMS Southeast Region Conference, 2001; Plenary Speaker, Conference on Orthogonal Polynomials, Carlos III University, Madrid, Spain, 2008; Colloquium Lectures, Steklov Institute, Moscow, 2007, University of New South Wales, Sydney, Australia, 2009; Main Presenter, Winter School on Applied Mathematics, City University, Hong Kong, 2009.
Additional Information: Fulbright Fellow (U.K.), Guggenheim Fellow, Erskine Fellow, University of Canterbury, New Zealand; ISI Highly Cited Researcher; Distinguished Professor (USF); Co-editor-in-chief, *Constructive Approximation Journal and Computational Methods and Function Theory*; Editor, *J. Approximation Theory, Foundations of Computational Math.* (1999–2004) and Cambridge University Press, Textbooks in Applied Mathematics (1995–2004).

Selected Publications: 1. with D. S. Lubinsky and H. N. Mhaskar, Freud's conjecture for exponential weights, *Bull. Amer. Math. Soc. (N.S.)*, **15** (1986), No. 2, 217–221. MR**0854558 (88d:42039)**; 2. with V. Totik, Logarithmic potentials with external fields, *Grundlehren Math. Wiss.*, **316**, Springer-Verlag, 1997. MR**1485778 (99h:31001)**; 3. with A. B. J. Kuijlaars, Asymptotics for minimal discrete energy on the sphere, *Trans. Amer. Math. Soc.*, **350** (1998), No. 2, 523–538. MR**1458327 (98e:11092)**; 4. with D. P. Hardin, Discretizing manifolds via minimum energy points, *Notices Amer. Math. Soc.*, **51** (2004), No. 10, 1186–1194. MR**2104914 (2006a:41049)**; 5. with B. Gustafsson, M. Putinar, and N. Stylianopoulos, Bergman polynomials on an archipelago: Estimates, zeros and shape reconstruction, *Adv. Math.*, **222** (2009), No. 4, 1405–1460. MR**2554940**.

Statement: The selection of editorial board members for the publications of the AMS is a great responsibility that entails a commitment (which I would be honored to make) to seek the most qualified individuals who represent the broad spectrum of mathematical pursuits. Indeed, the

editorial board is the journal since it speaks for both the quality and content of its publications. Maintaining a high intellectual standard, ensuring diversity, and guaranteeing the timely processing of manuscripts will be my guiding concerns in making board recommendations.

John R. Stembridge



Professor of Mathematics, University of Michigan.
Born: July 8, 1959, Glendale, California, USA.
Ph.D.: Massachusetts Institute of Technology, 1985.
AMS Offices: AMS-IMS-SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences, 1993–1996; David P. Robbins Prize Committee, 2009–2012.
Selected Addresses: Commutative Algebra and Combinatorics, Nagoya, 1990; Interactions of Combinatorics and Representation Theory, RIMS, Kyoto, 1998; Computational Lie Theory, CRM, Montreal, 2002; Combinatorics & Optimization 40th Anniversary, Waterloo, 2007; Topics in Combinatorial Representation Theory, MSRI, 2008.
Additional Information: Sloan Fellow, 1990–1992; Presidential Young Investigator, 1990–1995; Editorial Board Member, *Proc. Amer. Math. Soc.*, 1998–2005; Guggenheim Fellow, 2001; Editorial Board Member, *Trans. Amer. Math. Soc.*, 2006–.
Selected Publications: 1. Shifted tableaux and the projective representations of symmetric groups, *Adv. Math.*, **74** (1989), No. 1, 87–134. MR**0991411 (90k:20026)**; 2. Canonical bases and self-evacuating tableaux, *Duke Math. J.*, **82** (1996), No. 3, 585–606. MR**1387685 (97f:05193)**; 3. Combinatorial models for Weyl characters, *Adv. Math.*, **168** (2002), No. 1, 96–131. MR**1907320 (2003j:17007)**; 4. A local characterization of simply-laced crystals, *Trans. Amer. Math. Soc.*, **355** (2003), No. 12, 4807–4823. MR**1997585 (2005h:17024)**; 5. Coxeter cones and their *h* vectors, *Adv. Math.*, **217** (2008), 1935–1961. MR**2388082 (2010e:52027)**.
Statement: Communicating our ideas is the most important thing that we as mathematicians do. If elected, I will strive to find the best people to keep our Society's journals functioning well and meeting the needs of the mathematical community. In nominating members to serve on editorial boards, I think the most important qualities to look for are a strong sense of responsibility to the profession, good judgment and ethics, a wide range of contacts, and diversity of experience.

Sergei K. Suslov

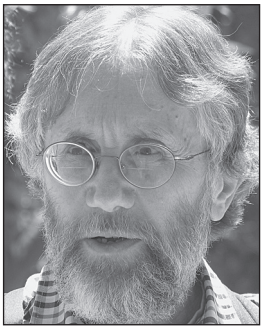
Professor, School of Mathematical and Statistical Sciences & Mathematical, Computational and Modeling Sciences Center, Arizona State University.
Ph.D.: Kurchatov Institute of Atomic Energy, Moscow, Russia, 1986.
Selected Addresses: Third International Symposium on Orthogonal Polynomials and their Applications, Erice, Italy, 1990; Workshop in Special Functions, *q*-Series and Related Topics at The Fields Institute, University of Toronto, 1995; Conference on Symbolic Computation, Number Theory, Special Functions, Physics, and Combinatorics, University of Florida, Gainesville, 1999; Sixth International Symposium on Orthogonal Polynomials, Special Functions, and Applications, Rome, Italy, 2001; International Conference on Difference Equations, Special Functions and Applications, Munich, Germany, 2005.

Additional Information: First Kurchatov Award to the Young Scientist, Kurchatov Institute, Moscow, Russia, 1985; Foreign Researcher Award, Natural Sciences and Engineering Research Council of Canada, 1994–1995; Member, Mathematical Sciences Research Institute, Berkeley, California, 1996–1997; NATO country director of the Advanced Study Institute "Special Functions 2000: Current Perspective and Future Directions", Tempe, Arizona, May–June 2000; Charles Wexler's Teaching Award for Distinguished Teaching of Mathematics, Department of Mathematics and Statistics, Arizona State University, Tempe, 2002; Editorial Board, *Journal of Difference Equations and Applications*.
Selected Publications: 1. with A. F. Nikiforov and V. B. Uvarov, *Classical Orthogonal Polynomials of a Discrete Variable*, Springer Series in Computational Physics, Springer-Verlag, 1991. MR**1149380 (92m:33019)**; 2. with R. Askey and M. Rahman, On a general *q*-Fourier transformation with nonsymmetric kernels, *J. Comput. Appl. Math.*, **68** (1996), No. 1–2, 25–55. MR**1418749 (98m:42033)**; 3. *An Introduction to Basic Fourier Series*, Developments in Mathematics, 9, Kluwer Academic Publishers, Dordrecht, 2003. MR**1978912 (2004h:33002)**; 4. with R. Cordero-Soto, R. M. Lopez, and E. Suazo, Propagator of a charged particle with a spin in uniform magnetic and perpendicular electric fields, *Lett. Math. Phys.*, **84** (2008), No. 2-3, 159–178. MR2**415547 (2009m:81055)**; 5. Mathematical structure of relativistic Coulomb integrals, *Phys. Rev. A.*, **81** (2010).
Statement: In a competitive world of traditional and electronic journals I will do my best to identify the best editorial board members who are energetic and open to new challenges and will maintain the integrity and high quality of the AMS journals. My personal research interests are in both mathematics and physics and I am dedicated to the support of women and minorities.

Nominating Committee

Richard A. Brualdi

Bascom Professor of Mathematics, emeritus, University of Wisconsin, Madison, WI.
Born: September 2, 1939.
Ph.D.: Syracuse University, 1964.
AMS Committees: Editorial Boards Committee, 2003–2007; Committee on Publications, 2010–2013.



Selected Addresses: AMS-MAA Plenary Lecture, Joint Mathematics Meetings, San Antonio, 1993; SIAM Conference on Applied Linear Algebra, Snowbird, Utah, 1997; British Combinatorics Conference, 2007; Spectral Graph Theory Conference, Rio de Janeiro, Brazil, 2008; IPM 20th Anniversary Combinatorics Conference, Tehran, Iran, 2009.

Additional Information: Board of Governors, Institute of Mathematics and its Applications, Minnesota, 1988–1991; Editor-in-chief, *Linear Algebra and its Applications* and *Electronic Journal of Combinatorics*; Chair, Department of Mathematics, University of Wisconsin, 1993–1999; President, International Linear Algebra Society, 1996–2002; Board of Trustees, Mathematical Sciences Research Institute, Berkeley, 1999–2002; Euler Medal, Institute of Combinatorics and its Applications, 2000; Hans Schneider Prize, International Linear Algebra Society, 2006.

Selected Publications: 1. with B. L. Shader, *Matrices of Sign-solvable Linear Systems*, Cambridge Tracts in Mathematics, **116**, Cambridge University Press, Cambridge, 1995. MR**1358133 (97k:15001)**; 2. with J. Shen, Landau's inequalities for tournament scores and a short proof of a theorem on transitive sub-tournaments, *J. Graph Theory*, **38** (2001), No. 4, 244–254. MR**1864924 (2002g:05056)**; 3. with S. Kirkland, Aztec diamonds and digraphs, and Hankel determinants of Schröder numbers, *J. Combin. Theory Ser. B*, **94** (2005), No. 2, 334–351. MR**2145518 (2006f:05010)**; 4. *Combinatorial Matrix Classes*, Encyclopedia of Mathematics and its Applications, 108, Cambridge University Press, Cambridge, 2006. MR**2266203 (2007k:05038)**; 5. with D. Cvetkovićs, *A Combinatorial Approach to Matrix Theory and Its Applications*, CRC Press, Boca Raton, FL, 2009. MR**2453822 (2009k:05002)**.

Statement: The main task of the Nominating Committee is to identify candidates for offices of the AMS. If elected, I would use my many years of experience in the mathematics community to recruit people of diverse interests who have the skill, foresight, and energy to serve in various capacities.

Beverly Diamond

Senior Vice Provost and Professor of Mathematics, College of Charleston.

Born: July 5, 1956, Charlottetown, Prince Edward Island, Canada.

Ph.D.: University of Manitoba, 1982.

AMS Offices: Member at Large of the Council, 2004–2008.

AMS Committees: Chair, Committee on Publications, 2005–2009; Committee on Education, 2009–2013.

Additional Information: American Association of University Women Fellowship, 1988–1989; Program Officer, National Science Foundation, 1996–1998; Associate Provost for Faculty Affairs, 2007–2009; Interim Provost, July 2009–January 2010.

Selected Publications: 1. with M. Barge, Stable and unstable manifold structures in the Hénon family, *Ergodic Theory Dynam. Systems*, **19** (1999), No. 2, 309–338. MR**1685396 (2000i:37057)**; 2. with M. Barge, A complete invariant for the topology of one-dimensional substitution tiling spaces, *Ergodic Theory Dynam. Systems*, **21** (2001), No. 5, 1333–1358. MR**1855835 (2002k:37026)**; 3. with M. Barge, Coincidence for substitutions of Pisot type, *Bull. Soc. Math. France*, **130** (2002), No. 4, 619–626. MR**1947456 (2004c:37018)**; 4. with M. Barge, Proximality in Pisot tiling spaces, *Fund. Math.*, **194** (2007), No. 3, 191–238. MR**2302003 (2008g:37016)**; 5. with M. Barge, Cohomology in one-dimensional substitution tiling spaces, *Proc. Amer. Math. Soc.*, **136** (2008), No. 6, 2183–2191. MR**2383524 (2009c:37005)**.

Statement: I will work hard to ensure a diverse, skilled and committed group of mathematicians to provide leadership to and conduct the business of the AMS.

Judy Anita Kennedy

Professor, Lamar University.

Born: July 24, 1947, Mobile, AL, USA.

Ph.D.: Auburn University, 1975.

AMS Offices: Member at Large of the Council, 2006–2008.

AMS Committees: Committee on Meetings and Conferences, 2006–2008; Task Force on the First-Year Mathematics Experience, 2007–2008.

Selected Addresses: Hour Address, Dynamics Days Conference, Tempe, AZ, 1997; Anatolian Lectures in Dynamical Systems (4 lectures), Middle East Technical University, Ankara, Turkey, 1997; Hour Address, International Conference on Geometric Topology, Dubrovnik, Croatia, 1998; Plenary Talk, 2000 Annual Spring Topology/Dynamics Systems Conference, University of Texas at Austin, Austin, TX, 2000; Invited Address, 17th Summer Topology Conference, University of Auckland, Auckland, New Zealand, 2002.

Selected Publications: 1. Stable extensions of homeomorphisms on the pseudo-arc, *Trans. Amer. Math. Soc.*, **310** (1988), No. 1, 167–178. MR**0939804 (89d:54023)**; 2. with J. A. Yorke, Basins of Wada, *Phys. D*, **51** (1991), No. 1–3, 213–225. MR**1128813 (92k:58177)**; 3. with J. A. Yorke, Bizarre topology is natural in dynamical systems, *Bull. Amer. Math. Soc. (N.S.)*, **32** (1995), No. 3, 309–316. MR**1307903 (95j:58107)**; 4. with E. Akin and M. Hurley, Dynamics of topologically generic homeomorphisms, *Mem. Amer. Math. Soc.*, **164** (2003), No. 783, viii+130 pp. MR**1980335 (2004j:37024)**; 5. with D. Stockman and J. A. Yorke, The inverse limits approach to chaos, *J. Math. Econom.*, **44** (2008), No. 5–6, 423–444. MR**2404675 (2009i:37038)**.

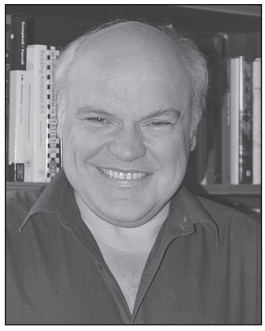
Statement: As a regular contributor to conferences at the regional, national and international level, I have an extensive base of colleagues and potential nominees ranging across a broad spectrum of institutions. This base also represents a broad array of mathematical areas ranging from applications to economics and physics, to dynamical systems, to topology. By utilizing this base and doing additional research, I will seek out underrepresented areas, institutions, and groups as a source of nominees to better fulfill the missions of the AMS.

Joshua D. Laison

Assistant Professor, Willamette University, Salem, Oregon.
Born: September 28, 1975, Philadelphia, PA, USA.
Ph.D.: Dartmouth College, 2001.
Selected Addresses: DIMACS Connect Institute, Piscataway, NJ, 2001; International Symposium on Graph Drawing, Limerick, Ireland, 2005; Special Session, SIAM Discrete Math Conference, Victoria, Canada, 2006; SIAM Special Session, Joint Mathematics Meetings, San Antonio, TX, 2006; Graph Portland Area Lecture Series, Portland, OR, 2008.
Additional Information: Project NExT Fellow, 2002; Editorial Board, Young Mathematicians' Network; Co-director, Rocky Mountain MAA Section meeting, 2004.
Selected Publications: 1. with A. Dean, W. Evans, E. Gethner, M. A. Safari, and W. T. Trotter, Bar *k*-visibility graphs, *J. Graph Algorithms Appl.*, **11** (2007), No. 1, 45–59. MR**2318424 (2008g:05139)**; 2. with M. Schick, Seeing dots: visibility of lattice points, *Math. Mag.*, **80** (2007), No. 4, 274–282. MR**2356579 (2008j:11079)**; 3. with C. R. Gibbons, Fixing numbers of graphs and groups, *Electron. J. Combin.*, **16** (2009), No. 1. MR**2491641 (2010e:05137)**; 4. Just visiting, *Notices Amer. Math. Soc.*, **56** (2009), No. 11, 1451–1454. 5. with H. Alpert and C. Koch, Obstacle numbers of graphs, *Discrete Comput. Geom.*, **44** (2010), No. 1, 223–244.
Statement: The American Mathematical Society has been vital in building a strong mathematical community in the U.S. I would be delighted to work to make this community even better.

Donal O'Shea

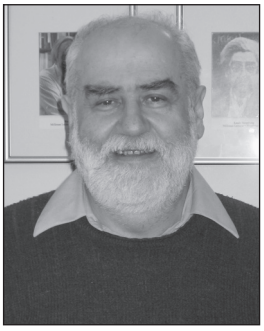
Elizabeth T. Kennan Professor of Mathematics, Dean of Faculty, and Vice-President for Academic Affairs, Mount Holyoke College.
Born: August 28, 1952, Saint John, N.B., Canada.
Ph.D.: Queen's University (Kingston, Canada), 1980.
AMS Committees: Committee to Select the Winner of the Prize for Exemplary Program or Achievement by a Mathematics Department, 2004–2007.
Selected Addresses: Peano Prize Address, Turin, Italy, 2008; Beyond Einstein, Mainz, Germany, 2008; Sulski Lecture, Holy Cross, Worcester, 2008; Shape of Content, Fields Institute, Toronto, 2009; Singularities in Aarhus, Aarhus, Denmark, 2009.



Additional Information: Director, NSF/Five Colleges Regional Geometry Institute, 1990–1993; Board of Directors, Canadian Mathematical Society, 1995–1999; Chief Academic Officers Task Force, Council of Independent Colleges, 2005–2008 (Chair, 2007–2008); Peano Prize, 2008; Visiting positions: IHES, 1983–1984, U. Massachusetts, Amherst, 1984–1985, U. Kaiserslautern, 1987–1988, U. of Hawaii, Manoa, 1991–1992, 1997–1998, U. Miami, 2004, U. Edinburgh, 2005; Member: MAA, SMF, LMS, EMS, CMS.
Selected Publications: 1. with J. Callahan, D. Cox, K. Hoffman, H. Pollatsek, and L. Senechal, *Calculus in Context*, New York: W. H. Freeman, 1995; 2. with L. Wilson, Limits of tangent spaces to real surfaces, *Amer. J. Math.*, **126** (2004), No. 5, 951–980. MR**2089078 (2005f:14110)**; 3. with D. Cox and J. Little, *Using Algebraic Geometry*, Springer, 1998, 2nd Edition, 2005, Japanese translation, 2000. MR**2122859 (2005i:13037)**; 4. with D. Cox and J. Little, *Ideals, Varieties and Algorithms: An Introduction to Computational Algebraic Geometry and Commutative Algebra*, New York: Springer, 1992. Second Edition, 1996, Russian Translation, Mir Moscow, 1998, Japanese Translation, Springer-Verlag Tokyo, 2000. Third Edition, 2007. MR**2290010 (2007h:13036)**; 5. *The Poincaré Conjecture: In Search of the Shape of the Universe*, New York: Walker & Company and UK: Penguin, 2007 (translated into German (S. Fischer), Italian (Rizzoli), French (Dunod), Greek (Travlos), Japanese (Nikkei), Hebrew (Aryeh Nir), Portuguese (Editoria Record), Korean (Kachi), Spanish (Tusquets), Czech (Acdemia), Chinese (Hunan Science)); all in 2007 except Hunan (2010). MR**2354336 (2008i:00001)**.
Statement: The disciplines that comprise mathematics, and the professions that rest on them, are among the most critical and least understood in today's society. As the oldest and most representative mathematical society in the United States, the American Mathematical Society plays a vital role in the development of mathematical scientists, in the dissemination of mathematics, and in support of the mathematical professions. This is a cause in which I believe deeply, and I will work hard to recruit as broad, as diverse, as representative, and as talented a group of individuals as possible for leadership roles in the AMS.

Gunther Uhlmann

Walker Family Endowed Professor of Mathematics, University of Washington.
Born: February 9, 1952, Quillota, Chile.
Ph.D.: Massachusetts Institute of Technology, 1976.
AMS Offices: Member at Large of the Council, 1992–1994.
AMS Committees: Committee to select winner of Birkhoff Prize, Chair, 2005; Committee to select speakers of AMS Western meetings, 2006–2007 (Chair, 2007); Program Committee, 8th Joint AMS-SMM meeting, 2009–2010.
Selected Addresses: Principal Speaker, CBMS, University of Kentucky, 1995; Invited Speaker, International Congress of Mathematicians, Berlin, 1998; One hour lecture,



Joint Mathematics Meetings, 2005; Plenary Lecture, International Congress of Industrial and Applied Mathematics, Zurich, 2007; Zygmund-Calderón Lectures, University of Chicago, Chicago, IL, 2008; E. Grosswald Lectures, Temple University, Philadelphia, PA, 2009.
Additional Information: A. P. Sloan Foundation Fellowship, 1984–1986; J. S. Guggenheim Fellowship, 2001–2002; Corresponding Member, Chilean Academy of Sciences, 2001; Member, American Academy of Arts and Sciences, 2009; SIAM Fellow, 2010; Chancellor Professor, MSRI, 2010; Senior Clay Scholar, 2010.
Selected Publications: 1. with J. Sylvester, A global uniqueness theorem for an inverse boundary value problem, *Ann. of Math. (2)*, **125** (1987), No. 1, 153–169. MR**0873380 (88b:35205)**; 2. with L. Pestov, Two dimensional compact simple Riemannian manifolds are boundary distance rigid, *Ann. of Math. (2)*, **161** (2005), No. 2, 1093–1110. MR**2153407 (2006c:53038)**; 3. with P. Stefanov, Boundary rigidity and stability for generic simple metrics, *J. Amer. Math. Soc.*, **18** (2005), No. 4, 975–1003. MR**2163868 (2006h:53031)**; 4. with C. Kenig and J. Sjöstrand, The Calderón problem for partial data, *Ann. of Math. (2)*, **22** (2007), No. 2, 567–591. MR**2299741 (2008k:35498)**; 5. with O. Imanuvilov and M. Yamamoto, Global uniqueness from partial Cauchy data in two dimensions, *J. Amer. Math. Soc.*, **23** (2010), 655–691.

CALL FOR Suggestions

Your suggestions are wanted by:

The Nominating Committee, for the following contested seats in the 2011 AMS elections:
vice president, trustee,
and five members at large of the Council

Deadline for suggestions: November 5, 2010

The President, for the following contested seats in the 2011 AMS elections:
three members of the Nominating Committee
two members of the Editorial Boards Committee

Deadline for suggestions: February 25, 2011

The Editorial Boards Committee, for appointments to various editorial boards of AMS publications

Deadline for suggestions: Can be submitted any time
Send your suggestions for any of the above to:

Robert J. Daverman, Secretary
American Mathematical Society
Department of Mathematics
302C Aconda Court
University of Tennessee
1534 Cumberland Avenue
Knoxville, TN 37996-0612 USA
email: secretary@ams.org

AMS
American Mathematical Society
www.ams.org

2011 AMS Election

Nominations by Petition

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 2011. 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 procedures, 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 procedures, 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 procedures, described below, should be followed.

Rules and Procedures

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

1. To be considered, petitions must be addressed to Robert J. Daverman, Secretary, American Mathematical Society, 302C Aconda Court, University of Tennessee, Knoxville, TN 37996-0612 USA, and must arrive by 25 February 2011.
2. The name of the candidate must be given as it appears in the *Combined Membership List* (`www.ams.org/cml`). 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 by the candidate contacting the AMS headquarters in Providence (amsmem@ams.org).
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. 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 2011 Election

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

_____

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

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

of the American Mathematical Society for a term beginning 1 February, 2012

Return petitions by 25 February 2011 to:
Secretary, AMS, 302C Aconda Court, University of Tennessee, Knoxville, TN 37996-0612 USA

Name and address (printed or typed)	Signature
	Signature
	Signature
	Signature
	Signature
	Signature

AMS EXEMPLARY PROGRAM PRIZE

At its meeting in January 2004, the AMS Council approved the establishment of a new award called the AMS Award for an Exemplary Program or Achievement in a Mathematics Department. It is to be presented annually to a department that has distinguished itself by undertaking an unusual or particularly effective program of value to the mathematics community, internally or in relation to the rest of society. Examples might include a department that runs a notable minority outreach program, a department that has instituted an unusually effective industrial mathematics internship program, a department that has promoted mathematics so successfully that a large fraction of its university's undergraduate population majors in mathematics, or a department that has made some form of innovation in its research support to faculty and/or graduate students, or which has created a special and innovative environment for some aspect of mathematics research.

The prize amount is $5,000. All departments in North America that offer at least a bachelor's degree in the mathematical sciences are eligible.

The Prize Selection Committee requests nominations for this award, which will be announced in Spring 2011. Letters of nomination may be submitted by one or more individuals. Nomination of the writer's own institution is permitted. The letter should describe the specific program(s) for which the department is being nominated as well as the achievements that make the program(s) an outstanding success, and may include any ancillary documents which support the success of the program(s). The letter should not exceed two pages, with supporting documentation not to exceed an additional three pages.

All nominations should be submitted to the AMS Secretary, Robert J. Daverman, American Mathematical Society, 302C Aconda Court, University of Tennessee, Knoxville TN 37996-0614. Include a short description of the work that is the basis of the nomination, with complete bibliographic citations when appropriate. The nominations will be forwarded by the Secretary to the Prize Selection Committee, which will make the final decision on the award.

Deadline for nominations is September 15, 2010.

Mathematics Calendar

September 2010

2–4 **Moduli spaces**, Institut de Recherche Mathématique Avancée, University of Strasbourg, France. (Jan. 2010, p. 76)

2–4 **Random Generation of Combinatorial Structures, GASCom 2010**, Laboratoire de combinatoire et d'informatique mathématique (LaCIM), Université du Québec à Montréal, Montréal, Quebec, Canada. (Jun./Jul. 2010, p. 780)

2–4 **The 6th William Rowan Hamilton Geometry and Topology Workshop. Knots, Surfaces and Three-Manifolds**, The Hamilton Mathematics Institute, Trinity College Dublin, Ireland. (June 2010, p. 780)

4–5 **Logic and Mathematics 2010**, Mathematics Department, University of Illinois, Urbana, Illinois. (Aug. 2010, p. 903)

4–5 **Symposium on Biomathematics and Ecology: Education and Research (BEER-2010)**, Illinois State University, Normal, Illinois. (Jun./Jul. 2010, p. 780)

* 4–10 **Summer School on General Algebra and Ordered Sets 2010**, Malenovice (near Frydlant nad Ostravici), Czech Republic.
Description: The 48th international algebraic conference devoted to universal algebra, ordered sets and related topics.
Information: `http://ssaos2010.inf.upol.cz/`.

* 6–8 **IMA Conference on Fluid Problems in Process Engineering**, University of Leeds, United Kingdom.
Description: Fluid flows are important in a wide range of engineering applications. Many industrially motivated flow problems lead to fascinating fundamental fluid mechanics studies, as well as providing profound challenges that drive the development of more powerful mathematical and simulation techniques. Understanding and predicting fluid behaviour is becoming increasingly important, especially for applications where experimentation is too difficult, expensive, or hazardous. This conference seeks to bring together academics and practitioners to explore the fundamental science, progress, and challenges in mathematical modelling and simulation technology inspired by fluid problems in process engineering.
Information: `http://www.ima.org.uk/Conferences/fluid_problems_in_process_engineering/index.html`.

* 6–9 **Contributions in Differential Geometry: A round table on occasion of the 65th birthday of Lionel Bérard Bergery**, University of Luxembourg, Luxembourg.
Description: The conference is dedicated to the 65th birthday and retirement of Lionel Bérard Bergery, professor at the university of Nancy.
Topic: Differential Geometry, should be intended in a broad sense, encompassing also connections with other fields of Mathematics and General Relativity.
Information: `http://math.uni.lu/confbb`.

6–9 **XIX International Fall Workshop on Geometry and Physics**, Oporto, Portugal. (Apr. 2010, p. 549)

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 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. 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 **eight 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/July, 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/`.

6–10 **Dynamics Days Europe 2010**, University of Bristol, Bristol, United Kingdom. (May 2010, p. 675)

6–10 **QMath11 - Mathematical Results in Quantum Physics**, University of Hradec Kralove, Hradec Kralove, Czech Republic. (Jun./Jul. 2010, p. 780)

7–10 **First International Workshop on Differential and Integral Equations with Applications in Biology and Medicine**, Aegean University, Karlovassi, Samos island, Greece. (Oct. 2009, p. 1148)

7–10 **Workshop on Computer Graphics, Computer Vision and Mathematics 2010 (GraVisMa 2010)**, Brno University of Technology, Faculty of Information Technology, Brno, Czech Republic. (Jun./Jul. 2010, p. 780)

7–11 **International Conference "Modern Stochastics: Theory and Applications II"**, Kyiv National Taras Shevchenko University, Kyiv, Ukraine. (Feb. 2010, p. 306)

7–11 **Logic, Algebra and Truth Degrees 2010**, Prague, Czech Republic. (Feb. 2010, p. 307)

7–12 **Geometry, Dynamics, Integrable Systems 2010**, Mathematical Institute SANU, Belgrade, Serbia. (Feb. 2010, p. 307)

9–12 **The Second Asian Conference on Nonlinear Analysis and Optimization (NAO-Asia2010)**, Royal Paradise Hotel & Spa, Patong Beach, Phuket, Thailand. (Apr. 2010, p. 549)

11–17 **NAFSA 9–The 9th International School on Nonlinear Analysis, Function Spaces and Applications**, Trest Castle, Czech Republic. (Oct. 2009, p. 1148)

12–17 **ESF Mathematics Conference in Partnership with EMS and ERCOM/INI: Highly Oscillatory Problems: From Theory to Applications**, The Isaac Newton Institute, Cambridge, United Kingdom. (Feb. 2010, p. 307)

13–15 **2nd IMA Numerical Linear Algebra and Optimisation Conference**, University of Birmingham, Birmingham, United Kingdom. (Aug. 2010, p. 903)

13–15 **IMA Hot Topics Workshop: Medical Device-Biological Interactions at the Material-Tissue Interface**, Institute for Mathematics and its Applications (IMA), University of Minnesota, Minneapolis, Minnesota. (May 2010, p. 675)

13–15 **Optimal Discrete Structures and Algorithms (ODSA 2010)**, University of Rostock, Rostock, Germany. (Apr. 2010, p. 549)

13–16 **Courant Colloquium 2010**, Georg-August-Universitaet Goettingen, Goettingen, Germany. (Jun./Jul. 2010, p. 780)

13–17 **AIM Workshop: Emerging applications of complexity for CR mappings**, American Institute of Mathematics, Palo Alto, California. (Apr. 2010, p. 550)

13–17 **Third International Congress on Mathematical Software [ICMS'2010—developers meeting]**, Department of Mathematics, Kobe University, Kobe, Japan. (Feb. 2010, p. 307)

13–17 **Random Matrix Theory and Its Applications I**, Mathematical Sciences Research Institute, Berkeley, California. (Dec. 2009, p. 1482)

13–17 **Summer School on Analysis: Spectral Theory and PDEs**, Leibniz University, Hannover, Germany. (Jun./Jul. 2010, p. 781)

13–18 **Meeting in Honor of Jouko Väänänen's 60th Birthday**, University of Helsinki, Finland. (Aug. 2010, p. 903)

13–December 17 **Modern Trends in Optimization and Its Application**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, CA. (Nov. 2009, p. 1361)

15–18 **Algebra, Geometry, and Mathematical Physics**, Technical University of Crete, Chania, Crete, Greece. (Apr. 2010, p. 550)

15–18 **Conference in Numerical Analysis (NumAn 2010): Recent Approaches to Numerical Analysis: Theory, Methods and Applications**, Great Arsenale (Old Venetian Harbor) Chania, Island of Crete, Greece. (Mar. 2010, p. 433)

17–19 S^4 **Conference on Symmetry, Separation, Superintegrability and Special Functions**, School of Mathematics, University of Minnesota, Minneapolis, Minnesota. (Feb. 2010, p. 307)

19–22 **Applied Statistics 2010 (AS2010)**, Ribno (Bled), Slovenia. (May 2010, p. 675)

19–25 **13th International Workshop for Young Mathematicians "Logic and Foundations of Mathematics"**, Jagiellonian University, Krakow, Poland. (Jun./Jul. 2010, p. 781)

19–25 **ICNAAM 2010 minisymposium: Semigroups of Linear Operators and Applications**, Hotel Rodos Palace, Rhodes, Greece. (Jun./Jul. 2010, p. 781)

20–21 **MSRI—Connections for Women: An Introduction to Random Matrices**, Mathematical Sciences Research Institute, Berkeley, California. (Dec. 2009, p. 1482)

20–24 **10th International Conference on Parametric Optimization and Related Topics (paraoptX)**, Karlsruhe Institute of Technology, Karlsruhe, Germany. (Dec. 2009, p. 1482)

* 20–24 **Machine Reasoning Workshops I & II: Mission-Focused Representation & Understanding of Complex Real-World Data**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California.
Description: These two workshops will address two topics important for efficiently obtaining and utilizing the information inherent in complex real-world data, namely Representation and Understanding. Each is described in detail on the web page. Workshop I on Data Representation will begin on Monday, September 20, in the morning and continue until lunch on Wednesday, September 22. Workshop II on Understanding of Data commences after lunch on Wednesday, September 22, and continues through Friday, September 24. Those wishing to participate in one or both workshops must apply and be accepted. There will be a combined reception on Tuesday evening. You must apply and be accepted in order to attend the workshop. We urge you to apply as early as possible. Applications received by July 26, 2010, will receive fullest consideration.
Information: `http://www.ipam.ucla.edu/programs/mrws1/`.

20–25 **DYSES2010 (V Meeting of Dynamics of Socio-economic Systems Society)**, University of Sannio, Faculty of Economic and business sciences, Benevento, Italy. (Apr. 2010, p. 550)

20–25 **XVI Geometrical Seminar**, Hotel Breza, Vrnjacka banja, Serbia. (Mar. 2010, p. 433)

20–October 1 **Berlin Mathematical School Summer School 2010 on Discretization in Geometry and Dynamics**, Technische Universität Berlin, Germany. (Oct. 2009, p. 1148)

21–24 **International Conference on Applications in Nonlinear Dynamics 2010**, The Fairmont Chateau, Lake Louise, Alberta, Canada. (Aug. 2010, p. 903)

21–24 **The 3rd International Conference on Nonlinear Dynamics**, National Technical University "Kharkov Polytechnical Institute", Kharkov, Ukraine. (Mar. 2010, p. 433)

21–25 **Geometry and Physics in Cracow**, Kraków, Poland. (Aug. 2010, p. 903)

22–25 **Seminal Interactions between Mathematics and Physics**, Accademia Nazionale dei Lincei, Roma, Italy. (Jun./Jul. 2010, p. 781)

23–26 **Second International Conference on Numerical Analysis and Approximation Theory: NAAT 2010**, Department of Applied Mathematics of the Faculty of Mathematics and Computer Science, Babes- Bolyai University, Cluj-Napoca, Romania. (Mar. 2010, p. 434)

24–26 **Info-Metrics: Theory and Applications**, American University, Washington, DC. (Jun./Jul. 2010, p. 781)

27–28 **Decision Analysis and Sustainable Development**, Centre de recherches mathématiques, Université de Montréal, Pavillon André-Aisenstadt, 2920, Chemin de la tour, 5th floor, Montréal (Québec), H3T 1J4 Canada. (Aug. 2010, p. 903)

27–30 **54th Annual Meeting of the Australian Mathematical Society**, The University of Queensland, Brisbane, Queensland, Australia. (Apr. 2010, p. 550)

28–October 1 **Convex Optimization and Algebraic Geometry**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Apr. 2010, p. 550)

October 2010

2–3 **AMS Eastern Section Meeting**, Syracuse University, Syracuse, New York. (Sept. 2009, p. 1032)

4–8 **AIM Workshop: Parameter identification in graphical models**, American Institute of Mathematics, Palo Alto, California. (Apr. 2010, p. 550)

4–9 **Group Actions and Dynamics**, Centre de recherches mathématiques, Université de Montréal, Pavillon André-Aisenstadt, 2920, Chemin de la tour, room 5357, Montréal (Québec) H3T 1J4 Canada. (Jan. 2010, p. 76)

7–10 **International Conference on Algebra in honor of the 70th Birthday of Professor Shum Kar-Ping**, Gajah-Mada University, Yogjakarta, Indonesia. (Apr. 2010, p. 550)

8–10 **Yamabe Symposium on "Geometry and Low-Dimensional Topology"**, University of Minnesota, Minneapolis, Minnesota. (May 2010, p. 675)

9–10 **AMS Western Section Meeting**, University of California, Los Angeles, California. (Sept. 2009, p. 1032)

10–15 **International Conference in Systems Biology (ICSB)**, Edinburgh International Conference Centre, The Exchange, Edinburgh, EH3 8EE, Scotland. (Jan. 2010, p. 76)

11–15 **Conference on Singularities, Geometry and Topology. In honour of the 60th Anniversary of Sabir Gusein-Zade**, Residencia San Jose, EL Escorial, Madrid, Spain. (Jun./Jul. 2010, p. 782)

11–15 **Equations and First-order Properties in Groups**, Centre de recherches mathématiques, Université de Montrèal, Pavillon André-Aisenstadt, 2920, Chemin de la tour, room 5357 Montréal (Québec) H3T 1J41 Canada. (Jan. 2010, p. 76)

11–15 **Numerical Methods for Continuous Optimization**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Apr. 2010, p. 550)

* 13–15 **Wolfram Technology Conference**, Hilton Garden Inn, Champaign, Illinois.
Description: This event brings together some of the leading minds in technical computing and education for presentations, seminars, and workshops. Whether you use Mathematica, Wolfram|Alpha, or other Wolfram products for computation, development, or deployment, you're sure to find informative and interesting sessions to attend. This year's conference will focus on Wolfram Research's latest tools and resources at your disposal—as well as forthcoming technologies—while still including all the training, discussion, and networking opportunities that people have come to expect from our conferences.
Information: `http://www.wolfram.com/events/techconf2010/`.

18–20 **2010 International Multiconference on Computer Science and Information Technology (IMCSIT)**, Hotel Golebiewski, Wisla, Poland. (Jun./Jul. 2010, p. 782)

18–22 **AIM Workshop: Algebraic systems with only real solutions**, American Institute of Mathematics, Palo Alto, California. (May 2010, p. 675)

18–22 **IMA Workshop: Computing with Uncertainty: Mathematical Modeling, Numerical Approximation and Large Scale Optimization of Complex Systems with Uncertainty**, Institute for Mathematics and its Applications (IMA), University of Minnesota, Minneapolis, Minnesota. (Apr. 2010, p. 550)

* 18–22 **Machine Reasoning Workshops III & IV: Mission-Focused Actions/Reactions Based on & System Integration of Information Derived from Complex Real-World Data**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California.
Description: These two workshops will address two topics important for efficiently obtaining and utilizing the information inherent in complex real-world data, namely Actions/Reactions and System Integration. Workshop III on Actions/Reactions will begin on Monday, October 18 in the morning and continue until lunch on Wednesday, October 20. Workshop IV on System Integration commences after lunch on Wednesday, October 20, and continues through Friday, October 22. Those wishing to participate in one or both workshops must apply and be accepted. There will be a combined reception on Tuesday evening. You must apply and be accepted in order to attend the workshop. We urge you to apply as early as possible. Applications received by August 23, 2010, will receive fullest consideration. The Office of Naval Research is supporting this workshop.
Information: `http://www.ipam.ucla.edu/programs/mrws2/`.

20–22 **International Conference in Modeling Health Advances 2010**, San Francisco, California. (May 2010, p. 434)

21–24 **Compact Moduli and Vector Bundles**, University of Georgia, Athens, Georgia. (Jun./Jul. 2010, p. 782)

23–24 **History and Pedagogy of Mathematics (HPM) Americas Section 2010 West Coast Meeting**, CalTech in Pasadena, California. (Aug. 2010, p. 903)

25–29 **AIM Workshop: The geometry of the outer automorphism group of a free group**, American Institute of Mathematics, Palo Alto, California. (May 2010, p. 675)

25–29 **Hot Topics: Kervaire invariant**, Mathematical Sciences Research Institute, Berkeley, California. (Jun./Jul. 2010, p. 782)

25–31 **Algebra, Geometry, Mathematical Physics**, The Sven Lovén Centre for Marine Sciences at the University of Gothenburg, Sweden. (Jun./Jul. 2010, p. 782)

26–29 **Discrete Optimization**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Apr. 2010, p. 551)

26–29 **SIAM Conference on Applied Linear Algebra (LA09)**, Embassy Suites Hotel, Monterey Bay-Seaside, California. (Sept. 2009, p. 1032)

27–30 **Fourth International Workshop on Differential Algebra and Related Topics (DART-IV)**, Key Laboratory of Mathematics Mechanization, Chinese Academy of Sciences, Beijing, China. (May 2010, p. 675)

29–30 **International Conference on Software Engineering, Management & Applications (ICSEMA'10)**, College of Open Learning, Kathmandu, Nepal. (Jun./Jul. 2010, p. 782)

29–31 **AMS Central Section Meeting**, Notre Dame University, Notre Dame, Indiana. (Sept. 2009, p. 1032)

November 2010

* 1–5 **3rd Odense Winter School on Geometry and Theoretical Physics**, University of Southern Denmark, Odense, Denmark.
Main speakers: Sergey Cherkis (Trinity College), Laura Covi (DESY), Gerard 't Hooft (Utrecht University), Claudio Pica (CP-Origins), Andrea Romanino (SISSA), Francesco Sannino (CP-Origins), Martin Speight (University of Leeds), Kimmo Tuominen (CP-Origins).
Information: `http://cp3-origins.dk/events/meetings/ws2010`.

1–5 **IMA Workshop: Numerical Solutions of Partial Differential Equations: Novel Discretization Techniques**, Institute for

Mathematics and its Applications (IMA), University of Minnesota, Minneapolis, Minnesota. (Apr. 2010, p. 551)

1–5 **K-theory, C^*-algebras and index theory**, Georg-August-Universität Göttingen, Goettingen, Germany. (Jun./Jul. 2010, p. 782)

1–December 19 **Hyperbolic Conservation Laws and Kinetic Equations: Theory, Computation, and Applications**, Institute for Mathematical Sciences, National University of Singapore, Singapore, Singapore. (Jun./Jul. 2010, p. 782)

* 2–4 **IPAM's 10th Anniversary Conference**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California.
Description: The role of mathematics in science has been transformed over the last few decades. Emerging applications in information science, nanosystems, multiscale and multiphysics problems, bioinformatics and other fields have required new kinds of math, both pure and applied. Since its inception in 2000, the Institute for Pure and Applied Mathematics (IPAM) has catalyzed the interaction of mathematics with science. IPAM's programs bring together researchers from both pure and applied mathematics and statistics, and from physical science, information and computer science, life science, engineering, social science, and humanities, to form new research communities. This workshop will assess the current state and the future of interdisciplinary mathematics and science and IPAM's role in this exciting endeavor. Speakers from academia, government and industry will present research results related to programs from IPAM's first ten years.
Information: `http://www.ipam.ucla.edu/programs/ann2010/`.

3–4 **The 6th IMT-GT International Conference on Mathematics, Statistics, and its Applications (ICMSA2010)**, Grand Seasons Hotel, Kuala Lumpur, Malaysia. (Aug. 2010, p. 903)

3–6 **3rd International Conference for Young Mathematicians on Differential Equations and Applications dedicated to Ya. Lopatynski**, The Ivan Franko National University of L'viv, L'viv, Ukraine. (Jun./Jul. 2010, p. 783)

4–6 **PDE and Applications**, Kairouan, Tunisia. (Aug. 2010, p. 903)

5–6 **IMA Special Event: Finite Element Circus Featuring a Scientific Celebration of Falk, Pasciak, and Wahlbin**, Institute for Mathematics and its Applications (IMA), University of Minnesota, Minneapolis, Minnesota (Apr. 2010, p. 551)

6–7 **AMS Southeastern Section Meeting**, University of Richmond, Richmond, Virginia. (Sept. 2009, p. 1032)

8–10 **2010 IEEE International Conference on Technologies for Homeland Security**, Westin Hotel, Waltham, Massachusetts. (Feb. 2010, p. 307)

8–12 **MSRI—Inverse Problems: Theory and Applications**, Mathematical Sciences Research Institute, Berkeley, California. (Dec. 2009, p. 1482)

8–12 **School of Applied Mathematics and Innovation 2010: Nonsmooth systems and applications**, Universidad Sergio Arboleda, Sede Rodrigo Noguera Laborde, Santa Marta, Colombia. (Jun./Jul. 2010, p. 783)

12–15 **Toric Geometry Seminar 2010 (Combinatorial Commutative Algebra, Optimization and Statistics)**, Residencia V Centenario. Universidad de Extremadura. Jarandilla de la Vera, Cáceres, Spain. (Aug. 2010, p. 904)

16–19 **Modern Trends in Optimization and Its Application**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Apr. 2010, p. 551)

17–19 **SIAM/MSRI Workshop on Hybrid Methodologies for Symbolic-Numeric Computation**, Mathematical Sciences Research Institute, Berkeley, California. (Jun./Jul. 2010, p. 783)

* 22–25 **Colloque d'Analyse et Géometrie Complexe**, Faculté des Sciences de Monastir, Monastir, Tunisie.
Invited Speakers: F. Berteloot (Institut de Mathématiques de Toulouse, France); J. P. Demailly (Institut Fourier Grenobele, France); H. El Mir (Faculté des Sciences Monastir, Tunisie); H. Gaussier (Institut Fourier Grenobele, France); A. Zeriahi (Institut de Mathématiques de Toulouse, France).
Information: You can find further information about the courses and the possibility to contribute with a talk at: `http://www.fsg.rnu.tn/colloque.htm`.

23–27 **International Conference on Mathematical Sciences, Turkey'10**, Abant Izzet Baysal University, Izzet Baysal Kampüsü, Bolu, Turkey. (Jun./Jul. 2010, p. 783)

28–December 3 **International Conference on Applied Mathematics and Informatics - ICAMI 2010**, San Andres Island, Colombia. (Aug. 2010, p. 904)

29–December 3 **IMA Workshop: Numerical Solutions of Partial Differential Equations: Fast Solution Techniques**, Institute for Mathematics and its Applications (IMA), University of Minnesota, Minneapolis, Minnesota. (Apr. 2010, p. 551)

30–December 3 **Applications of Optimization in Science and Engineering**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Jun./Jul. 2010, p. 783)

December 2010

2–4 **4th Global Conference on Power Control and Optimization (PCO'2010)**, Damai Puri Resort, Kucing, Sarawak, Malaysia. (May 2010, p. 675)

4–6 **2010 CMS Winter Meeting**, Coast Hotel and Suites, Vancouver (BC), Canada. (Jun./Jul. 2010, p. 784)

5–10 **66th Annual Deming Conference on Applied Statistics**, Atlantic City, New Jersey. (Jun./Jul. 2010, p. 784)

6–10 **AIM Workshop: Waves and multiscale processes in the tropics**, American Institute of Mathematics, Palo Alto, California. (May 2010, p. 675)

6–10 **MSRI—Random Matrix Theory and its Applications II**, Mathematical Sciences Research Institute, Berkeley, California. (Dec. 2009, p. 1482)

9–11 **International Conference on Recent Development in Mathematical Sciences and its Applications (ICRDMSA-2010)**, Calcutta Mathematical Society AE-374, Sector-I, Salt Lake Kolkata-700064, West-Bengal, India. (Aug. 2010, p. 904)

13–17 **AIM Workshop: Random matrices**, American Institute of Mathematics, Palo Alto, California. (May 2010, p. 676)

13–17 **Conference in Geometry and Global Analysis Celebrating P. Gilkey's 65th Birthday**, Universidade de Santiago de Compostela/ Universidade da Coruña Santiago de Compostela, A Coruña, Spain. (Jun./Jul. 2010, p. 784)

13–17 **Conference "Quantization of Singular Spaces"**, University of Aarhus, Denmark. (Jun./Jul. 2010, p. 784)

15–16 **The International Conference on Mathemtics Education Research**, Malacca, Malaysia. (May 2010, p. 676)

17–21 **The 15th Asian Technology Conference in Mathematics (ATCM 2010)**, University of Malaya, Kuala Lumpur, Malaysia. (Apr. 2010, p. 551)

19–21 **"Mathematical Sciences for Advancement of Science and Technology" (MSAST 2010)**, IMBIC Hall, Salt Lake, Kolkata (Calcutta), India. (Apr. 2010, p. 551)

25–27 **International Conference on Current trends in Mathematics**, Allahabad, Uttar Pradesh, India. (May 2009, p. 659)

27–30 **The 76th Annual Conference of the Indian Mathematical Society**, S. V. National Institute of Technology, SURAT -395007, Gujarat, India. (Jun./Jul. 2010, p. 784)

29–31 **ICCAM 2010: "International Conference on Computational and Applied Mathematics" Symposium Partial Differential Equations:Modeling, Analysis and Numerical Methods**, First Hotel Bangkong 2 Soi Somprasong 1, Petchaburi Road, Tanonphayathai, Rajthavee, Bangkok 10400 Thailand. (Nov. 2009, p. 1361)

January 2011

3–5 **ICMS 2011: International Conference on Mathematical Sciences in Honour of Professor A. M. Mathai**, St. Thomas College Pala, Kottayam 686574, Kerala, India. (May 2010, p. 676)

* 6–9 **Joint Mathematics Meetings**, New Orleans, Louisiana.
Information: `http://www.ams.org/meetings/national/jmm/2125_intro.html`.

10–14 **Algorithmic Game Theory**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Jun./Jul. 2010, p. 784)

10–14 **IMA Workshop: High Performance Computing and Emerging Architectures**, Institute for Mathematics and its Applications (IMA), University of Minnesota, Minneapolis, Minnesota. (Apr. 2010, p. 552)

10–May 20 **MSRI Future Scientific Programs: Arithmetic Statistics**, Mathematical Sciences Research Institute, Berkeley, California. (Aug. 2009, p. 864)

10–May 20 **MSRI Future Scientific Programs: Free Boundary Problems, Theory and Applications**, Mathematical Sciences Research Institute, Berkeley, California. (Aug. 2009, p. 864)

12–14 **Statistical Methods for Meteorology and Climate Change**, Centre de recherches mathématiques, Université de Montréal, Pavillon André-Aisenstadt, Montréal, (Québec) H3T 1J4 Canada. (Aug. 2010, p. 904)

13–14 **Connections for Women: Free Boundary Problems, Theory and Applications**, Mathematical Sciences Research Institute, Berkeley, California. (Jun./Jul. 2010, p. 784)

17–21 **AIM Workshop: Deformation theory, patching, quadratic forms, and the Brauer group**, American Institute of Mathematics, Palo Alto, California. (May 2010, p. 676)

18–21 **Efficiency of the Simplex Method; Quo Vadis Hirsch Conjecture?**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Jun./Jul. 2010, p. 785)

18–21 **Introductory Workshop: Free Boundary Problems, Theory and Applications**, Mathematical Sciences Research Institute, Berkeley, California. (Jun./Jul. 2010, p. 785)

23–25 **ACM-SIAM Symposium on Discrete Algorithms (SODA11)**, Holiday Inn, San Francisco Golden Gateway, San Francisco, California. (Mar. 2010, p. 434)

* 26–28 **International Conference on Operations Research and Optimization 2011 (ORO2011)**, School of Mathematics, Institute for Research in Fundamental Sciences (IPM), Tehran, Iran.
Description: The aim of the conference is to bring together researchers and scientists from all over the world to discuss theoretical and applied aspects of Operations Research and Optimization. There will be rigorous plenary talks by invited speakers as well as contributed talks.
Language: English.
Subjects: Discrete/Continuous Optimization; Linear/Nonlinear Programming; Multiple-Objective Programming; Multi-Criteria Decision Making and Performance Analysis; Network Flows; Nonlinear Analysis and Convex Analysis with Applications in OR and Optimization; Nonsmooth Optimization and Variational Analysis; Optimal Control, OR in Biology, Industry, Management, and Economics; Stochastic Programming.
Information: `http://math.ipm.ac.ir/conferences/2011/ORO2011`.

27–28 **Connections for Women: Arithmetic Statistics**, Mathematical Sciences Research Institute, Berkeley, California. (Jun./Jul. 2010, p. 785)

31–February 4 **Introductory Workshop: Arithmetic Statistics**, Mathematical Sciences Research Institute, Berkeley, California. (Jun./Jul. 2010, p. 785)

February 2011

6–8 **3rd International Conference on Wireless Information Networks & Business Information System (WINBIS'11)**, Open Learning Society, Kathmandu, Nepal. (Jun./Jul. 2010, p. 785)

7–12 **Complex Geometry—Extremal metrics: Evolution equations and stability**, CIRM, Marseille, France. (Aug. 2010, p. 904)

14–19 **Fourth School and Workshop on Mathematical Methods in Quantum Mechanics**, Casa della Gioventù, University of Padova, Bressanone, Italy. (Aug. 2010, p. 904)

16–19 **International Conference on Operator Theory**, Monastir, Tunisia. (Jun./Jul. 2010, p. 785)

28–March 4 **SIAM Conference on Computational Science and Engineering (CSE11)**, Grand Sierra Resort and Casino, Reno, Nevada. (Jun./Jul. 2010, p. 785)

March 2011

7–11 **Free Boundary Problems, Theory and Applications Workshop**, Mathematical Sciences Research Institute, Berkeley, California. (Jun./Jul. 2010, p. 785)

7–11 (NEW DATE) **IMA Workshop: Computing in Image Processing, Computer Graphics, Virtual Surgery, and Sports**, Institute for Mathematics and its Applications (IMA), University of Minnesota, Minneapolis, Minnesota. (Apr. 2010, p. 552)

* 12–13 **AMS Southeastern Section Meeting**, Georgia Southern University, Statesboro, Georgia.
Information: `http://www.ams.org/meetings/sectional/sectional.html`.

14–June 17 **Navigating Chemical Compound Space for Materials and BioDesign**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Jan. 2010, p. 76)

16–18 **IAENG International Conference on Operations Research 2011**, Royal Garden Hotel, Kowloon, Hong Kong. (Aug. 2010, p. 904)

* 18–20 **AMS Central Section Meeting**, University of Iowa, Iowa City, Iowa.
Information: `http://www.ams.org/meetings/sectional/sectional.html`.

21–25 **AIM Workshop: Hypergraph Turán Problem**, American Institute of Mathematics, Palo Alto, California. (Aug. 2010, p. 905)

28–April 1 **International Conference on Homotopy and Non-Commutative Geometry**, Batumi State University, Batumi, Republic of Georgia. (Jun./Jul. 2010, p. 785)

April 2011

7–9 **ICMCS'11 - IEEE co-sponsored Conference 2nd International Conference on Multimedia Computing and Systems**, Ouarzazate, Morocco. (Aug. 2010, p. 905)

* 9–10 **AMS Eastern Section Meeting**, College of the Holy Cross, Worcester, Massachusetts.
Information: `http://www.ams.org/meetings/sectional/sectional.html`.

11–15 **Arithmetic Statistics**, Mathematical Sciences Research Institute, Berkeley, California. (Jun./Jul. 2010, p. 785)

11–15 **IMA Workshop: Societally Relevant Computing**, Institute for Mathematics and its Applications (IMA), University of Minnesota, Minneapolis, Minnesota. (Apr. 2010, p. 552)

* 17–19 **7th IMA Modelling in Industrial Maintenance and Reliability**, Sidney Sussex College, University of Cambridge, United Kingdom.
Topics: Asset Life Cycle Costing; Condition Monitoring, Prognostics, and Health Management; Expert Elicitation in Reliability Modelling; Human Factors in Maintenance; Information, Communication, and Al in Maintenance; Integrated Maintenance and Supply Chain Management; Modelling of Inspection, Overhaul and Replacement; Reliability Modelling of Maintained Systems; Warranty and Maintenance Contract Analysis; TPM, RCM, and TQM.
Information: http://www.ima.org.uk/Conferences/7th_mimar/index.html.

18–22 **Computational Statistical Methods for Genomics and Systems Biology**, Centre de recherches mathématiques, Université de Montréal, Pavillon André-Aisenstadt, Montréal, (Québec) H3T 1J4 Canada. (Aug. 2010, p. 905)

27–28 **Third Conference on Mathematical Sciences (CMS'2011)**, Department of Mathematics, Faculty of Science and Information Technology, Zarqa Private University, Zarqa, Jordan. (Aug. 2010, p. 905)

* 30–May 1 **AMS Western Section Meeting**, University of Nevada, Las Vegas, Nevada.
Information: http://www.ams.org/meetings/sectional/sectional.html.

May 2011

1–August 31 **MITACS International Focus Period on Advances in Network Analysis and its Applications**, Locations throughout Canada. (Apr. 2010, p. 552)

2–4 **Statistical Issues in Forest Management**, Université Laval, Québec City, Canada. (Aug. 2010, p. 905)

9–13 **Causal Inference in Health Research**, Centre de recherches mathématiques, Université de Montréal, Pavillon André-Aisenstadt, Montréal, (Québec) H3T 1J4 Canada. (Aug. 2010, p. 905)

16–19 **Analysis of Survival and Event History Data**, Centre de recherches mathématiques, Université de Montréal, Pavillon André-Aisenstadt, Montréal, (Québec) H3T 1J4 Canada. (Aug. 2010, p. 905)

22–26 **SIAM Conference on Applications of Dynamical Systems (DS11)**, Snowbird Ski and Summer Resort, Snowbird, Utah. (Mar. 2010, p. 434)

June 2011

5–7 **National Conference On Nonlinear Analysis and Applications**, Department of Mathematics, H.N.B. Garhwal University, Campus Pauri, Pauri Garhwal, Uttarakhand. (Jun./Jul. 2010, p. 786)

6–9 **Copula Models and Dependence**, Centre de recherches mathématiques, Université de Montréal, Pavillon André-Aisenstadt, Montréal, (Québec) H3T 1J4 Canada. (Aug. 2010, p. 905)

6–10 **IMA Workshop: Large-scale Inverse Problems and Quantification of Uncertainty**, Institute for Mathematics and its Applications (IMA), University of Minnesota, Minneapolis, Minnesota. (Apr. 2010, p. 552)

* 14–17 **2011 World Conference on Natural Resource Modeling**, Ottowa, Canada.
Theme: Modeling for a Sustainable Environment. This multidisciplinary conference provides a forum for new developments in modeling and analysis of natural resource systems, particularly involving the conference theme of modeling for a sustainable environment. Student prizes for posters and presentations given by the journal *Natural Resource Modeling*.
Information: Visit the website for updated information on keynote speakers, the scientific program, conference registration, and accommodation. Questions can be directed to Catherine A. Roberts, email: editor@resourcemodeling.org; http://resourcemodeling.org/conferences/2011.

* 22–24 **3rd IMA International Conference Mathematics in Sport**, The Lowry, Salford Quays, United Kingdom.
Topics: Econometrics in sport; competitive strategy; match outcome models; decision support systems; analysis of sporting technologies; analysis of rules and adjudication; performance measures and models; optimisation of sports performance; mathematics education and sport, optimal tournament design and scheduling; computationally intensive methods; financial valuation in sport. The term sport is interpreted liberally here and includes: games and pastimes; gambling and on-line gaming; lotteries; and general fitness and health-related activities.
Information: http://www.ima.org.uk/Conferences/3rd_maths_sport/.

July 2011

* 6–8 **IMA Conference on Nonlinearity and Coherent Structures**, University of Reading, United Kingdom.
Description: Nonlinear phenomena are ubiquitous in the natural world. Very often the nonlinearity coexists with a degree of order, and the associated coherent structures offer a solid reference point for theory and experiments. A noteworthy example are the so-called solitons, localised waves propagating nonlinearly and yet displaying many features of linearity. The theoretical developments in the field of nonlinear evolution phenomena and the mathematical study of coherent structures are relevant to many disparate fields, including nonlinear optics, random media, atmosphere and ocean dynamics, general relativity, high-energy particle physics, plasma physics, fluid and solid mechanics, Bose-Einstein condensation, nonlinear electrical circuits, and reaction-diffusion processes.
Information: http://www.ima.org.uk/Conferences/ncs/index.html

* 10–16 **International Conference on Rings and Algebras in Honor of Professor Pjek-Hwee Lee**, National Taiwan University, Taipei, Taiwan.
Description: This conference honors Professor Pjek-Hwee Lee, a mathematician who devoted his life to research in ring and algebra theory and to promoting mathematics in Taiwan.
Invited Speakers: Matej Bresar (Slovenia), Surender Jain (USA), Chi-Kwong Li (USA), Cheng-Kai Liu (Taiwan), Leonid Makar-Limanov (USA), Hidetoshi Marubayashi (Japan), Jae Keol Park (Korea), Edmund Puczylowski (Poland), Louis Rowen (Israel), Peter Semrl (Slovenia), Lance Small (USA), Agata Smoktunowicz (UK), Robert Wisbauer (Germany), Efim Zelmanov (USA), Yiqiang Zhou (Canada).
Information: http://moonstone.math.ncku.edu.tw/2011AlgConference/index.html.

11–15 **The 10th International Conference on Finite Fields and their Applications**, Ghent, Belgium. (Jun./Jul. 2010, p. 786)

18–22 **7th International Congress on Industrial and Applied Mathematics - ICIAM 2011**, Vancouver, BC, Canada. (Jun./Jul. 2010, p. 786)

* 18–22 **Geometry & Topology Down Under – A Conference in Honour of Hyam Rubinstein**, The University of Melbourne, Australia.
Description: Lecture series aimed at students and early career researchers will be given in the week prior to the conference, July 11–15, 2011.

* 25–27 **SIAM Conference on Control and Its Applications (CT11)**, Hyatt Regency Baltimore, Baltimore, Maryland.
Description: This conference is sponsored by the SIAM Activity Group on Control and Systems Theory.
Information: http://www.siam.org/meetings/ct11/.

26–29 **Conference in Harmonic Analysis and Partial Differential Equations in honour of Eric Sawyer**, Fields Institute, Toronto, Canada. (Jun./Jul. 2010, p. 786)

August 2011

1–5 **Categories, Geometry and Physics**, Santa Marta, Colombia. (Jun./Jul. 2010, p. 786)

1–5 **Conference in Honour of Søren Asmussen—New Frontiers in Applied Probability**, Sandbjerg Estate, Sønderborg, Denmark. (Jun./Jul. 2010, p. 786)

* 8–13 **Formal and analytic solutions of differential and difference equations**, Mathematical Research and Conference Center in Bedlewo, Poland.
Scientific topics: Ordinary differential equations in the complex domain; Holomorphic vector fields, normal forms; Summability of WKB solutions; Gevrey solutions, summability of divergent series, Stokes phenomena; Formal solutions of PDEs; Small divisors phenomena; Nonlinear PDEs: semilinear heat, Burgers, KdV, Schrˆdinger, Navier-Stokes; Summability of formal solutions of difference equations; Analytic and Gevrey hypoellipticity and solvability; Applications to integrable systems and mathematical physics.
Information: `http://www.impan.pl/~fasde/index.php`.

* 15-19 **AIM Workshop: Graph and Hypergraph Limits**, American Institute of Mathematics, Palo Alto, California.
Description: This workshop, sponsored by AIM and the NSF, will be devoted to the emerging theory of graph and hypergraph limits.
Information: `http://aimath.org/ARCC/workshops/graphlimits.html`.

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.

September 2011

* 10–11 **AMS Eastern Section Meeting**, Cornell University, Ithaca, New York.
Information: `http://www.ams.org/meetings/sectional/sectional.html`.

10–16 **Turning Dreams into Reality: Transformations and Paradigm Shifts in Mathematics Education**, Rhodes University, Grahamstown, South Africa. (Feb. 2010, p. 307)

12–16 **AIM Workshop: L^2 invariants and their relatives for finitely generated groups**, American Institute of Mathematics, Palo Alto, California. (Aug. 2010, p. 905)

* 12–16 **Mathematical and Computational Approaches in High-Throughput Genomics**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California.
Description: The goal of this long program is to bring together mathematical and computational scientists, sequencing technology developers in both industry and academia, and the biologists who use the instruments for particular research applications. This presents a unique opportunity to foster interactions between these three communities over an extended period of time and advance the mathematical foundations of this exciting field. We urge you to apply as early as possible. Applications will be accepted through May 12, 2011, but decisions will be made starting in December.
Information: `http://www.ipam.ucla.edu/programs/gen2011/`.

* 24–25 **AMS Western Section Meeting**, Wake Forest University, Winston Salem, North Carolina.
Information: `http://www.ams.org/meetings/sectional/sectional.html`.

October 2011

* 14–16 **AMS Central Section Meeting**, University of Nebraska-Lincoln, Lincoln, Nebraska.
Information: `http://www.ams.org/meetings/sectional/sectional.html`.

* 22–23 **AMS Western Section Meeting**, University of Utah, Salt Lake City, Utah.
Information: `http://www.ams.org/meetings/sectional/sectional.html`.

December 2011

16–18 **The International Congress on Science and Technology**, Allahabad, U.P., INDIA (Oct. 2009, p. 1148)

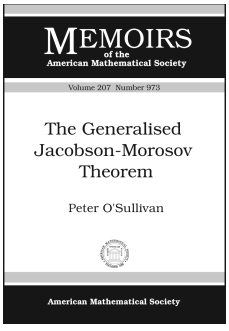
April 2013

4–6 **38th Arkansas Spring Lecture Series in the Mathematical Sciences: "Extension and Interpolation of Functions"**, University of Arkansas, Fayetteville, Arkansas. (Jun./Jul. 2010, p. 786)

New Publications Offered by the AMS

To subscribe to email notification of new AMS publications, please go to http://www.ams.org/bookstore-email.

Algebra and Algebraic Geometry



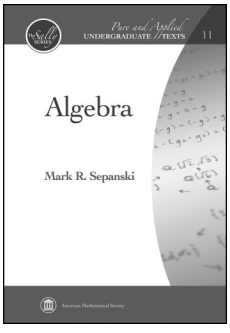
The Generalised Jacobson-Morosov Theorem

Peter O'Sullivan, *University of Sydney, NSW, Australia*

Contents: Introduction; Notation and terminology; Affine group schemes over a field of characteristic zero; Universal and minimal reductive homomorphisms; groups with action of a proreductive group; Families of minimal reductive homomorphisms; Bibliography; Index.

Memoirs of the American Mathematical Society, Volume 207, Number 973

September 2010, 120 pages, Softcover, ISBN: 978-0-8218-4895-1, LC 2010022758, 2000 *Mathematics Subject Classification:* 20G15; 13A50, 14L30, **Individual member US$41.40**, List US$69, Institutional member US$55.20, Order code MEMO/207/973



Algebra

Mark R. Sepanski, *Baylor University, Waco, TX*

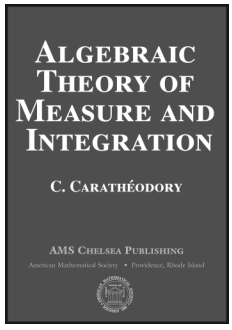
Mark Sepanski's *Algebra* is a readable introduction to the delightful world of modern algebra. Beginning with concrete examples from the study of integers and modular arithmetic, the text steadily familiarizes the reader with greater levels of abstraction as it moves through the study of groups, rings, and fields. The book is equipped with over 750 exercises suitable for many levels of student ability. There are standard problems, as well as challenging exercises, that introduce students to topics not normally covered in a first course. Difficult problems are broken into manageable subproblems and come equipped with hints when needed. Appropriate for both self-study and the classroom, the material is efficiently arranged so that milestones such as the Sylow theorems and Galois theory can be reached in one semester.

Contents: Arithmetic; Groups; Rings; Field theory; Index.

Pure and Applied Undergraduate Texts, Volume 11

November 2010, approximately 264 pages, Hardcover, ISBN: 978-0-8218-5294-1, LC 2010022789, 2000 *Mathematics Subject Classification:* 00-01; 20-01, 12-01, 13-01, 16-01, **AMS members US$49.60**, List US$62, Order code AMSTEXT/11

Analysis



Algebraic Theory of Measure and Integration

Second English Edition

C. Carathéodory

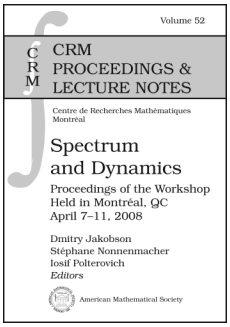
By generalizing the concept of point function to that of a function ("soma" function) over a Boolean ring, Carathéodory gives in this book an elegant algebraic treatment of measure and integration.

Contents: Somas: 1.1-2 The axiomatic method; 1.3-7 Elementary theory of somas; 1.8-13 Somas as elements of a Boolean algebra; 1.14-16 The main properties of the union; 1.17-22 The decomposability of somas; 1.23-24 The intersection of an infinite number of somas; 1.25-32 Limits and bounds; Sets of Somas: 2.33-40 Sets of somas closed under a binary operation; 2.41-46 Complete rings; 2.47-53 Ordinal numbers of the second class; 2.54-55 Hereditary sets of somas; 2.56-64 Homomorphisms of rings of somas; Place Functions: 3.65-68 Finitely-valued place functions; 3.69-75 Nests of somas; 3.76-79 Altering the domain of definition; 3.80-88 Principal properties of the soma functions $\alpha(X)$ and $\beta(X)$; Calculation with Place Functions: 4.89-94 Limit processes; 4.95-106 Elementary operations on place functions; 4.107-110 Uniform and absolute convergence; 4.111-117 Composition of place functions; 4.118-125 Homomorphisms of place functions; Measure Functions: 5.126-128 Additive and union-bounded soma functions; 5.129-130 Measurability; 5.131-135 Measure functions; 5.136-140

The measure function on its ring of measurability; 5.141-143 Sequences of measure functions and their limits; 5.144-147 Transformation of measure functions by homomorphisms; 5.148-153 The Borel-Lebesgue content; The Integral: 6.154 Fields of place functions; Measurable place functions; 6.155-162 The notion of the integral; 6.163-166 Linearity of the integral and the integration of place functions of arbitrary sign; 6.167-172 Comparable measure functions and the Lebesgue decomposition; 6.173-175 Abstract differentials; 6.176-177 The absolute continuity of two comparable measure functions; 6.178-180 Transformation of the integral by means of homomorphisms; Application of the Theory of Integration to Limit Processes: 7.181-183 The theorem of Egoroff; 7.184-189 Continuity of the integral as a functional; 7.190-197 Convergence in the mean; 7.198-205 Ergodic theory; The Computation of Measure Functions: 8.206-210 Maximal measure functions; 8.211-215 The bases of an arbitrary measure function; 8.216-221 Relative measurability; Regular Measure Functions: 9.222-224 The definition and principal properties of regular measure functions; 9.225-229 Inner measure; 9.230-235 Comparison of inner and outer measures; 9.236-240 The arithmetic mean of the inner and outer measures; Isotypic Regular Measure Functions: 10.241-244 The principal properties of isotypic measure functions; 10.245-248 The Jordan decomposition of completely additive soma functions; 10.249-255 The difference of two isotypic regular measure functions; 10.256-257 Comparable outer measures; Content Functions: 11.258-259 The definition of content functions; 11.260-267 Reduced content functions and their homomorphisms; 11.268-271 The Jessen infinite-dimensional torus; 11.272-278 The Vitali covering theorem; 11.279-282 The Lebesgue integral; 11.283-284 Comparable content functions; 11.285-289 Linear measure; Appendix: Somas as elements of partially ordered sets: 12.290-297 A new axiom system for somas; 12.298-302 The partitioning of a set into classes; 12.303-304 Partially ordered sets; 12.305-308 Applications to the theory of somas; 12.309-312 Systems of somas that are not isomorphic to systems of subsets of a set; Bibliography: Earlier publications by Constantin Carathéodory on the algebraization of measure and integral; List of symbols; Index.

AMS Chelsea Publishing, Volume 161

November 2010, 378 pages, Hardcover, ISBN: 978-0-8218-5273-6, LC 63-13094, 2000 *Mathematics Subject Classification:* 28-01, **AMS members US$45**, List US$50, Order code CHEL/161.H



Spectrum and Dynamics

Proceedings of the Workshop Held in Montréal, QC, April 7–11, 2008

Dmitry Jakobson, *McGill University, Montréal, QC, Canada*, **Stéphane Nonnenmacher**, *CEA-Saclay, Gif-sur-Yvette, France*, and **Iosif Polterovich**, *Université de Montréal, QC, Canada*, Editors

This volume contains a collection of papers presented at the workshop on Spectrum and Dynamics held at the CRM in April 2008. In recent years, many new exciting connections have been established between the spectral theory of elliptic operators and the theory of dynamical systems. A number of articles in the proceedings highlight these discoveries. The volume features a diversity of topics, such as quantum chaos, spectral geometry, semiclassical analysis, number theory and ergodic theory. Apart from the research papers aimed at the experts, this book includes several survey articles accessible to a broad mathematical audience.

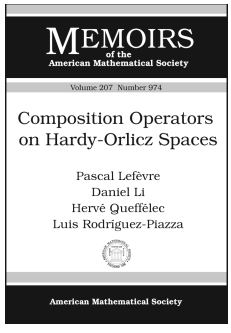
This item will also be of interest to those working in differential equations.

Titles in this series are co-published with the Centre de Recherches Mathématiques.

Contents: S. Nonnenmacher, Notes on the minicourse "Entropy of chaotic eigenstates"; **A. Strohmaier**, Geometry of the high energy limit on differential operators on vector bundles; **Y. A. Kordyukov**, Classical and quantum dynamics in transverse geometry of Riemannian foliations; **L. Hillairet**, Eigenvalue variations and semiclassical concentration; **H. Lapointe**, A remainder estimate for Weyl's law on Liouville tori; **H. Donnelly**, Embedding eigenvalues for Cartan-Hadamard manifolds; **B. Helffer** and **T. Hoffmann-Ostenhof**, On minimal partitions: New properties and applications to the disk; **M. Pollicott**, Asymptotic vertex growth for graphs; **D. Mayer** and **T. Mühlenbruch**, Nearest λ_q-multiple fractions; **R. Sharp**, Comparing length functions on free groups.

CRM Proceedings & Lecture Notes, Volume 52

August 2010, 207 pages, Softcover, ISBN: 978-0-8218-4778-7, LC 2010020469, 2000 *Mathematics Subject Classification:* 58Jxx, 37Dxx; 35Pxx, **AMS members US$79.20**, List US$99, Order code CRMP/52



Composition Operators on Hardy-Orlicz Spaces

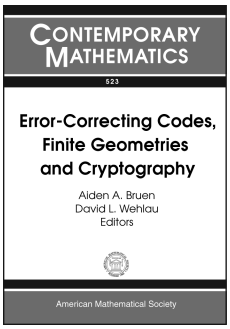
Pascal Lefèvre and **Daniel Li**, *Université d'Artois, Lens, France*, **Hervé Queffélec**, *Université des Sciences et Technologies de Lille, Villeneuve d'Ascq, France*, and **Luis Rodríguez-Piazza**, *Universidad de Sevilla, Spain*

Contents: Introduction; Notation; Composition operators on Hardy-Orlicz spaces; Carleson measures; Bergman spaces; References.

Memoirs of the American Mathematical Society, Volume 207, Number 974

September 2010, 74 pages, Softcover, ISBN: 978-0-8218-4637-7, LC 2010022778, 2000 *Mathematics Subject Classification:* 47B33, 46E30, **Individual member US$38.40**, List US$64, Institutional member US$51.20, Order code MEMO/207/974

Applications



Error-Correcting Codes, Finite Geometries and Cryptography

Aiden A. Bruen, *University of Calgary, AB, Canada*, and **David L. Wehlau**, *Royal Military College of Canada, Kingston, ON, Canada*, Editors

This interdisciplinary volume contains papers from both a conference and special session on Error-Control Codes, Information Theory and Applied Cryptography. The conference was held at the Fields Institute in Toronto, ON, Canada from December 5–6, 2007, and the special session was held at the Canadian Mathematical Society's winter meeting in London, ON, Canada from December 8–10, 2007.

The volume features cutting-edge theoretical results on the Reed–Muller and Reed–Solomon codes, classical linear codes, codes from nets and block designs, LDPC codes, perfect quantum and orthogonal codes, iterative decoding, magnetic storage and digital memory devices, and MIMO channels. There are new contributions on privacy reconciliation, resilient functions, cryptographic hash functions, and new work on quantum coins. Related original work in finite geometries concerns two-weight codes coming from partial spreads, (0,1) matrices with forbidden configurations, André embeddings, and representations of projective spaces in affine planes.

Great care has been taken to ensure that high expository standards are met by the papers in this volume. Accordingly, the papers are written in a user-friendly format. The hope is that this volume will be of interest and of benefit both to the experienced and to newcomers alike.

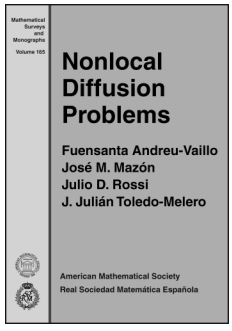
This item will also be of interest to those working in discrete mathematics and combinatorics.

Contents: *Cryptography:* **C. J. Colbourn** and **J. Torres-Jimenez**, Heterogeneous hash families and covering arrays; **W. J. Martin** and **B. Sunar**, Resilient functions: Just how resilient are they?; **M. Mosca** and **D. Stebila**, Quantum coins; **J. R. Oldford** and **D. L. Wehlau**, Optimal block lengths for secret key distillation; *Finite geometries:* **T. L. Alderson**, Hyperconics and multiple weight codes for OCDMA; **A. A. Bruen**, Blocking sets and large transversal-free systems of mutually orthogonal Latin squares; **A. A. Bruen**, **T. C. Bruen**, and **R. Silverman**, Incidence matrices with forbidden configurations; **M. Iurlo** and **S. Rajola**, A new method to construct maximal partial spreads of smallest size in PG(3,q); **M. S. Tallini**, A representation of the projective space $P(r,k)$ on the affine plane $A(2,k)$ and the geometric equivalence between the Veblen configuration in $P(3,k)$ and the Desargues configuration in $A(2,k)$; **J. A. Thas** and **H. Van Maldeghem**, André embeddings of affine planes; *Codes:* **A. Barg** and **P. Purkayastha**, Near MDS poset codes and distributions; **J. Bierbrauer**, **D. Bartoli**, **S. Marcugini**, and **F. Pambianco**, Geometric constructions of quantum codes; **A. Bogatyrev**, **M. Hassner**, and **D. Yarmolich**, An exact analytical-expression for the read sensor signal in magnetic data storage channels; **A. A. Bruen**, Blocking sets and low-weight codewords in the generalized Reed-Muller codes; **V. C. Gaudet**, Low-power LDPC decoding by exploiting the fault-tolerance of the sum-product algorithm; **O. Heden**, On perfect codes over non prime power alphabets; **M. Lavrauw**, **L. Storme**, and **G. Van de Voorde**, Linear codes from projective spaces; **T. P. McDonough** and **V. C. Mavron**, The dimension of the code of a strongly resolvable design; **G. E. Moorhouse**, Codes of nets and projective planes; **C. Schlegel**, Minimum output symbol error variance of forward error control codes; **D. Truhachev** and **M. Rahbari**, Multi-stream information transmission in random power attenuation environments.

Contemporary Mathematics, Volume 523

October 2010, 244 pages, Softcover, ISBN: 978-0-8218-4956-9, LC 2010013261, 2000 *Mathematics Subject Classification:* 05B25, 94B05, 94A60, 94B25, 05B15, 51E14, 81P94, 68W35, 94B35, 94A05, **AMS members US$63.20**, List US$79, Order code CONM/523

Differential Equations



Nonlocal Diffusion Problems

Fuensanta Andreu-Vaillo, **José M. Mazón**, *Universitat de València, Spain*, **Julio D. Rossi**, *Universidad de Alicante, Spain*, and **J. Julián Toledo-Melero**, *Universitat de València, Spain*

Nonlocal diffusion problems arise in a wide variety of applications, including biology, image processing, particle systems, coagulation models, and mathematical finance. These types of problems are also of great interest for their purely mathematical content.

This book presents recent results on nonlocal evolution equations with different boundary conditions, starting with the linear theory and moving to nonlinear cases, including two nonlocal models for the evolution of sandpiles. Both existence and uniqueness of solutions are considered, as well as their asymptotic behaviour. Moreover, the authors present results concerning limits of solutions of the nonlocal equations as a rescaling parameter tends to zero. With these limit procedures the most frequently used diffusion models are recovered: the heat equation, the p-Laplacian evolution equation, the porous media equation, the total variation flow, a convection-diffusion equation and the local models for the evolution of sandpiles due to Aronsson-Evans-Wu and Prigozhin.

Readers are assumed to be familiar with the basic concepts and techniques of functional analysis and partial differential equations. The text is otherwise self-contained, with the exposition emphasizing an intuitive understanding and results given with full proofs. It is suitable for graduate students or researchers.

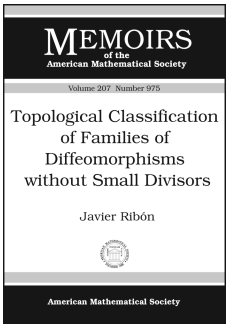
The authors cover a subject that has received a great deal of attention in recent years. The book is intended as a reference tool for a general audience in analysis and PDEs, including mathematicians, engineers, physicists, biologists, and others interested in nonlocal diffusion problems.

Contents: The Cauchy problem for linear nonlocal diffusion; The Dirichlet problem for linear nonlocal diffusion; The Neumann problem for linear nonlocal diffusion; A nonlocal convection

diffusion problem; The Neumann problem for a nonlocal nonlinear diffusion equation; Nonlocal p-Laplacian evolution problems; The nonlocal total variation flow; Nonlocal models for sandpiles; Nonlinear semigroups; Bibliography; Index.

Mathematical Surveys and Monographs, Volume 165

October 2010, approximately 264 pages, Hardcover, ISBN: 978-0-8218-5230-9, LC 2010020473, 2000 *Mathematics Subject Classification:* 45E10, 45A05, 45G10, 47H20, 45M05, 35K05, 35K55, 35K57, 35K92, **AMS members US$65.60**, List US$82, Order code SURV/165



Topological Classification of Families of Diffeomorphisms without Small Divisors

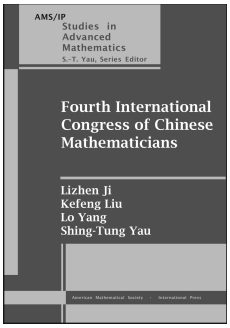
Javier Ribón, *University Federal Fluminense, Centro, Niterói, Brazil*

Contents: Outline of the monograph; Flower type vector fields; A clockwork orange; The T-sets; The long limits; Topological conjugation of (NSD) vector fields; Families of diffeomorphisms without small divisors; Topological invariants of (NSD) diffeomorphisms; Tangential conjugations; List of notations; Bibliography; Index.

Memoirs of the American Mathematical Society, Volume 207, Number 975

September 2010, 166 pages, Softcover, ISBN: 978-0-8218-4748-0, LC 2010022791, 2000 *Mathematics Subject Classification:* 37C15, 37F45, 37G10; 37F75, 37G05, **Individual member US$46.20**, List US$77, Institutional member US$61.60, Order code MEMO/207/975

General Interest



Fourth International Congress of Chinese Mathematicians

Lizhen Ji, *University of Michigan, Ann Arbor, MI*, **Kefeng Liu**, *University of California, Los Angeles, CA*, **Lo Yang**, *Chinese Academy of Sciences, Beijing, China*, and **Shing-Tung Yau**, *Harvard University, Cambridge, MA*, Editors

This volume represents selected proceedings of the Fourth International Congress of Chinese Mathematicians, held in Hangzhou, China. The Congress brought together eminent Chinese and overseas mathematicians to discuss the latest developments in pure and applied mathematics. Approximately fifteen hundred mathematicians participated in the Congress.

Included in this volume are the complete Morningside Lectures, the complete plenary lectures, and selected invited lectures.

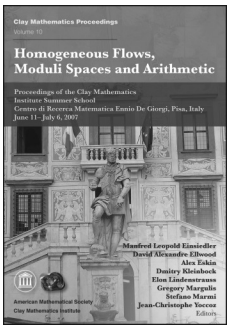
Titles in this series are co-published with International Press, Cambridge, MA.

Contents: *Morningside lectures:* **J. Coates**, Number theory, ancient and modern; **C. Procesi**, Partition functions and box–spline; **C. Voisin**, Cohomology algebras in symplectic, Kähler and algebraic geometry; *Plenary lectures:* **R. Bhatia**, Calculus of operator functions; **I. Biswas**, Torelli for some moduli spaces; **Z. Chen** and **X. Wu**, The adaptive PML method for acoustic wave scattering problems; **A. Futaki**, Toric Sasaki-Einstein geometry; **L. Ji**, Arithmetic groups, mapping class groups, related groups, and their associated spaces; **D. Jiang**, On some topics in automorphic representations; **F. Luo**, Rigidity of polyhedral surfaces; **T. Mabuchi**, An affine sphere equation associated to Einstein toric surfaces; **G. Prasad** and **A.S. Rapinchuk**, Number-theoretic techniques in the theory of Lie groups and differential geometry; **R. Sujatha**, Local-global principles; **R. G. Swan**, The flabby class group of a finite cyclic group; **J. Xiao** and **F. Xu**, Green's formula in Hall algebras and cluster algebras; **X.-P. Zhu**, The Ricci flow and geometrization of three-manifolds; *Three lectures by Chinese women mathematicians:* **F. Chung**, Four proofs for the Cheeger inequality and graph partition algorithms; **W.-C. W. Li**, Zeta functions in combinatorics and number theory; **C.-L. Terng**, Soliton hierarchies constructed from involutions.

AMS/IP Studies in Advanced Mathematics, Volume 48

September 2010, 381 pages, Softcover, ISBN: 978-0-8218-5021-3, LC 2010019768, 2000 *Mathematics Subject Classification:* 00Bxx, 05-XX, 08-XX, 11-XX, 14-XX, 22-XX, 35-XX, 37-XX, 80-XX, **AMS members US$88**, List US$110, Order code AMSIP/48

Geometry and Topology



Homogeneous Flows, Moduli Spaces and Arithmetic

Manfred Leopold Einsiedler, *ETH, Zurich, Switzerland*, **David Alexandre Ellwood**, *Clay Mathematics Institute, Cambridge, MA*, **Alex Eskin**, *University of Chicago, IL*, **Dmitry Kleinbock**, *Brandeis University, Waltham, MA*, **Elon Lindenstrauss**, *The Hebrew University of Jerusalem, Israel*, **Gregory Margulis**, *Yale University, New Haven, CT*, **Stefano Marmi**, *Scuola Normale Superiore di Pisa, Italy*, and **Jean-Christophe Yoccoz**, *College de France, Paris, France*, Editors

This book contains a wealth of material concerning two very active and interconnected directions of current research at the interface of dynamics, number theory and geometry. Examples of the dynamics considered are the action of subgroups of $\mathrm{SL}(n,\mathbb{R})$ on the space of unit volume lattices in $\mathbb{R}^n$ and the action of $\mathrm{SL}(2,\mathbb{R})$ or its subgroups on moduli spaces of flat structures with prescribed singularities on a surface of genus ≥ 2.

Topics covered include the following:

(a) Unipotent flows: non-divergence, the classification of invariant measures, equidistribution, orbit closures.

(b) Actions of higher rank diagonalizable groups and their invariant measures, including entropy theory for such actions.

(c) Interval exchange maps and their connections to translation surfaces, ergodicity and mixing of the Teichmüller geodesic flow, dynamics of rational billiards.

(d) Application of homogeneous flows to arithmetic, including applications to the distribution of values of indefinite quadratic forms at integral points, metric Diophantine approximation, simultaneous Diophantine approximations, counting of integral and rational points on homogeneous varieties.

(e) Eigenfunctions of the Laplacian, entropy of quantum limits, and arithmetic quantum unique ergodicity.

(f) Connections between equidistribution and automorphic forms and their L-functions.

The text includes comprehensive introductions to the state-of-the-art in these important areas and several surveys of more advanced topics, including complete proofs of many of the fundamental theorems on the subject. It is intended for graduate students and researchers wishing to study these fields either for their own sake or as tools to be applied in a variety of fields such as arithmetic, Diophantine approximations, billiards, etc.

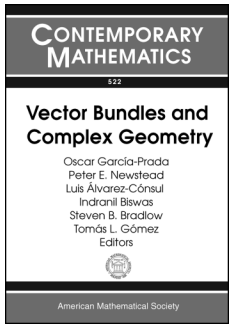
This item will also be of interest to those working in number theory.

Titles in this series are co-published with the Clay Mathematics Institute (Cambridge, MA).

Contents: J.-C. Yoccoz, Interval exchange maps and translation surfaces; **A. Eskin**, Unipotent flows and applications; **D. Kleinbock**, Quantitative nondivergence and its Diophantine applications; **M. Einsiedler** and **E. Lindenstrauss**, Diagonal actions on locally homogeneous spaces; **S. Katok**, Fuchsian groups, geodesic flows on surfaces of constant negative curvature and symbolic coding of geodesics; **A. Avila**, Chaoticity of the Teichmüller flow; **H. Oh**, Orbital counting via mixing and unipotent flows; **G. Harcos**, Equidistribution on the modular surface and L-functions; **N. Anantharaman**, Eigenfunctions of the Laplacian on negatively curved manifolds: A semiclassical approach.

Clay Mathematics Proceedings, Volume 10

September 2010, approximately 440 pages, Softcover, ISBN: 978-0-8218-4742-8, LC 2010021098, 2000 *Mathematics Subject Classification:* 37A17, 37A45, 37A35, 37C85, 37D40, 37E05, 11J13, 11J83, 58J51, 81Q50, **AMS members US$79.20**, List US$99, Order code CMIP/10



Vector Bundles and Complex Geometry

Oscar García-Prada, *Consejo Superior de Investigaciones Científicas, Madrid, Spain*, **Peter E. Newstead**, *University of Liverpool, United Kingdom*, **Luis Álvarez-Cónsul**, *Consejo Superior de Investigaciones Científicas, Madrid, Spain*, **Indranil Biswas**, *Tata Institute of Fundamental Research, Mumbai, India*, **Steven B. Bradlow**, *University of Illinois at Urbana-Champaign, IL*, and **Tomás L. Gómez**, *Consejo Superior de Investigaciones Científicas, Madrid, Spain*, Editors

This volume contains a collection of papers from the Conference on Vector Bundles held at Miraflores de la Sierra, Madrid, Spain on June 16–20, 2008, which honored S. Ramanan on his 70th birthday.

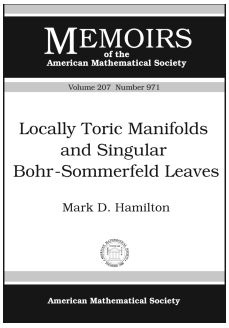
The main areas covered in this volume are vector bundles, parabolic bundles, abelian varieties, Hilbert schemes, contact structures, index theory, Hodge theory, and geometric invariant theory. Professor Ramanan has made important contributions in all of these areas.

Contents: M. S. Narasimhan, The work of S. Ramanan; **V. Balaji** and **A. Dey**, Parabolic bundles on algebraic surfaces II–Irreducibility of the moduli space; **A. Beauville**, Finite subgroups of $\mathrm{PGL}_2(K)$; **U. N. Bhosle**, Picard groups of moduli spaces of torsionfree sheaves on curves; **U. N. Bhosle**, On the moduli of orthogonal bundles on a nodal hyperelliptic curve; **A. Hirschowitz** and **J. NN Iyer**, Hilbert schemes of fat r-planes and the triviality of Chow groups of complete intersections; **N. Hitchin**, Vector bundles and the icosahedron; **K. Hulek** and **O. Tommasi**, Cohomology of the

toroidal compactification of $\mathcal{A}_3$; **J.-M. Hwang** and **L. Manivel**, Quasi-complete homogeneous contact manifold associated to a cubic form; **I. Mundet i Riera** and **A. Schmitt**, Maximal weights in Kähler geometry: Flag manifolds and Tits distance (with an Appendix by A. Schmitt); **C. Pauly**, Orthogonal bundles over curves in characteristic two; **M. S. Raghunathan**, The Atiyah-Singer index theorem; **T. R. Ramadas**, Spin(7) instantons and the Hodge conjecture for certain abelian four-folds: A modest proposal; **C. S. Seshadri**, Remarks on parabolic structures; **C. Simpson**, Iterated destabilizing modifications for vector bundles with connection.

Contemporary Mathematics, Volume 522

October 2010, 206 pages, Softcover, ISBN: 978-0-8218-4750-3, LC 2010011114, 2000 *Mathematics Subject Classification:* 14H60, 14D20, 20G15, 14D07, 14D22, 58J20, 14C30, 14J60, **AMS members US$55.20**, List US$69, Order code CONM/522



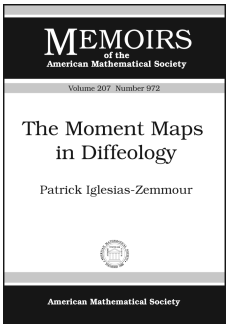
Locally Toric Manifolds and Singular Bohr-Sommerfeld Leaves

Mark D. Hamilton, *University of Toronto, ON, Canada*

Contents: Introduction; Background; The cylinder; The complex plane; Example: S^2; The multidimensional case; A better way to calculate cohomology; Piecing and glueing; Real and Kähler polarizations compared; Bibliography.

Memoirs of the American Mathematical Society, Volume 207, Number 971

September 2010, 60 pages, Softcover, ISBN: 978-0-8218-4714-5, LC 2010022712, 2000 *Mathematics Subject Classification:* 53D50, **Individual member US$34.80**, List US$58, Institutional member US$46.40, Order code MEMO/207/971



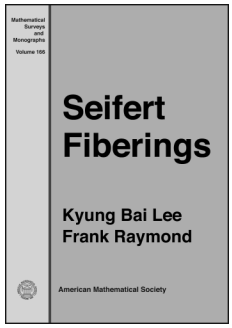
The Moment Maps in Diffeology

Patrick Iglesias-Zemmour, *CNRS, Marseille, France*

Contents: Introduction; Few words about diffeology; Diffeological groups and momenta; The paths moment map; The 2-points moment map; The moment maps; The moment maps for exact 2-forms; Functoriality of the moment maps; The universal moment maps; About symplectic manifolds; The homogeneous case; Examples of moment maps in diffeology; Bibliography.

Memoirs of the American Mathematical Society, Volume 207, Number 972

September 2010, 72 pages, Softcover, ISBN: 978-0-8218-4709-1, LC 2010022756, 2000 *Mathematics Subject Classification:* 53C99, 53D30, 53D20, **Individual member US$38.40**, List US$64, Institutional member US$51.20, Order code MEMO/207/972



Seifert Fiberings

Kyung Bai Lee, *University of Oklahoma, Norman, OK*, and **Frank Raymond**, *University of Michigan, Ann Arbor, MI*

Seifert fiberings extend the notion of fiber bundle mappings by allowing some of the fibers to be singular. Away from the singular fibers, the fibering is an ordinary bundle with fiber a fixed homogeneous space. The singular fibers are quotients of this homogeneous space by distinguished groups of homeomorphisms. These fiberings are ubiquitous and important in mathematics. This book describes in a unified way their structure, how they arise, and how they are classified and used in applications. Manifolds possessing such fiber structures are discussed and range from the classical three-dimensional Seifert manifolds to higher dimensional analogues encompassing, for example, flat manifolds, infra-nil-manifolds, space forms, and their moduli spaces. The necessary tools not covered in basic graduate courses are treated in considerable detail. These include transformation groups, cohomology of groups, and needed Lie theory. Inclusion of the Bieberbach theorems, existence, uniqueness, and rigidity of Seifert fiberings, aspherical manifolds, symmetric spaces, toral rank of spherical space forms, equivariant cohomology, polynomial structures on solv-manifolds, fixed point theory, and other examples, exercises and applications attest to the breadth of these fiberings. This is the first time the scattered literature on singular fiberings is brought together in a unified approach. The new methods and tools employed should be valuable to researchers and students interested in geometry and topology.

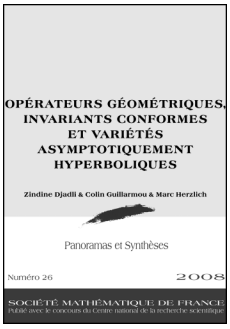
Contents: Introduction; Transformation groups; Group actions and the fundamental group; Actions of compact Lie groups on manifolds; Definition of Seifert fibering; Group cohomology; Lie groups; Seifert fiber space construction for $G \times W$; Generalization of Bieberbach's theorems; Seifert manifolds with $\Gamma \setminus G/K$-fiber; Locally injective Seifert fiberings with torus fibers; Applications; Seifert fiberings with compact connected Q; Deformation spaces; S^1-actions on 3-dimensional manifolds; Classification of Seifert 3-manifolds via equivariant cohomology; Bibliography; Index.

Mathematical Surveys and Monographs, Volume 166

October 2010, approximately 411 pages, Hardcover, ISBN: 978-0-8218-5231-6, 2000 *Mathematics Subject Classification:* 55R55, 57S30, 57-XX; 53C30, 55R91, 58E40, 58D19, 57N16, **AMS members US$79.20**, List US$99, Order code SURV/166

New AMS-Distributed Publications

Algebra and Algebraic Geometry



Opérateurs Géométriques, Invariants Conformes et Variétés Asymptotiquement Hyperboliques

Zindine Djadli, *Université Grenoble I, St. Martin d'Heres, France*, **Colin Guillarmou**, *Université de Nice-Sophia Antipolis, France*, and **Marc Herzlich**, *Université Montpellier II, France*

In 1985, Fefferman and Graham initiated an ambitious program of study of conformal geometry known as the "ambient metric" method. This program has developed tremendously in the last few years, leading to the definition of a number of new invariants: Graham-Jenne-Mason-Sparling (GJMS) operators generalizing the Yamabe and Paneitz operators, Branson Q-curvatures … and to remarkable applications to conformally flat manifolds of dimension 4 and nonnegative Euler characteristic, or to conformally invariant pinching theorems. An essential role is played in the theory by asymptotically hyperbolic Einstein metrics (or Poincaré-Einstein metrics) associated to a conformal class.

This book is devoted to a presentation of the theory together with a description of the latest developments. It should be accessible to all readers having a basic knowledge of Riemannian geometry.

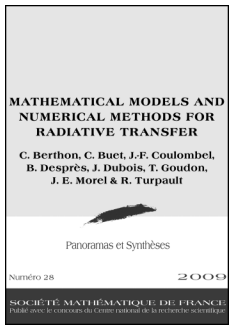
A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: Introduction; Métriques AHE et ambiantes; Premières applications; Intégrales renormalisées; Théorie de la diffusion; Laplaciens conformes et Q-courbure; Fonctionnelle log-déterminant, Q-courbure et applications en dimension 4; Variétés riemanniennes mesurées; La métrique ambiante et le fibré de Cartan; Déterminants des opérateurs GJMS et fonctions Zêta; Bibliographie.

Panoramas et Synthèses, Number 26

May 2010, 171 pages, Softcover, ISBN: 978-2-85629-260-0, 2000 *Mathematics Subject Classification:* 58J05, 58J50, **Individual member US$49.50**, List US$55, Order code PASY/26

Differential Equations



Mathematical Models and Numerical Methods for Radiative Transfer

C. Berthon, *Université de Nantes, France*, **C. Buet**, *CEA/DAM Ile de France, Bruyères-Le-Châtel, France*, **J.-F. Coulombel**, *CNRS, Villeneuve d'Ascq, France*, **B. Després**, *Université Paris VI, France*, **J. Dubois**, *CEA-CESTA, Le Barp, France*, **T. Goudon**, *INRIA Lille Nord Europe, Villeneuve d'Ascq, France*, **J. E. Morel**, *Texas A & M University, College Station, TX*, and **R. Turpault**, *Université de Nantes, France*

Radiative transfer phenomena arise in many applications ranging from astrophysics to photon beam radiotherapy. This volume describes some aspects of modern radiative transfer theory, dealing with models where the transport equation for the radiative energy is coupled to hydrodynamic systems. The discussion is specifically oriented to the design of dedicated efficient numerical methods. In particular, details are given on asymptotic regimes and asymptotic models that lead to diffusion approximations, intermediate models such as the M_1 model based on an entropy minimization closure, and the analysis of shock profiles in radiative hydrodynamics.

This item will also be of interest to those working in applications.

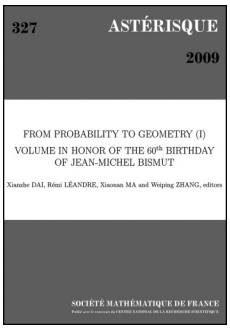
A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: B. Després and **C. Buet**, Grey radiative hydrodynamics—Hierarchy of models and numerical approximation; **J. E. Morel**, Discrete-ordinates transport methods for non-relativistic radiation-hydrodynamics; **C. Berthon**, **J. Dubois**, and **R. Turpault**, Numerical approximation of the M_1-model; **J.-F. Coulombel** and **T. Goudon**, Shock profiles in radiative hydrodynamics.

Panoramas et Synthèses, Number 28

May 2010, 108 pages, Softcover, ISBN: 978-2-85629-274-7, 2000 *Mathematics Subject Classification:* 35B35, 35L67, 65M06, 65M12, 65M60, 65N06, 76L05, 78A40, 85A15, 85A25, **Individual member US$37.80**, List US$42, Order code PASY/28

General Interest



From Probability to Geometry (I)

Volume in Honor of the 60th Birthday of Jean-Michel Bismut

Xianzhe Dai, *University of California, Santa Barbara, CA*, **Rémi Léandre**, *Université de Bourgogne, Dijon, France*, **Xiaonan Ma**, *Université Paris 7, France*, and **Weiping Zhang**, *Nankai University, Tianjin, China*, Editors

This is the first of two volumes that contain original research articles submitted by colleagues and friends to celebrate the 60th birthday of Jean-Michel Bismut.

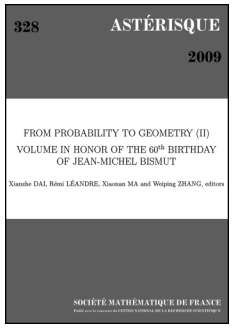
These articles cover a wide range of subjects in probability theory, global analysis, and arithmetic geometry to which Jean-Michel Bismut has made fundamental contributions.

A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: S. Aida, Semi-classical limit of the lowest eigenvalue of a Schrödinger operator on a Wiener space: I. Unbounded one particle Hamiltonians; **S. Albeverio** and **S. Mazzucchi**, Infinite dimensional oscillatory integrals with polynomial phase function and the trace formula for the heat semigroup; **R. F. Bass** and **E. Perkins**, A new technique for proving uniqueness for martingale problems; **M. Grothaus**, **L. Streit**, and **A. Vogel**, Feynman integrals as Hida distributions: the case of non-perturbative potentials; **H. Kunita**, Smooth density of canonical stochastic differential equations with jumps; **J. R. Norris**, Two-parameter stochastic calculus and Malliavin's integration-by-parts formula on Wiener space; **I. Shigekawa**, Witten Laplacian on a lattice spin system; **A. Alekseev**, **H. Bursztyn**, and **E. Meinrenken**, Pure spinors on Lie groups; **M.-T. Benameur** and **P. Piazza**, Index, eta and rho invariants on foliated bundles; **A. Berthomieu**, Direct image for some secondary K-theories; **J.-B. Bost** and **K. Künnemann**, Hermitian vector bundles and extension groups on arithmetic schemes II. The arithmetic Atiyah extension.

Astérisque, Number 327

May 2010, 420 pages, Softcover, ISBN: 978-2-85629-288-4, 2000 *Mathematics Subject Classification:* 11J95, 14F05, 14F40, 14G40, 15A66, 19D55, 19E20, 19K56, 28C20, 32L10, 34E05, 35C15, 35C20, 35J10, 35K05, 35P15, 47A10, 47D08, 58J28, 53C05, 53D17, 53D20, 55R50, 57R20, 58J42, 60H07, 60H15, 60H40, 60J60, 60J75, 81Q20, 81S40, **Individual member US$121.50**, List US$135, Order code AST/327



From Probability to Geometry (II)

Volume in Honor of the 60th Birthday of Jean-Michel Bismut

Xianzhe Dai, *University of California, Santa Barbara, CA*, **Rémi Léandre**, *Université de Bourgogne, Paris, France*, **Xiaonan Ma**, *Université Paris 7, France*, and **Weiping Zhang**, *Nankai University, Tianjin, China*, Editors

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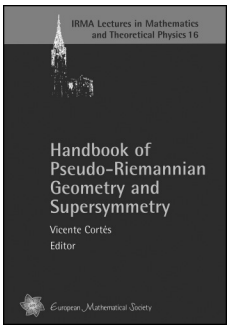
Contents: J. Brüning, The signature operator on manifolds with a conical singular stratum; **U. Bunke** and **T. Schick**, Smooth K-theory; **H. Gillet** and **F. M. Ünlü**, An explicit proof of the generalized Gauss-Bonnet formula; **S. Goette**, Torsion invariants for families; **F. R. Harvey** and **H. B. Lawson, Jr.**, Boundaries of positive holomorphic chains and the relative Hodge question; **K. Liu** and **H. Xu**, Mirzakharni's recursion formula is equivalent to the Witten-Kontsevich theorem; **V. Maillot** and **D. Rössler**, Formes automorphes et théorèmes de Riemann-Roch arithmétiques; **V. Mathai**, **R. B. Melrose**, and **I. M. Singer**, The index of projective families of elliptic operators: the decomposable case; **P.-É. Paradan** and **M. Vergne**, Index of transversally elliptic operators; **S. T. Paul** and **G. Tian**, CM stability and the generalized Futaki invariant II; **K.-i. Yoshikawa**, Calabi–Yau threefolds of Borcea–Voisin, analytic torsion, and Borcherds products.

Astérisque, Number 328

May 2010, 420 pages, Softcover, ISBN: 978-2-85629-289-1, 2000 *Mathematics Subject Classification:* 11J95, 14F05, 14F40, 14G40, 15A66, 19D55, 19E20, 19K56, 28C20, 32L10, 34E05, 35C15, 35C20, 35J10, 35K05, 35P15, 47A10, 47D08, 53C05, 53D17, 53D20, 55R50, 57R20, 58J28, 58J42, 60H07, 60H10, 60H15, 60H40, 60J60, 60J75, 81Q20, 81S40, **Individual member US$121.50**, List US$135, Order code AST/328

Geometry and Topology



Handbook of Pseudo-Riemannian Geometry and Supersymmetry

Vicente Cortés, *University of Hamburg, Germany*, Editor

The purpose of this handbook is to give an overview of some recent developments in differential geometry related to supersymmetric field theories. The main themes covered are:

- Special geometry and supersymmetry
- Generalized geometry
- Geometries with torsion
- Para-geometries
- Holonomy theory
- Symmetric spaces and spaces of constant curvature
- Conformal geometry
- Wave equations on Lorentzian manifolds
- D-branes and K-theory

The intended audience consists of advanced students and researchers working in differential geometry, string theory, and related areas. The emphasis is on geometrical structures occurring on target spaces of supersymmetric field theories. Some of these structures can be fully described in the classical framework of pseudo-Riemannian geometry. Others lead to new concepts relating various fields of research, such as special Kähler geometry or generalized geometry.

This item will also be of interest to those working in mathematical physics.

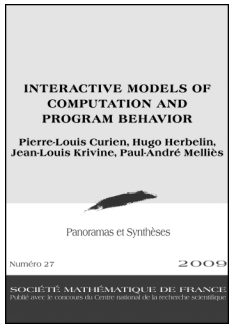
A publication of the European Mathematical Society. Distributed within the Americas by the American Mathematical Society.

Contents: *Part A. Special geometry and supersymmetry:* **M. Roček**, **C. Vafa**, and **S. Vandoren**, Quaternion-Kähler spaces, hyper-Kähler cones, and the c-map geometry; **G. Weingart**, Differential forms on quaternionic Kähler manifolds; **C. P. Boyer** and **K. Galicki**, Sasakian geometry, holonomy, and supersymmetry; **M. A. Lledó**, **O. Maciá**, **A. Van Proeyen**, and **V. S. Varadarajan**, Special geometry for arbitrary signatures; **T. Mohaupt**, Special geometry, black holes and Euclidean supersymmetry; *Part B. Generalized geometry:* **N. Hitchin**, Generalized geometry—an introduction; **A. Kotov** and **T. Strobl**, Generalizing geometry—algebroids and sigma models; **U. Lindström**, **M. Roček**, **R. von Unge**, and **M. Zabzine**, A potential for generalized Kähler geometry; *Part C. Geometries with torsion:* **I. Agricola**, Non-integrable geometries, torsion, and holonomy; **P.-A. Nagy**, Totally skew-symmetric torsion and nearly-Kähler geometry; **J.-B. Butruille**, Homogeneous nearly Kähler manifolds; **L. Schäfer** and **F. Schulte-Hengesbach**, Nearly pseudo-Kähler and nearly para-Kähler six-manifolds; **A. Swann**, Quaternionic geometries from superconformal symmetry; *Part D. Para-geometries:* **S. Ivanov**, **I. Minchev**, and **S. Zamkovoy**, Twistor and reflector spaces of almost para-quaternionic manifolds; **M. Krahe**, Para-pluriharmonic maps and twistor spaces; **D. V. Alekseevsky**, **C. Medori**, and **A. Tomassini**, Maximally homogeneous para-CR manifolds of semisimple type; *Part E. Holonomy theory:* **A. Galaev** and **T. Leistner**, Recent developments in pseudo-Riemannian holonomy theory; **A. J. Di Scala**, **T. Leistner**, and **T. Neukirchner**, Geometric applications of irreducible representations of Lie groups; **K. Waldorf**, Surface holonomy; *Part F. Symmetric spaces and spaces of constant curvature theory:* **I. Kath**, Classification results for pseudo-Riemannian symmetric spaces; **D. V. Alekseevsky**, Pseudo-Kähler and para-Kähler symmetric spaces; **O. Baues**, Prehomogeneous affine representations and flat pseudo-Riemannian manifolds; *Part G. Conformal geometry:* **H. Baum**, The conformal analog of Calabi-Yau manifolds; **Y. Kamishima**, Nondegenerate conformal structures, CR structures and quaternionic CR structures on manifolds; *Part H. Other topics of recent interest:* **C. Bär**, Linear wave equations on Lorentzian manifolds; **D. S. Freed**, Survey of D-branes and K-theory; List of contributors; Index.

IRMA Lectures in Mathematics and Theoretical Physics, Volume 16

June 2010, 964 pages, Hardcover, ISBN: 978-3-03719-079-1, 2000 *Mathematics Subject Classification:* 53-00, 53C26, 53C50, 81T60, 83E30, 83E50, 53C25, 53C29, 53C35, 53C10, **AMS members US$110.40**, List US$138, Order code EMSILMTP/16

Logic and Foundations



Interactive Models of Computation and Program Behavior

Pierre-Louis Curien, **Hugo Herbelin**, and **Jean-Louis Krivine**, *Université Paris VII, France*, and **Paul-André Melliès**, *Université Paris Diderot, France*

This volume contains three contributions in the field of logic and computation that reflect current trends towards an interactive account of the meaning of proofs and programs. The contributions can be read independently and use or introduce fundamental tools in the field: categories, realizability, abstract machines. Throughout the volume, a unifying theme is that of games and strategies, which turns the correspondence between proofs and programs (the so-called Curry-Howard isomorphism) into a triangle whose third corner emphasizes interaction and duality between a program and its environment or between a proof and counter-proofs. The introduction to the volume places the contributions in perspective and provides a gentle beginner's introduction to the lambda-calculus, which is and remains the backbone of the whole field.

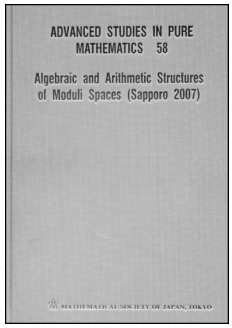
A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: **P.-A. Melliès**, Categorical semantics of linear logic; **J.-L. Krivine**, Realizability in classical logic; **P.-L. Curien** and **H. Herbelin**, Abstract machines for dialogue games.

Panoramas et Synthèses, Number 27

May 2010, 275 pages, Softcover, ISBN: 978-2-85629-273-0, 2000 *Mathematics Subject Classification:* 03F05, 03F52, 68Q55, 03B40, 03B70, 03G30, 68N18, 68N20, **Individual member US$64.80**, List US$72, Order code PASY/27

Number Theory



Algebraic and Arithmetic Structures of Moduli Spaces (Sapporo 2007)

Iku Nakamura, *Hokkaido University, Sapporo, Japan*, and **Lin Weng**, *Kyushu University, Fukuoka, Japan*, Editors

The conference on Algebraic and Arithmetic Structures of Moduli Spaces was held at Hokkaido University in Sapporo, Japan in September 2007. Twenty talks were delivered by invited speakers on arithmetic geometry, algebraic geometry and complex geometry. This volume is the proceedings of the conference—a collection of eleven papers contributed by some of the speakers. The papers have undergone rigorous refereeing.

The articles cover a diverse range of topics such as class field theory, zeta functions, moduli of arithmetic vector bundles, moduli of complex vector bundles, moduli of abelian varieties and theory of display, moduli of Fermat varieties and some topics on cubic threefolds. Among others, the papers by Pappas and Rapoport, Rajan, and Weng address many new interesting questions in the related fields and will be worthy reading for young researchers.

This item will also be of interest to those working in algebra and algebraic geometry.

Published for the Mathematical Society of Japan by Kinokuniya, Tokyo, and distributed worldwide, except in Japan, by the AMS.

Contents: C. Deninger and **A. Werner**, Vector bundles on p-adic curves and parallel transport II; **G. van der Geer** and **A. Kouvidakis**, A note on Fano surfaces of nodal cubic threefolds; **E. Looijenga**, Fermat varieties and the periods of some hypersurfaces; **I. Nakamura**, Another canonical compactification of the moduli space of abelian varieties; **C. S. Rajan**, Some questions on spectrum and arithmetic of locally symmetric spaces; **G. Pappas** and **M. Rapoport**, Some questions about G-bundles on curves; **L. Weng**, Symmetries and the Riemann Hypothesis; **L. Weng**, Stability and arithmetic; **T. Yoshida**, On non-abelian Lubin–Tate theory via vanishing cycles; **K. Yoshioka**, An action of a Lie algebra on the homology groups of moduli spaces of stable sheaves; **A. Vasiu** and **T. Zink**, Breuil's classification of p-divisible groups over regular local rings of arbitrary dimension.

Advanced Studies in Pure Mathematics, Volume 58

June 2010, 479 pages, Hardcover, ISBN: 978-4-931469-59-4, 2000 *Mathematics Subject Classification:* 11Gxx; 11Mxx, 11Sxx, 14D20, 14Jxx, 14Kxx, 14Mxx, **AMS members US$67.20**, List US$84, Order code ASPM/58

AMERICAN MATHEMATICAL SOCIETY

AMS Sectional Meetings – Fall 2010

OCT 2-3

Syracuse University, Syracuse, NY

October 2-3

Syracuse University, Syracuse, NY

Invited Addresses by **Alan Frieze**, Carnegie-Mellon University; **Yan Guo**, Brown University; **William Minicozzi**, Johns Hopkins University; and **Andrei Zelevinsky**, Northeastern University

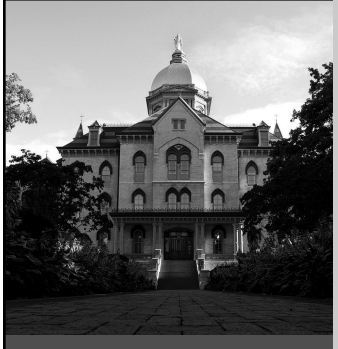
OCT 9-10

University of California Los Angeles, Los Angeles, CA

October 9-10

University of California Los Angeles, Los Angeles, CA

Invited Addresses by **Greg Kuperberg**, University of California Davis; **Cris Moore**, University of New Mexico; **Stanley Osher**, University of California Los Angeles; **Terence Tao**, University of California Los Angeles (Einstein Public Lecture in Mathematics); and **Melanie Wood**, Princeton University



NOV 5-7

Notre Dame University, Notre Dame, IN

November 5–7

Notre Dame University, Notre Dame, IN

Invited Addresses by **Laura DeMarco**, University of Illinois at Chicago; **Jordan Ellenberg**, University of Wisconsin; **David Fisher**, Indiana University; and **Jared Wunsch**, Northwestern University

NOV 6-7

University of Richmond, Richmond, VA

November 6-7

University of Richmond, Richmond, VA

Invited Addresses by **Matthew H. Baker**, Georgia Institute of Technology; **Michael J. Field**, University of Houston; **Sharon R. Lubkin**, North Carolina State University; and **Stefan Richter**, University of Tennessee, Knoxville

See the AMS website for the most up-to-date lists of Invited Addresses and Special Sessions.

www.ams.org/amsmtgs/sectional.html

Come to hear presentations, connect with researchers in your field, and meet colleagues, mentors, and students.
While at the meetings visit the AMS exhibit to see the book sale and receive information on AMS membership and programs.

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Classified Advertisements

Positions available, items for sale, services available, and more

CALIFORNIA

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MSRI invites applications for 40 Research Professors, 200 Research Members, and 30 semester-long Post-Doctoral Fellows in the following programs: Quantitative Geometry (August 15 to December 16, 2011), and Random Spatial Processes (January 09, 2012 to May 18, 2012). In addition a very small number of positions may be available as part of our Complementary Program. Research Professorships are intended for senior researchers who will be making key contributions to a program, including the mentoring of postdoctoral fellows, and who will be in residence for three or more months. Research Memberships are intended for researchers who will be making contributions to a program and who will be in residence for one or more months. Post-Doctoral Fellowships are intended for recent Ph.D.s. Interested individuals should carefully describe the purpose of their proposed visit, and indicate why a residency at MSRI will advance their research program. To receive full consideration, application must be complete, including all letters of support by the following deadlines: Research Professorships, October 01, 2010; Research Memberships, December 01, 2010; Postdoctoral Fellowships, December 01, 2010. Application information: `http://www.msri.org/propapps/applications/application_material`. The Institute is committed to the principles of Equal Opportunity and Affirmative Action.

000028

TEXAS

TEXAS A&M UNIVERSITY
The Department of Mathematics

The Department of Mathematics anticipates up to six openings for postdoctoral positions at the level of Visiting Assistant Professor, subject to budgetary approval. Our Visiting Assistant Professor positions are three-year appointments and carry a three-course-per-year teaching load. They are intended for those who have recently received their Ph.D.s and preference will be given to mathematicians whose research interests are close to those of our regular faculty members. We also anticipate up to six short-term (semester or year-long) visiting positions at various ranks, depending on budget. A complete dossier should be received by December 15, 2010. Early applications are encouraged since the department will start the review process in October 2010. Applicants should send the completed "AMS Application Cover Sheet", a vita, a summary statement of research and teaching experience, and arrange to have letters of recommendation sent to: Faculty Hiring, Department of Mathematics, Texas A&M University, 3368 TAMU, College Station, Texas 77843-3368. Further information can be obtained from: `http://www.math.tamu.edu/hiring`.

Texas A&M University is an Equal Opportunity Employer. The university is dedicated to the goal of building a culturally diverse and pluralistic faculty and staff committed to teaching and working in a multicultural environment, and strongly encourages applications from women, minorities, individuals with disabilities, and veterans. The university is responsive to the needs of dual career couples.

000034

CANADA

UNIVERSITY OF BRITISH COLUMBIA
Mathematics Department

The Mathematics Department at the University of British Columbia is seeking outstanding candidates for at least one position, subject to funding, at the tenure-track Assistant Professor level, with a starting date of July 1, 2011. Exceptional candidates at the Associate Professor or Full Professor level may be considered. Postdoctoral experience is normally expected and a Ph.D. is required. Priority research areas are Partial Differential Equations and Probability. More detail on hiring priorities will be posted by September 1, 2010, at: `http://www.math.ubc.ca/Dept/Jobs/priorities`. In any event, exceptional candidates in any area of mathematics may be considered. Joint

Suggested uses for classified advertising are positions available, books or lecture notes for sale, books being sought, exchange or rental of houses, and typing services.

The 2010 rate is $3.25 per word. No discounts for multiple ads or the same ad in consecutive issues. For an additional $10 charge, announcements can be placed anonymously. Correspondence will be forwarded.

Advertisements in the "Positions Available" classified section will be set with a minimum one-line headline, consisting of the institution name above body copy, unless additional headline copy is specified by the advertiser. Headlines will be centered in boldface at no extra charge. Ads will appear in the language in which they are submitted.

There are no member discounts for classified ads. Dictation over the telephone will not be accepted for classified ads.

Upcoming deadlines for classified advertising are as follows: October 2010 issue–July 29, 2010; November 2010 issue–August 30, 2010; December 2010 issue–September 28, 2010; January 2011 issue–October 28, 2010; February 2011 issue–November 29, 2010; March 2011 issue–December 28, 2010.

U.S. laws prohibit discrimination in employment on the basis of color, age, sex, race, religion, or national origin. "Positions Available" advertisements from institutions outside the U.S. cannot be published unless they are accompanied by a statement that the institution does not discriminate on these grounds whether or not it is subject to U.S. laws. Details and specific wording may be found on page 1373 (vol. 44).

Situations wanted advertisements from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-321-4AMS (321-4267) in the U.S. and Canada or 401-455-4084 worldwide for further information.

Submission: Promotions Department, AMS, P.O. Box 6248, Providence, Rhode Island 02940; or via fax: 401-331-3842; or send email to `classads@ams.org`. AMS location for express delivery packages is 201 Charles Street, Providence, Rhode Island 20904. Advertisers will be billed upon publication.

positions with other departments may also be possible.

The successful applicant is expected to work in an area of interest to current faculty, to interact with related groups in the department, and to have demonstrated interest and ability in teaching. The salary will be commensurate with experience and research record.

Applicants are strongly encouraged to apply online; submissions can be made at: http://www.mathjobs.org/.

Alternatively, applicants may send a current CV including a list of publications, statement of research and teaching interests, a teaching dossier or similar record of teaching experience, and should arrange for three letters of recommendation to be sent directly to:

Chair, Departmental Committee on Appointments
Department of Mathematics
#121-1984 Mathematics Road
University of British Columbia
Vancouver, B.C., Canada, V6T 1Z2

In order to ensure full consideration, applications should be received by November 15, 2010.

The department has strong connections with other mathematical institutes, such as the Pacific Institute for the Mathematical Sciences (PIMS), Mathematics of Information Technology and Complex Systems (MITACS), Banff International Research Station (BIRS), and the UBC Institute of Applied Mathematics (IAM). For more information see: http://www.math.ubc.ca.

The University of British Columbia hires on the basis of merit and is committed to employment equity. We encourage all qualified persons to apply; however Canadian citizens and permanent residents will be given priority. We strongly encourage candidates from underrepresented groups to apply, including women, visible minorities, people of aboriginal origin, and people with disabilities.

000032

ENGLAND

UNIVERSITY OF BRISTOL, UK
Chairs
Professorial Grade Salary
Bristol

The University of Bristol is seeking applications for the following three newly established positions:

• Professor/Reader in Algebraic/Arithmetic Geometry

• Professor/Reader in Combinatorics

• Professor/Reader in Probability Theory

These positions form part of the university's strategic expansion in research areas that complement existing strengths in Pure Mathematics and Statistics at Bristol. The successful candidates will be expected to build up and lead a research group of the highest international level.

The School of Mathematics is one of the leading centres for research and teaching in mathematics in the UK. There are groups working in Applied Mathematics, Pure Mathematics, and Statistics. In the 2008 Research Assessment Exercise (RAE), Applied Mathematics ranked third, Pure Mathematics ranked joint fifth, and Statistics ranked joint fourth in terms of grade-point average. Furthermore, the school has close links with the Heilbronn Institute for Mathematical Research, which is based in Bristol and runs a coordinated series of research programmes, conferences and workshops. (See http://www.maths.bris.ac.uk/research/heilbronn_institute).

Women are currently underrepresented in the School of Mathematics, therefore we particularly welcome applications from women for these posts. The university has numerous family-friendly policies which can be found on the Positive Working Environment website: http://www.bris.ac.uk/pwe.

In order to receive full attention, applications should be received by 9:00 a.m. on Friday, October 1, 2010.

To discuss any aspect of the posts, please contact Professor Guy Nason, Head of the School of Mathematics and Academic Secretary to the Appointment Committee. Telephone: +44 (0)117 928 8633; email: hod-maths@bristol.ac.uk.

Alternatively, please feel free to contact any of the people listed below for informal discussions with respect to the posts:

Professor M. van den Berg, Head of the Pure Mathematics Group: +44 (0)117 331 1666; email: m.vandenberg@bristol.ac.uk.

Professor C. Andrieu, Head of the Statistics Group: +44 (0)117 928 9134; email: c.andrieu@bristol.ac.uk.

Prof. T. Wooley, FRS, Associate Director of the Heilbronn Institute: +44 (0)117 331 5240; email: trevor.wooley@bristol.ac.uk.

For further details and an application form, please click on the "apply now" button. Alternatively you can email: recruitment@bristol.ac.uk or telephone +44 (0)117 954 6947, quoting the reference number 15489.

The closing date for applications is 9:00 a.m., October 1, 2010.

EXCELLENCE THROUGH DIVERSITY

000033

KOREA

KOREA INSTITUTE FOR ADVANCED STUDY (KIAS)
Postdoctoral Research Fellowships

The School of Mathematics at the Korea Institute for Advanced Study (KIAS) invites applicants for the positions at the level of postdoctoral research fellows in pure and applied mathematics. KIAS, founded in 1996, is committed to the excellence of research in basic sciences (mathematics, theoretical physics, and computational sciences) through high-quality research programs and a strong faculty body consisting of distinguished scientists and visiting scholars. Applicants are expected to have demonstrated exceptional research potential through the doctoral dissertation and beyond. The annual salary ranges from approximately ¥32,000,000–¥46,000,000 (equivalent to US$29,000–US$42,000). In addition, research fund in the amount of approximately ¥7,000,000–¥10,000,000 (equivalent to US$6,400–US$9,000) is provided each year. Appointments may start as early as March 1, 2011. The initial appointment will be for two years with a possibility of renewal for two additional years. Those interested are encouraged to contact a faculty member in their research areas at http://www.kias.re.kr/en/about/members.jsp. Also, for more information please visit http://www.kias.re.kr/en/notice/job_opportunity.jsp. Applicants should send a cover letter specifying the research area, a curriculum vita with a list of publications, and a summary of research plan, and arrange three recommendation letters to be sent to:

School of Mathematics:
Mr. Kang Won Lee (math@kias.re.kr)
KIAS, 207-43 Cheongnyangni-dong
Dongdaemun-gu, Seoul 130-722,
Korea

Email applications are strongly encouraged. We review the applications twice a year; the deadlines are June 30 and December 31.

000020

Mathematical Sciences Employment Center

New Orleans Marriott, New Orleans, Louisiana
January 6–9, 2011

The Employment Center offers a convenient, safe, and practical meeting place for employers and applicants attending the Joint Meetings. The focus of the Employment Center is on Ph.D.-level mathematical scientists and those that seek to hire them from academia, business, and government.

Employment Center Web Services

All resume and job forms will be submitted and accessed electronically on the Web. In addition, registered attendees will also be able to utilize a basic scheduling tool in advance on the Web. The website and all information will be available beginning in mid-August, 2010, and will remain accessible through the period of the Employment Center. The same applicant and job information available on the Employment Center/EIMS website during the months preceding the event in New Orleans will be accessible during the JMM on computer terminals available at the Employment Center. While some schools may delay appointment setting until late December, virtually all scheduling will be done before travel takes place, so applicants should expect few or no further appointments after arrival. Registering on site, for applicants, serves no real purpose.

There will be no printed books or paper forms. Also, there will be no paper message center since the new electronic system allows for interview arrangements. Computer scheduling is no longer provided at the Employment Center.

2011 Employment Center Schedule:

November 1, 2010–Suggested deadline for electronic forms submission to allow for advanced scheduling.

December 15, 2010–Advance registration deadline for JMM. Meeting badge will be required for admittance. After this date, meeting registration fees go up and meeting registration may only happen on site in New Orleans.

OPEN HOURS (NO access before opening time):

Thursday, January 6, 2011–8:00 a.m.–7:00 p.m.

Friday, January 7, 2011–8:00 a.m.–7:00 p.m.

Saturday, January 8, 2011–8:00 a.m.–7:00 p.m.

Sunday, January 9, 2011–9:00 a.m.–12:00 noon.

Location: Marriott Preservation Hall, Second Floor, New Orleans Marriott, 555 Canal Street, New Orleans

Do not schedule an interview to begin until 15 minutes after opening.

Note: When deciding on travel dates, keep in mind that employers may wish to conduct interviews on any of the days listed above.

No Admittance Without a JMM Badge

All applicants and employers planning to enter the Employment Center—even just for one interview—must present a 2011 Joint Meeting Registration badge or they will be denied admittance. This is not a new policy, but it is now strictly enforced. Meeting badges are obtained by registering for the Joint Mathematics Meetings and paying a meeting registration fee. See the JMM website at: `http://ams.org/meetings/national/jmm/2125_intro.html` for registration instructions and rates.

Employers: Choose a Table

There are two table types available for employers, based on the number of interviewers who will be present at any one time:

• one or two interviewers per table in the "Quiet Area" (US$295), additional table (US$105).

• three to six interviewers per table in the "Committee Table" area (US$400), additional table (US$105).

• If a table ONLY is desired, without an ad submission, just enter the Web system, look for pricing under "Career Fair", purchase any table/ad combination, and then do not post the ad. Ad submission is not required, however, prices are the same whether the ad is used or not.

• All tables include the option to set appointments on the EIMS system where schools and employers can access the information.

The fee includes one ad, which will run in EIMS and serve as the Employment Center ad through January. Please note that the traditional advertising site on the AMS website, EIMS, now also serves as the ad placement site for the Employment Center. Employers should be sure and place their ad through the "Career Fair" tab which will be available on the EIMS website by mid-August. There is no point in placing an EIMS ad and an Employment Center ad separately; one ad will serve both purposes, but it MUST be placed using the Employment Center table purchase options.

All fees are to be paid at the EIMS ad website; fees are no longer paid through the JMM registration form. However, individual registration for the JMM is required for all interviews and no admittance is possible without a JMM badge.

Employers: How to Register

• Registration runs mid-August 2010 through January 6, 2011, at the following website: `www.eims.ams.org`. The suggested deadline is November 1 if possible.

• Use your existing EIMS account or create a new Employer account at `eims.ams.org`. Look under "Career Fair" to find the right table option and complete the purchase. Once a table is reserved, the ad can be placed at any time (or never) and will run until late January.

• Each person who will need to enter the Employment Center area must have a meeting badge (obtained by registering for the JMM and paying a meeting registration fee).

Once registered, employers will gain access to applicant data as it is submitted to the site. There will be applicant resumes on the site, but employers will want to notice especially the resumes marked "Employment Center" (EC logo). Also, employers can review the requests for interviews submitted by applicants on the system. To respond to a request, employers will be able to access the applicant's pre-approved schedule and fill in the desired slot or slots. In this way, employers will build their own schedule, which is also viewable on the system.

To display an ad on site, and use no Employment Center services at all, submit your one page paper ad on site to the Employment Center staff. There is no fee for this service.

For complete information, visit `http://www.ams.org/emp-reg/`.

Applicants: Making the Decision to Attend

• The Employment Center offers no guarantees of interviews or jobs. Hiring decisions are not made during or immediately following interviews. In the current job market, the ratio of applicants to employers is about 10:1, and many applicants go completely unnoticed.

• There will ordinarily be no research-oriented postdoctoral positions listed or discussed at the Employment Center.

• Interviews will go to applicants who applied to jobs during the fall and are now being sought out by the institutions for in person meetings during the JMM.

• There will be no opportunity to speak to employers without a pre-arranged interview, and no walk-up job information tables.

In the current job market, the majority of Employment Center employers are academic departments of mathematical sciences seeking to meet a short list of applicants who applied for their open positions during the fall. Each year, a few government or industry employers are present. Often, they are seeking U.S. citizens only due to existing contracts.

All job postings and interview request arrangements are available on the website in advance, and now that this electronic service is in place, there is no other messaging conducted on paper. Please note, also, that there is no connection between Mathjobs.org and the Employment Center. The Employment Center shares web software with the EIMS ads on the AMS website, but not with Mathjobs.org.

Past attendees have pointed out that all interviews are arranged in advance, and there is no opportunity to make connections on site if it has not happened before the meeting. In a recent survey, fifty percent of applicants responding reported being invited for at least one on-campus visit to an employer they had interviewed with at the Employment Center. Please visit the Employment Center website for further advice, information, and program updates at www.ams.org/emp-reg/.

Applicants: How to Register

• Early registration is vital since most employers will finalize schedules before arriving in New Orleans.

• Register for the JMM by completing a meeting registration form and paying a meeting registration fee. No admittance without a meeting badge.

• Create an Applicant account on the Employment Center/EIMS website. Review job ads with the "EC" logo, upload documents, and request interviews.

After submitting information and a limited number of documents on the Employment Center/EIMS website, applicants should mark their hours of availability on their interview schedule/calendar. Applicants can then review the jobs ads marked "Employment Center" (EC logo) and, if desirable, click the "request an interview" button to show interest in the job. This may appear at times like making a job application, but it really only serves as an interview request with backup documentation. If an application has already been made separately (as is often the case) applicants should indicate that in a brief cover letter. Employers may, at any time, respond to your "request for interview" by filling in an interview slot on your schedule. Employers are usually happy if you then send a quick email agreeing to the appointment.

There are no Employment Center fees for applicants; however, admission to the Employment Center room requires a 2011 JMM badge, obtainable by registering (and paying a fee) for the Joint Mathematics Meetings. To register for the meeting, go to http://ams.org/meetings/national/jmm/2125_intro.html.

It is possible to attend one or more privately arranged interviews without official Employment Center registration, however, a meeting badge is required to access the interview room.

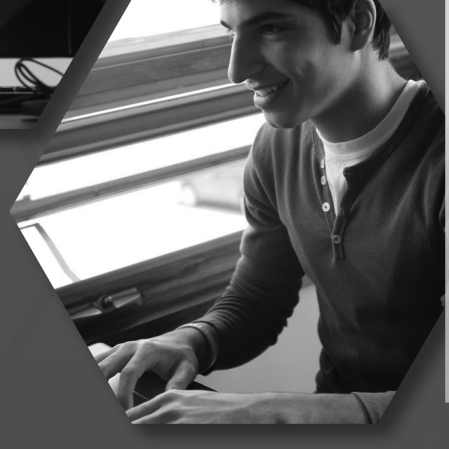
For complete information, visit http://www.ams.org/emp-reg/.

Questions about the Employment Center registration and participation can be directed to Steve Ferrucci, AMS Membership and Programs Department, at 800-321-4267, ext. 4113, or by e-mail to emp-info@ams.org.

Announcing...

The creators of MathJobs.Org welcome you to:

MathPrograms.Org



Receive, read, rate, and respond to electronic applications for your mathematical sciences programs, such as undergraduate summer research programs and travel grant arrangements.

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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/`. Final programs for Sectional Meetings will be archived on the AMS website accessible from the stated URL and in an electronic issue of the *Notices* as noted below for each meeting.

Syracuse, New York

Syracuse University

October 2–3, 2010

Saturday – Sunday

Meeting #1062

Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: June 2010
Program first available on AMS website: August 19, 2010
Program issue of electronic *Notices*: October
Issue of *Abstracts*: Volume 31, Issue 4

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: Expired

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Alan Frieze, Carnegie-Mellon University, *Hamilton cycles in random graphs*.

Yan Guo, Brown University, *Asymptotic stability in some fluid problems*.

William Minicozzi, Johns Hopkins University, *Generic singularities of mean curvature flow*.

Andrei Zelevinsky, Northeastern University, *Cluster algebras via quivers with potentials*.

Special Sessions

Advances in Theory and Applications of Evolution Equations, **Tokia Diagana**, Howard University, and **Gaston Ní Guerekata**, **Alexander Pankov**, **Xuming Xie**, and **Guoping Zhang**, Morgan State University.

Analysis, Probability and Mathematical Physics on Fractals, **Luke Rogers**, University of Connecticut, **Robert Strichartz**, Cornell University, and **Alexander Teplyaev**, University of Connecticut.

Analytic Combinatorics, **Miklos Bona**, University of Florida, and **Alex Iosevich**, University of Rochester.

Commutative Algebra and Algebraic Geometry, **Anthony Geramita**, Queen's University, **Graham Leuschke** and **Claudia Miller**, Syracuse University, and **Michael Stillman**, Cornell University.

Difference Equations and Applications, **Michael Radin**, Rochester Institute of Technology.

Geometric Analysis and Flows, **William P. Minicozzi II**, Johns Hopkins University, **Xiaodong Cao**, Cornell University, and **Junfang Li**, University of Alabama at Birmingham.

Graphs Embedded in Surfaces, and Their Symmetries, **Jack E. Graver** and **Mark E. Watkins**, Syracuse University.

Harmonic Analysis, **Dmitriy Bilyk**, University of South Carolina, and **Svitlana Mayboroda**, Purdue University.

Lie Algebras and Representation Theory, **David Hemmer**, State University of New York at Buffalo, and **Emilie Wiesner**, Ithaca College.

Mathematical Image Processing, **Lixin Shen** and **Yuesheng Xu**, Syracuse University.

Nonlinear Analysis and Geometry, **Tadeusz Iwaniec**, **Leonid V. Kovalev**, and **Jani Onninen**, Syracuse University.

Quasiconformal Mappings, Riemann Surfaces, and Teichmüller Spaces (in honor of Clifford J. Earle), **Yunping Jiang**, Queens College and The Graduate Center, City University of New York, and **Sudeb Mitra**, Queens College, City University of New York.

Representations of Algebras, **Ed Green**, Virginia Polytechnic Institute, **Mark Kleiner** and **Dan Zacharia**, Syracuse University, and **Andrei Zelevinsky**, Northeastern University.

Several Complex Variables, **Dan F. Coman** and **Evgeny A. Poletsky**, Syracuse University.

Topology and Combinatorics, **Laura Anderson**, SUNY Binghamton, and **Patricia Hersh**, North Carolina State University.

Los Angeles, California

University of California Los Angeles

October 9–10, 2010

Saturday – Sunday

Meeting #1063

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: August 2010
Program first available on AMS website: August 26, 2010
Program issue of electronic *Notices*: October 2010
Issue of *Abstracts*: Volume 31, Issue 4

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: August 17, 2010

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Cristopher Moore, University of New Mexico and the Santa Fe Institute, *Phase transitions in NP-complete problems: A challenge for probability, combinatorics, and computer science*.

Stanley Osher, University of California Los Angeles, *New algorithms in image science*.

Terence Tao, University of California Los Angeles, *The cosmic distance ladder* (Einstein Public Lecture in Mathematics).

Melanie Wood, Princeton University, *Moduli spaces for rings and ideals*.

Special Sessions

Algebraic Structures in Knot Theory (Code: SS 8A), **Sam Nelson**, Claremont McKenna College, and **Carmen Caprau**, California State University Fresno.

Applications of Nonlinear PDE (Code: SS 5A), **Susan J. Friedlander** and **Igor Kukavica**, University of Southern California.

Automorphic Forms and Number Theory (Code: SS 12A), **William Duke**, University of California Los Angeles, **Ozlem Imamoglu**, ETH Zurich, and **Kimberly Hopkins**, University of California Los Angeles.

Combinatorics and Probability on Groups (Code: SS 3A), **Jason Fulman** and **Robert Guralnick**, University of Southern California, and **Igor Pak**, University of California Los Angeles.

Continuous and Discrete Dynamical Systems (Code: SS 11A), **Mario Martelli**, Claremont Graduate University, and **Robert Sacker**, University of Southern California.

Extremal and Probabilistic Combinatorics (Code: SS 4A), **Benny Sudakov**, University of California Los Angeles, and **Jacques Verstraete**, University of California San Diego.

Free Probability and Subfactors (Code: SS 17A), **Edward Effros** and **Dimitri Shlyakhtenko**, University of California Los Angeles, and **Dan-Virgil Voiculescu**, University of California Berkeley.

Global Geometric Analysis (Code: SS 13A), **William Wylie**, University of Pennsylvania, **Joseph E. Borzellino**, California State University San Luis Obispo, and **Peter Petersen**, University of California Los Angeles.

Harmonic Analysis (Code: SS 9A), **Christoph Thiele**, University of California Los Angeles, and **Ignacio Uriarte-Tuero** and **Alexander Volberg**, Michigan State University.

Homotopy Theory and K-theory (Code: SS 10A), **Julie Bergner**, University of California Riverside, and **Christian Haesemeyer**, University of California Los Angeles.

Large Cardinals and the Continuum (Code: SS 2A), **Matthew Foreman**, University of California Irvine, **Alekos Kechris**, California Institute for Technology, **Itay Neeman**, University of California Los Angeles, and **Martin Zeman**, University of California Irvine.

Mathematical Models of Random Phenomena (Code: SS 7A), **Mark Burgin**, University of California Los Angeles, and **Alan C. Krinik**, California State Polytechnic University Pomona.

Mathematics of Criminality (Code: SS 14A), **Andrea Bertozzi**, **Martin Short**, and **George Mohler**, University of California Los Angeles.

Metric and Riemannian Methods in Shape Analysis (Code: SS 16A), **Andrea Bertozzi** and **Mario Micheli**, University of California Los Angeles.

Nonlinear Phenomena—Applications of PDEs to Fluid Flows (Code: SS 15A), **Andrea Bertozzi**, **Nebojsa Murisic**, and **David Uminsky**, University of California Los Angeles.

Recent Trends in Probability and Related Fields (Code: SS 6A), **Marek Biskup**, University of California Los Angeles, **Yuval Peres**, Microsoft Research, and **Sebastien Roch**, University of California Los Angeles.

Rigidity in von Neumann Algebras and Ergodic Theory (Code: SS 18A), **Adrian Ioana**, University of California Los Angeles, **Narutaka Ozawa**, Tokyo University, and **Sorin Popa** and **Yehudah Shalom**, University of California Los Angeles.

Topology and Symplectic Geometry (Code: SS 1A), **Robert Brown** and **Ciprian Manolescu**, University of California Los Angeles, and **Stefano Vidussi**, University of California Riverside.

Notre Dame, Indiana

Notre Dame University

November 5–7, 2010

Friday – Sunday

Meeting #1064

Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: September 2010
Program first available on AMS website: September 23, 2010
Program issue of electronic *Notices*: November 2010
Issue of *Abstracts*: Volume 31, Issue 4

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: September 14, 2010

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Laura DeMarco, University of Illinois at Chicago, *Polynomial dynamics: Critical points and moduli.*

Jordan Ellenberg, University of Wisconsin, *Geometric analytic number theory.*

David Fisher, Indiana University, *Coarse geometry of solvable groups.*

Jared Wunsch, Northwestern University, *Geometry and analysis of diffracted waves.*

Special Sessions

Algebraic Group Actions on Affine Varieties (Code: SS 25A), **Harm Derksen**, University of Michigan, and **Gene Freudenburg**, University of Western Michigan.

Algebraic and Topological Combinatorics (Code: SS 9A), **John Shareshian**, Washington University, and **Bridget Tenner**, DePaul University.

Applications of Stochastic Processes in Cell Biology (Code: SS 20A), **Peter Thomas**, Case Western University.

Arithmetic, Groups and Geometry (Code: SS 23A), **Jordan Ellenberg**, University of Wisconsin, and **Michael Larsen**, Indiana University.

Commutative Algebra and Its Interactions with Algebraic Geometry (Code: SS 2A), **Claudia Polini**, University of Notre Dame, **Alberto Corso**, University of Kentucky, and **Bernd Ulrich**, Purdue University.

Complex Analysis and Dynamical Systems (Code: SS 15A), **Laura DeMarco**, University of Illinois at Chicago, and **Jeffrey Diller**, University of Notre Dame.

Computability and Its Applications (Code: SS 11A), **Peter Cholak**, **Peter Gerdes**, and **Karen Lange**, University of Notre Dame.

Computation, Analysis, Modeling in PDE and their Applications (Code: SS 17A), **Bei Hu** and **Yongtao Zhang**, University of Notre Dame.

Computational Electromagnetics and Acoustics (Code: SS 18A), **David Peter Nicholls**, University of Illinois at Chicago.

Differential Geometry and its Applications (Code: SS 16A), **Jianguo Cao** and **Brian Smyth**, University of Notre Dame.

Geometry and Lie Theory (Code: SS 10A), **John Caine** and **Samuel Evens**, University of Notre Dame.

Graphs and Hypergraphs (Code: SS 19A), **David Galvin**, University of Notre Dame, and **Hemanshu Kaul**, Illinois Institute of Technology.

Groups, Representations, and Characters (Code: SS 4A), **James P. Cossey**, University of Akron, and **Mark Lewis**, Kent State University.

Hilbert Functions in Commutative Algebra and Algebraic Combinatorics (Code: SS 3A), **Fabrizio Zanello**, Michigan Technological University, **Juan Migliore**, University of Notre Dame, and **Uwe Nagel**, University of Kentucky.

Interdisciplinary Session on Deterministic and Stochastic Partial Differential Equations (Code: SS 5A), **Nathan Glatt-Holtz**, Indiana University, and **Vlad Vicol**, University of Southern California.

Mathematical Modeling and Computation with Applications in Biology (Code: SS 22A), **Mark Alber** and **Zhiliang Xu**, University of Notre Dame.

Nonlinear Evolution Equations (Code: SS 7A), **Alex Himonas** and **Gerard Misiolek**, University of Notre Dame.

Number Theory and Physics (Code: SS 8A), **Adrian Clingher**, University of Missouri St. Louis, **Charles Doran**, University of Alberta, **Shabnam N. Kadir**, Wilhelm Leibniz Universitat, and **Rolf Schimmrigk**, Indiana University.

Numerical Algebraic Geometry (Code: SS 13A), **Daniel J. Bates**, Colorado State University, **Jonathan D. Hauenstein**, Texas A&M University, **Andrew J. Sommese**, University of Notre Dame, and **Charles W. Wampler**, General Motors.

Quasigroups, Loops, and Nonassociative Division Algebras (Code: SS 6A), **Clifton E. Ealy**, Western Michigan University, **Stephen Gagola**, University of Arizona, **Julia Knight**, University of Notre Dame, **J. D. Phillips**, Northern Michigan University, and **Petr Vojtechovsky**, University of Denver.

Rigidity (Code: SS 24A), **David Fisher**, Indiana University, and **Ralf Spatzier**, University of Michigan.

Singularities in Algebraic Geometry (Code: SS 1A), **Nero Budur**, University of Notre Dame, and **Lawrence Ein**, University of Illinois at Chicago.

The Geometry of Submanifolds (Code: SS 21A), **Yun Myung Oh**, Andrews University, **Mihaela Vajiac**, Chapman University, and **Ivko Dimitric**, Pennsylvania State University.

Topology, Geometry and Physics (Code: SS 14A), **Ralph Kaufmann**, Purdue University, and **Stephan Stolz**, University of Notre Dame.

Undergraduate Mathematics Education: A Vision for the 21st Century (Code: SS 12A), **Steven Broad**, St. Mary's College, **Nahid Erfan** and **Alex Himonas**, University of Notre

Dame, and **Morteza Shafii-Mousavi**, Indiana University South Bend.

Accommodations

Participants should make their own arrangements directly with a hotel of their choice as early as possible. Special rates have been negotiated with the hotels listed below. Rates quoted do not include sales tax of 13%. The AMS is not responsible for rate changes or for the quality of the accommodations. When making a reservation, participants should state that they are with the **American Mathematical Society (AMS) Meeting at Notre Dame group**. Cancellation and early checkout policies vary; be sure to check when you make your reservation.

The Inn at Saint Mary's, 53993 US Route 31, South Bend, IN, 46637; phone: 574-232-4000, toll free: 800-94ST-MAR; fax: 574-289-0986. http://www.innatsaintmarys.com/. Rates are US$99 single/double and include a full breakfast. This hotel is not within easy walking distance of the meeting. Cancellation and early checkout policies vary; be sure to check when you make your reservation. **The deadline for reservations is October 5, 2010**.

The Morris Inn at Notre Dame, Notre Dame Avenue, Notre Dame, IN 46556; phone: 219-631-2000; fax: 574-631-2017. http://morrisinn.nd.edu/. Rates are US$132-US$152 single/double and include a full breakfast. Located on campus across the street from McKenna Hall/CCE—easy walk to the meeting. Cancellation and early checkout policies vary; be sure to check when you make your reservation. **The deadline for reservations is October 5, 2010**.

Suggested Lodging Alternatives:

Ivy Court Inn and Suites, 1404 Ivy Road, South Bend, IN 46637; phone: 574-277-6500; fax: 574-271-0586. http://dorahotels.com/IvyCourt/IvyCourt.htm.

Residence Inn by Marriott—South Bend, 716 North Niles Avenue, South Bend, IN 46617; phone: 574-289-5555; fax: 574-288-4531. http://www.marriott.com/hotels/trave/sbnri-residence-inn-south-bend.

Hilton Garden Inn—South Bend, 53995 Indiana State Route 933, South Bend, IN 46637; phone: 574-232-7700; fax: 574-232-7711. http://hiltongardeninn.hilton.com/en/gi/hotels/index/jhtiml?ctyhocn=SBNINGI&WT.srch=1.

Food Service

A list of on-campus and off-campus restaurants will be available at the registration desk.

Local Information

Please visit the websites maintained by the University of Notre Dame at http://www.nd.edu and the department of mathematics at http://www.math.nd.edu.

Other Activities

Book Sales: Examine the newest titles from the AMS! Many of the AMS books will be available at a special 25% 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

The walking time from the conference lot to the Notre Dame Conference Center is approximately five minutes. If you approach the lot from the North, exit Interstate 80/90 at Exit 77 and turn right onto Michigan Ave. (Indiana 933). Turn left at the fourth stop light onto Angela Blvd. Then turn left at the second stoplight onto Eddy St. Follow Eddy to the stop sign and turn right into the conference parking lot. If you approach the lot from the South, take US 31 North which becomes Indiana 933 just south of South Bend. Stay on Indiana 933 then turn right onto Angela Blvd. (second stop light north of the St. Joseph River). Continue on Angela then take a left at the second stop light onto Eddy St. Follow Eddy to the stop sign and turn right into the conference parking lot. When you get to the conference center at McKenna Hall, be sure to ask for a free parking token which you will need to get out of the lot.

Reception

The Department of Mathematics will host a reception for all conference participants on Saturday evening in McKenna Hall (CCE). The AMS thanks the department for its gracious hospitality.

Registration and Meeting Information

The registration desk will be located on the first floor of the Notre Dame Conference Center (McKenna Hall) and will be open from 7:30 a.m. to 4:00 p.m. on Saturday, and 8:00 a.m. to noon on Sunday. All talks will take place in McKenna Hall and DeBartolo Hall.

Registration Fees: Fees are US$50 for AMS or CMS members, US$70 for nonmembers; and US$5 for students/unemployed/emeritus—payable on site by cash, check, or credit card.

Travel

The Notre Dame Conference Center is located in McKenna Hall on Notre Dame Avenue, near the main entrance to the campus and directly across from the Morris Inn. The Center's phone number is 574-631-6691. Messages for conference participants can be left at this number. The fax number is 574-631-8083. The Center can also be contacted at the email address: cce@nd.edu.

The university is easily accessible from various methods of transportation:

If you are driving: the campus is located just South of the Indiana Toll Road (Interstate 80/90). From the Toll Road, use Exit 77, which is the South Bend/Notre Dame-St. Mary's exit. Turn right (south) onto Indiana 933 (Michigan Street). Turn left (east) onto Angela Blvd. (the 4^{th} light). Drive approx. 1 mile and turn left (north) at the first light, which is Notre Dame Avenue. The Center is the third building on the right.

If you are flying into South Bend Regional Airport: The campus is a 10-minute taxi ride away. The fare is

around US$15.00. Many car rental agencies are located in the airport if you are planning on renting a car.

Driving directions to campus from the airport: Exit the airport, and turn left (east) on to US20 (Lincolnway). Turn left (north) on Bendix Drive. Stay on Bendix Drive to Cleveland Road. Turn right (east) on Cleveland. Turn right (south) onto Indiana 933 (Michigan Street). Turn left (east) onto Angela Blvd. (the 4th light), drive approx. 1 mile and turn left (north) at the first light, which is Notre Dame Avenue. The Center is the third building on the right

If you are flying into Chicago's O'Hare or Midway Airports: Chicago, IL, is 90 miles west of Notre Dame, IN. Most airlines have connecting schedules to the South Bend Regional Airport.

There is frequent bus transportation to campus from the Chicago airports by Coach USA. Information of their services, schedules and fares can be obtained at their website: http://www.coachusa.com/tristateunitedlimo/ or at their toll free number 800-833-5555. Travel to and from Chicago O'Hare International Airport and Chicago Midway is easily obtained using Coach USA bus service with bi-hourly departure schedules.

If you choose to drive to South Bend from Chicago, follow the Indiana Toll Road (Interstate 80/90) instructions as stated above to campus.

The South Shore Line trains run directly from the Chicago Loop to Michiana Regional Transportation Center (airport) in South Bend.

Car Rental

Avis Rent A Car is the official car rental company for the meeting. Depending on variables such as location, length of rental, and size of vehicle, Avis will offer participants the best available rate which can range from 5–25% discount off regular rates. Participants must use the assigned **Meeting Avis Discount Number (J098887)** and meet Avis rate requirements to receive the discount. (Rate discounts are available at all corporate and participating licensee locations.) The best rates are available by calling 800-331-1600 or online at www.avis.com/AvisWeb/reservation/ReservationsInitializer?AWD_NUMBER=J098887.

All car rentals include unlimited free mileage and are available to renters 25 years and older. Renters must also meet Avis's driver and credit requirements. Return to the same rental location or additional surcharges may apply. Rates do not include any state or local surcharges, tax, optional coverages, or gas refueling charges.

Weather

The weather in November is variable, with daytime temperatures from 40º Fahrenheit to 55º Fahrenheit, and occasional rain with a remote possibility of snow.

Information for International Participants

Visa regulations are continually changing for travel to the United States. Visa applications may take from three to four months to process and require a personal interview, as well as specific personal information. International participants should view the important information about travel to the U.S. found at http://sites.nationalacademies.org/pga/biso/visas/and http://travel.state.gov/visa/visa_1750.html. If you need a preliminary conference invitation in order to secure a visa, please send your request to dls@ams.org.

If you discover you do need a visa, the National Academies website (see above) provides these tips for successful visa applications:

* Visa applicants are expected to provide evidence that they are intending to return to their country of residence. Therefore, applicants should provide proof of "binding" or sufficient ties to their home country or permanent residence abroad. This may include documentation of the following:
  - Family ties in home country of legal permanent residence
  - Property ownership
  - Bank accounts
  - Employment contract or statement from employer stating the position will continue when the employee returns;
* Visa applications are more likely to be successful if done in a visitor's home country than in a third country;
* Applicants should present their entire trip itinerary, including travel to any countries other than the United States, at the time of their visa application; include a letter of invitation from the meeting organizer or the U.S. host, specifying the subject, location and dates of the activity, and how travel and local expenses will be covered;
* If travel plans will depend on early approval of the visa application, specify this at the time of the application;
* Provide proof of professional scientific and/or educational status (students should provide a university transcript).

This list is not to be considered complete. Please visit the websites for the most up-to-date information.

Richmond, Virginia

University of Richmond

November 6–7, 2010

Saturday—Sunday

Meeting #1065

Southeastern Section
Associate secretary: Matthew Miller
Announcement issue of *Notices*: September 2010
Program first available on AMS website: September 23, 2010
Program issue of electronic *Notices*: November 2010
Issue of *Abstracts*: Volume 31, Issue 4

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: September 14, 2010

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Matthew H. Baker, Georgia Institute of Technology, *Preperiodic points and unlikely intersections.*

Michael J. Field, University of Houston, *Symmetry, structure, and stochastic fluctuations associated to some models of neural dynamics.*

Sharon R. Lubkin, North Carolina State University, *Model perspectives on self-organizing tissues.*

Stefan Richter, University of Tennessee, Knoxville, *Boundary behavior and invariant subspaces in spaces of analytic functions.*

Special Sessions

Applications of Non-Archimedean Geometry (Code: SS 6A), **Matthew H. Baker**, Georgia Institute of Technology, and **Xinyi Yuan**, Harvard University.

Codes and Designs (Code: SS 13A), **James A. Davis**, University of Richmond, and **Qing Xiang**, University of Delaware.

Computational and Applied Mathematics (Code: SS 11A), **Ludwig Kohaupt**, Beuth University, and **Mohammad Siddique**, Fayetteville State University.

Convexity and Combinatorics (Code: SS 9A), **Valeriu Soltan** and **James F. Lawrence**, George Mason University.

Differential Equations and Applications to Physics and Biology (Code: SS 8A), **Junping Shi**, College of William and Mary, and **Zhifu Xie**, Virginia State University.

Geometry of Banach Spaces and Connections with Other Areas (Code: SS 12A), **Frank Sanacory**, College at Old Westbury, and **Kevin Beanland**, Virginia Commonwealth University.

History of Mathematics: A Transnational Discourse (Code: SS 14A), **Della Fenster**, University of Richmond, and **Frédéric Brechenmacher**, University of Lille-North of France-Université d'Artois.

Kac-Moody Algebras, Vertex (Operator) Algebras, and Applications (Code: SS 7A), **William J. Cook**, Appalachian State University, and **Kailash C. Misra**, North Carolina State University.

Mathematical Models in Biology and Medicine (Code: SS 10A), **Lester Caudill**, University of Richmond.

Mathematics and the Arts (Code: SS 5A), **Michael J. Field**, University of Houston, **Gary R. Greenfield**, University of Richmond, and **Reza Sarhangi**, Towson University.

Minimum Rank Problems (Code: SS 3A), **Lon H. Mitchell**, Virginia Commonwealth University, and **Sivaram K. Narayan**, Central Michigan University.

Numerical Methods for Solving Partial Differential Equations in Practice (Code: SS 15A), **Kathryn Trapp**, University of Richmond, and **Katie Gurski**, Howard University.

Operator Theory (Code: SS 2A), **Stefan Richter**, University of Tennessee, and **William T. Ross**, University of Richmond.

Statistical Properties of Dynamical Systems (Code: SS 4A), **Michael J. Field** and **Matthew J. Nicol**, University of Houston.

Topics in Graph Theory (Code: SS 1A), **Daniel W. Cranston**, Virginia Commonwealth University, and **Gexin Yu**, College of William & Mary.

Accommodations

Participants should make their own arrangements directly with the hotel of their choice and state that they are with the **AMS Math Meeting at the University of Richmond** to receive the discounted rate. Rates do not include the applicable tax rate of 13%. The AMS is not responsible for rate changes or for the quality of the accommodations. Hotels have varying cancellation and early checkout penalties; be sure to ask for details when making your reservation.

Hotels are all in the same general location, approximately 3.5 miles from the University of Richmond campus, approximately 15 miles from Richmond International Airport (estimated travel time 25 minutes, taxi fare US$40, and approximately 3 miles from the Richmond-Staples Mill Road Amtrak Station (estimated travel time 10 minutes, taxi fare US$10). There is ample free parking at each of the hotels. Participants are discouraged from walking to the campus.

There are several restaurants within walking distance of these hotels; some of these hotels have on-site restaurants.

Courtyard Richmond West by Marriott, 6400 West Broad Street, Richmond, VA, 23230; phone: 804-282-1881; fax: 804-288-2934. Rates start at US$89 per night. Amenities include exercise center, free high-speed Internet access, free coffee in lobby (coffeemakers in rooms), and a breakfast buffet is available for a modest fee. For more information please visit http://www.marriott.com/hotels/travel/ricwe-courtyard-richmond-west. **The deadline for reservations is October 6**. Please be sure to check the early checkout and cancellation policy.

Crowne Plaza Hotel Richmond West, 6531 West Broad Street, Richmond, VA 23230; phone: 804-285-9951; fax: 804-673-9632. Rates start at US$84 per night. Amenities include fitness center; business center; indoor pool; complimentary high-speed Internet access and wireless data connection; ATM; restaurant in hotel (with lounge) available for breakfast, lunch, and dinner. For more information please visit http://www.ichotelsgroup.com/h/d/cp/1/en/hotel/ricbs. **The deadline for reservations is October 15**. Please be sure to check the early checkout and cancellation policy

Westin Hotel, 6631 West Broad Street, Richmond, VA, 23230; phone: 804-282-8444. Rates start at US$99 per night. Amenities include refrigerator and coffeemaker in room, workout room, indoor pool, wireless high-speed Internet access (free in lobby, US$9.95 per day in room), ATM, in-hotel restaurant offers 24-hour room service. For more information please visit http://www.starwoodhotels.com/westin/property/overview/index.html?propertyID=1993. **The deadline for reservations is October 22**. Please be sure to check the early checkout and cancellation policy

Best Western Executive Hotel, 7007 W Broad Street, Richmond, Virginia 23294; phone: 804-672-7007; fax: 804-672-3251. Rates start at US$69.99 per night. Amenities include in-room refrigerators and microwaves, fit-

ness center, pool, free high-speed Internet access, and complimentary continental breakfast. For more information please visit http://bestwesternvirginia.com/hotels/best-western-executive-hotel. **The deadline for reservations is October 22**. Please be sure to check the early checkout and cancellation policy

Baymont Inn and Suites Richmond, 7201 West Broad Street, Richmond, VA, 23294; phone: 804-672-1108. Rates start at US$49.99 per night. Amenities include microwave and refrigerator in some rooms, exercise room, pool, coffee in lobby (coffeemakers in all rooms), free wireless Internet access, and complimentary deluxe continental breakfast. For more information please visit http://www.baymontinns.com/Baymont/control/Booking/property_info?propertyId=20276. **The deadline for reservations is November 1**. Please be sure to check the early checkout and cancellation policy

Driving Directions to Hotels

From the North on I-95: Travel along I-95 South to Exit 79. Merge onto I-64 West. Remain on I-64 West to Exit 183. For the Crowne Plaza and Westin Hotel, take Exit 183B to merge onto West Broad Street / US-250 East. Proceed 0.5 miles to the Westin, 0.8 miles to the Crowne Plaza. For the Marriott, take Exit 183B to merge onto West Broad Street/US-250 East. Proceed 1.4 miles to make a U-turn at W. Club Lane. Proceed 0.3 miles to the Marriott. For the Best Western and Baymont Inn, take Exit 183C to merge onto West Broad Street/US 250-West. Proceed 0.8 miles to make a U-turn at Bethlehem Road. Proceed 430 feet to the Baymont Inn, 0.3 miles then right on Bynum Road to the Best Western.

From the South on I-95: Travel along I-95 North to Exit 79 (I-64W, I-195S to Powhite Parkway/Charlottesville). Stay on I-64 Westbound to Exit 183. For the Crowne Plaza and Westin Hotel, take Exit 183B to merge onto West Broad Street US-250 East. Proceed 0.5 miles to the Westin, 0.8 miles to the Crowne Plaza. For the Marriott, take Exit 183B to merge onto West Broad Street/US-250 East. Proceed 1.4 miles to make a U-turn at W. Club Lane. Proceed 0.3 miles to the Marriott. For the Best Western and Baymont Inn, take Exit 183C to merge onto West Broad Street/US 250-West. Proceed 0.8 miles to make a U-turn at Bethlehem Road. Proceed 430 feet to the Baymont Inn, 0.3 miles then right on Bynum Road to the Best Western.

From the East on I-64 (from Richmond International Airport): Travel along I-64 Westbound to Exit 183. For the Crowne Plaza and Westin Hotel, take Exit 183B to merge onto West Broad Street/US-250 East. Proceed 0.5 miles to the Westin, 0.8 miles to the Crowne Plaza. For the Marriott, take Exit 183B to merge onto West Broad Street/US-250 East. Proceed 1.4 miles to make a U-turn at W. Club Lane. Proceed 0.3 miles to the Marriott. For the Best Western and Baymont Inn, take Exit 183C to merge onto West Broad Street/US 250-West. Proceed 0.8 miles to make a U-turn at Bethlehem Road. Proceed 430 feet to the Baymont Inn, 0.3 miles then right on Bynum Road to the Best Western.

From the West on I-64: Travel along I-64 Eastbound to Exit 183. For the Crowne Plaza and Westin Hotel, exit onto West Broad Street/US 250 East. Proceed 0.2 miles to the Westin, 0.5 miles to the Crowne Plaza. For the Marriott, exit onto West Broad Street / US 250 East. Proceed 1.4 miles to make a U-turn at W. Club Lane. Proceed 0.3 miles to the Marriott. For the Best Western and Baymont Inn, exit onto West Broad Street/US 250 East. At the first stoplight (Forest Avenue) make a U-turn. Proceed west on US-250 0.9 miles to make a U-turn at Bethlehem Road. Proceed 430 feet to the Baymont Inn, 0.3 miles then right on Bynum Road to the Best Western.

From the Staples Mill Road Amtrak Station: Exit the station by turning left onto Staples Mill Road (US-33 South). Take the 2nd right onto Glenside Drive. After 1.3 miles, Glenside intersects West Broad Street. For the Crowne Plaza and Westin Hotel, turn left onto West Broad Street / US 250 East. Proceed 0.4 miles to the Westin, 0.7 miles to the Crowne Plaza. For the Marriott, turn left onto West Broad Street / US 250 East. Proceed 1.1 miles to make a U-turn at W. Club Lane. Proceed 0.3 miles to the Marriott. For the Best Western and Baymont Inn, turn right onto West Broad Street / US 250 West. Proceed 0.4 miles to make a U-turn at Bethlehem Road. Proceed 430 feet to the Baymont Inn, 0.3 miles then right on Bynum Road to the Best Western.

Note: For those who will be driving, the intersection of Broad and Glenside is a central location for conference hotels and restaurants: 7000 West Broad and 5400 Glenside Drive. Heading west on West Broad Street takes you from lower numbered addresses to higher, with even numbered addresses on your right.

Local Information and Parking

Information about the University of Richmond Math and Computer Science Department may be found at http://mathcs.richmond.edu/. Please watch the website available through http://www.ams.org/meetings/sectional/sectional.html for information on parking close to the meeting site on campus. A great campus map is found at http://www.richmond.edu/visit/maps/index.html.

Other Activities

Book Sales: Stop by the on-site AMS bookstore and review the newest titles from the AMS, enjoy up to 25% off all AMS publications, or take home an AMS t-shirt! 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.

Registration and Meeting Information

Invited Addresses, other sessions, registration, and the AMS Book Exhibit will be held on campus in locations to be announced. The registration desk will be open Saturday, November 6, 7:30 a.m.–4:00 p.m., and Sunday, November 7, 8:00 a.m.–noon. Fees are US$50 for AMS members, US$70 for nonmembers; and US$5 for students, unemployed mathematicians, and emeritus members. Fees are payable on-site by cash, check, or credit card.

Travel to Campus

Richmond International Airport (RIC) is located seven miles northeast of the city of Richmond and approximately twelve miles from campus; the approximate taxi fare is US$40. Van service is available through Groome Transportation for $US31.75; you must make a reservation at 800-552-7911 (lower prices are available if there is more than one person making the trip).

From the North

From I-95 South: Take Exit 79. Stay to the left to merge onto I-195 S, the Downtown Expressway. Continue on I-195 S for approximately two miles. Take the Cary St./VA-147 exit. Bear right on the ramp and turn right onto Cary Street. Continue straight on Cary for approximately two miles and pass through the intersection at Three Chopt Road. At the bottom of the hill, bear right at the intersection onto westbound River Road. Continue straight for approximately .75 miles and make the second right onto College Road. Continue for approximately one mile, going past Westhampton Lake and the Robins Center arena. Turn right at the University of Richmond sign onto Campus Drive. Make the first right into the Gateway Entrance of campus.

From the South

I-85 to/or I-95 North: Take Exit 79. Stay to the left to merge onto I-195 S, the Downtown Expressway. Continue on I-195 S for approximately two miles. Take the Cary St./VA-147 exit. Bear right on the ramp and turn right onto Cary Street. Continue straight on Cary for approximately two miles and pass through the intersection at Three Chopt Road. At the bottom of the hill, bear right at the intersection onto westbound River Road. Continue straight for approximately .75 miles and make the second right onto College Road. Continue for approximately one mile, going past Westhampton Lake and the Robins Center arena. Turn right at the University of Richmond sign onto Campus Drive. Make the first right into the Gateway Entrance of campus.

From the East (including Richmond International Airport)

From I-64 West: Merge onto I-95 N toward Washington. Take Exit 79. Stay to the left to merge onto I-195 S, the Downtown Expressway. Continue on I-195 S for approximately two miles. Take the Cary St./VA-147 exit. Bear right on the ramp to turn right onto Cary Street. Continue straight on Cary for approximately two miles and pass the intersection of Three Chopt Road. At the bottom of the hill, bear right at the intersection onto River Road. Continue straight for approximately .75 miles and make the second right onto College Road. Continue straight for approximately one mile, going past the lake and the Robins Center arena. Turn right at the University of Richmond sign onto Campus Drive. Make the first right into the Gateway Entrance of campus.

From the West

From I-64 East: Take Exit 183/Glenside Drive south. Continue south on Glenside Drive to the fourth traffic light (Three Chopt Road). Turn left on Three Chopt Road. Continue through the intersection at Patterson Avenue. Continue straight for .5 miles. Turn right onto Boatwright Drive. At the bottom of the hill, make a left onto Campus Drive. Make the first right into the Gateway Entrance of campus.

From US 60 (Midlothian Turnpike) East:

Turn left on State Route 147 (Huguenot Road) and continue approximately 7 miles and cross the Huguenot Bridge over the James River. At the next traffic light, take a hard left onto westbound River Road. Continue straight for approximately .75 miles and make the second right onto College Road. Continue for approximately one mile, going past Westhampton Lake and the Robins Center arena. Turn right at the University of Richmond sign onto Campus Drive. Make the first right into the Gateway Entrance of campus.

Car Rental

Avis Rent A Car is the official car rental company for the meeting. Depending on variables such as location, length of rental, and size of vehicle, Avis will offer participants the best available rate which can range from 5–25% discount off regular rates. Participants must use the assigned **Meeting Avis Discount Number (J098887)** and meet Avis rate requirements to receive the discount. (Rate discounts are available at all corporate and participating licensee locations.) The best rates are available by calling 800-331-1600 or online at `www.avis.com/AvisWeb/reservation/ReservationsInitializer?AWD_NUMBER=J098887`.

All car rentals include unlimited free mileage and are available to renters 25 years and older. Renters must also meet Avis's driver and credit requirements. Return to the same rental location or additional surcharges may apply. Rates do not include any state or local surcharges, tax, optional coverages, or gas refueling charges.

Weather

Early November temperatures range from the low 40's at night to the low 60's during the day. It rains an average of eight days during the month of November. For-up-to-the-minute weather please visit `http://www.weather.com/weather/today/23173`.

Information for International Participants

Visa regulations are continually changing for travel to the United States. Visa applications may take from three to four months to process and require a personal interview, as well as specific personal information. International participants should view the important information about traveling to the U.S. found at `http://sites.nationalacademies.org/pga/biso/visas/` and `http://travel.state.gov/visa/visa_1750.html`. If you need a preliminary conference invitation in order to secure a visa, please send your request to `dls@ams.org`.

If you discover you do need a visa, the National Academies website (see above) provides these tips for successful visa applications:

* Visa applicants are expected to provide evidence that they are intending to return to their country of residence. Therefore, applicants should provide proof of "binding" or sufficient ties to their home country or permanent

residence abroad. This may include documentation of the following:

- family ties in home country or country of legal permanent residence
- property ownership
- bank accounts
- employment contract or statement from employer stating that the position will continue when the employee returns;

* Visa applications are more likely to be successful if done in a visitor's home country than in a third country;

* Applicants should present their entire trip itinerary, including travel to any countries other than the United States, at the time of their visa application;

* Include a letter of invitation from the meeting organizer or the U.S. host, specifying the subject, location and dates of the activity, and how travel and local expenses will be covered;

* If travel plans will depend on early approval of the visa application, specify this at the time of the application;

* Provide proof of professional scientific and/or educational status (students should provide a university transcript).

This list is not to be considered complete. Please visit the websites above for the most up-to-date

Pucón, Chile

December 15–18, 2010

Wednesday – Saturday

Meeting #1066

First Joint International Meeting between the AMS and the Sociedad de Matematica de Chile.
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: August 2010
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: To be announced
For abstracts: To be announced

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/internmtgs.html`.

AMS Invited Addresses

Ricardo Baeza, Universidad de Talca, Chile, *p-cohomological dimension of fields of characteristic p*.

Igor Dolgachev, University of Michigan, *Cremona groups and their subgroups*.

Andres Navas, Universidad de Santiago de Chile, *Probabilistic, dynamical and topological aspects of orderable groups*.

Rodolfo Rodriguez, Universidad de Concepcion, *Numerical solution of time-domain electromagnetic problems arising from some metallurgical processes*.

Gunther Uhlmann, University of Washington, *Inside-out: Inverse problems*.

S. R. Srinivasa Varadhan, New York University, *Large deviations*.

AMS Special Sessions

Algebra and Model Theory, **Thomas Scanlon**, University of California, Berkeley, **Xavier Vidaux**, Universidad de Concepcion, **Charles Steinhorn**, Vassar College, and **Alf Onshuus**, Universidad de los Andes, Columbia.

Algebraic Modeling of Knotted Objects, **Vaughan F. R. Jones**, University of California, Berkeley, **Jesús Juyumaya**, Universidad de Valparaìso, **Louis H. Kauffman**, University of Illinois at Chicago, and **Sofia Lambropoulou**, National Technical University of Athens.

Applications of Differential and Difference Equations in Biology and Ecology, **J. Robert Buchanan**, Millersville University, **Fernando Córdova**, Universidad Católica de Maule, and **Jorge Velasco Hernandez**, Institute Nacional de Petroleo.

Arithmetic of Quadratic Forms and Integral Lattices, **Maria Ines Icaza**, Universidad de Talca, Chile, **Wai Kiu Chan**, Wesleyan University, and **Ricardo Baeza**, Universidad de Talca, Chile.

Automorphic Forms and Dirichlet Series, **Yves Martin**, Universidad de Chile, Chile, and **Solomon Friedberg**, Boston College.

Complex Algebraic Geometry, **Giancarlo Urzua** and **Eduardo Cattani**, University of Massachusetts.

Foliations and Dynamics, **Andrés Navas**, Universidad de Santiago de Chile, and **Steve Hurder**, University of Illinois at Chicago.

Group Actions: Probability and Dynamics, **Andrés Navas**, Universidad de Santiago de Chile, and **Rostislav Grigorchuk**, University of Texas.

Inverse Problems and PDE Control, **Matias Courdurier**, Pontificia Universidad Católica de Chile, **Axel Osses**, Universidad de Chile, and **Gunther Uhlmann**, University of Washington.

Non-Associative Algebras, **Alicia Labra**, Universidad de Chile, and **Kevin McCrimmon**, University of Virginia.

Probability and Mathematical Physics, **Hui-Hsiung Kuo**, Louisiana State University, and **Rolando Rebolledo**, Pontificia Universidad Católica de Chile.

Representation Theory, **Jorge Soto Andrade**, Universidad de Chile, and **Philip Kutzko**, University of Iowa.

Spectral Theory and Mathematical Physics, **Bruno Nachtergaele**, University of California, Davis, and **Rafael Tiedra**, Pontificia Universidad Católica de Chile.

New Orleans, Louisiana

New Orleans Marriott and Sheraton New Orleans Hotel

January 6–9, 2011
Thursday – Sunday

Note: Change in Dates!!

Meeting #1067

Joint Mathematics Meetings, including the 117th Annual Meeting of the AMS, 94th 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), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: October 2010
Program first available on AMS website: November 1, 2010
Program issue of electronic *Notices*: January 2011
Issue of *Abstracts*: Volume 32, Issue 1

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: September 22, 2010

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/national.html`.

Joint Invited Addresses

Robert J. Lang, Robert J. Lang Origami, *From flapping birds to space telescopes: The mathematics of origami* (AMS-MAA-SIAM Gerald and Judith Porter Public Lecture).

Kannan Soundararajan, Stanford University, *To be announced* (AMS-MAA Invited Address).

Chuu-Lian Terng, University of California Irvine, *Title to be announced* (AMS-MAA Invited Address).

AMS Invited Addresses

Denis Auroux, University of California Berkeley, *Title to be announced*.

Andrea L. Bertozzi, University of California Los Angeles, *Title to be announced*.

Alexander Lubotzky, The Hebrew University of Jerusalem, *Expander graphs in pure and applied mathematics,* (AMS Colloquium Lectures).

George Papanicolaou, Stanford University, *Title to be announced* (AMS Josiah Willard Gibbs Lecture).

Scott Sheffield, Massachusetts Institute of Technology, *Title to be announced*.

Tatiana Toro, University of Washington, *Title to be announced*.

Akshay Venkatesh, Stanford University, *Title to be announced*.

AMS Special Sessions

Some sessions are cosponsored with other organizations. These are noted within the parentheses at the end of each listing, where applicable.

Analysis of Reaction-Diffusion Models (Code: SS 31A), **Junping Shi**, College of William and Mary, and **Xuefeng Wang**, Tulane University.

Analytic and Geometric Methods in Representation Theory (Code: SS 38A), **Leticia Barchini**, Oklahoma State University, and **Hongyu He**, Louisiana State University.

Applications of Stochastic Processes in Neuroscience (Code: SS 21A), **Peter Thomas**, Case Western Reserve University, **Kreso Josic**, University of Houston, and **Carson C. Chow**, Institutes of Health (AMS-SIAM).

Applied Optimization and Douglas-Rachford Splitting Methods for Convex Programming (Code: SS 15A), **Ram U. Verma**, Seminole State College of Florida.

Asymptotic Methods in Analysis with Applications (Code: SS 10A), **Diego Dominici**, State University of New York at New Paltz, and **Peter A. McCoy**, U.S. Naval Academy.

Boundary Control and Moving Interface in Coupled Systems of Partial Differential Equations (Code: SS 53A), **Lorena Bociu**, University of Nebraska-Lincoln, and **Jean-Paul Zolesio**, CNRS-INLN and INRIA, Sophia Antipolis, France.

Centers for Teaching/Education/Outreach in Departments of Mathematics (Code: SS 14A), **Michael E. Mays**, West Virginia University (AMS-MAA).

Combinatorial Algebraic Geometry (Code: SS 42A), **Frank Sottile**, Texas A&M University, and **Alexander T. Yong**, University of Illinois, Urbana-Champaign.

Completely Integrable Systems, Random Matrices, and the Bispectral Problem (Code: SS 28A), **Bojko Bakalov**, North Carolina State University, **Michael Gekhtman**, University of Notre Dame, **Plamen Iliev**, Georgia Institute of Technology, and **Milen T. Yakimov**, Louisiana State University.

Computational Algebraic and Analytic Geometry for Low-Dimensional Varieties (Code: SS 47A), **Mika K. Seppala**, Florida State University, **Tanush Shaskas**, Oakland University, and **Emil Volcheck**, National Security Agency.

Continued Fractions (Code: SS 40A), **James G. McLaughlin**, West Chester University, and **Nancy J. Wyshinski**, Trinity College.

Control and Inverse Problems for Partial Differential Equations (Code: SS 33A), **Ana-Maria Croicu** and **Michele L. Joyner**, Kennesaw State University (AMS-SIAM).

Difference Equations and Applications (Code: SS 6A), **Michael A. Radin**, Rochester Institute of Technology.

Dirac Operators (Code: SS 61A), **Craig A. Nolder**, Florida State University, and **John Ryan**, University of Arkansas.

Expander Graphs in Pure and Applied Mathematics (Code: SS 66A), **Alireza Salehi Golsefidy**, Princeton University, and **Alexander Lubotzky**, Hebrew University of Jerusalem.

Formal Mathematics for Mathematicians: Developing Large Repositories of Advanced Mathematics (Code: SS

12A), **Krystyna M. Kuperberg**, Auburn University, and **Andrzej Trybulec**, **Artur Kornilowicz**, and **Adam Naumowicz**, University of Bialystok.

Geometric Group Theory (Code: SS 46A), **Joshua B. Barnard**, University of South Alabama, and **Pallavi Dani**, Louisiana State University.

Global Dynamics of Discrete Dynamical Systems in the Plane with Applications (Code: SS 56A), **M. R. S. Kulenovic** and **Orlando Merino**, University of Rhode Island.

Groups, Geometry, and Applications (Code: SS 7A), **Delaram Kahrobaei**, City University of New York.

Harmonic Analysis and Partial Differential Equations (Code: SS 65A), **Svitlana Mayboroda**, Purdue University, and **Tatiana Toro**, University of Washington.

History of Mathematics (Code: SS 37A), **Sloan E. Despeaux**, Western Carolina University, **Craig G. Fraser**, University of Toronto, and **Deborah Kent**, Hillsdale College (AMS-MAA).

Hopf Algebras and Their Representations (Code: SS 4A), **M. Susan Montgomery**, University of Southern California, **Siu-Hung Ng**, Iowa State University, and **Sarah J. Witherspoon**, Texas A&M University (AMS-AWM).

Integral Geometry: Analysis and Applications (Code: SS 20A), **Gaik Ambartsoumian**, University of Texas, Arlington, **Gestur Olafsson**, Louisiana State University, **Eric Todd Quinto**, Tufts University, and **Boris S. Rubin**, Louisiana State University.

Interactions of Inverse Problems, Signal Processing, and Imaging (Code: SS 54A), **Zuhair Nashed**, University of Central Florida.

Knot Theory (Code: SS 63A), **Tim D. Cochran** and **Shelley Harvey**, Rice University.

Knots, Links, 3-Manifolds, and Physics (Code: SS 44A), **Robert Kusner**, University of Massachusetts, Amherst, and **Rafal Komendarczyk**, Tulane University.

Lie Algebras, Algebraic Groups, and Related Topics (Code: SS 23A), **Audrey L. Malagon** and **Julie C. Beier**, Mercer University, and **Daniel K. Nakano**, University of Georgia.

Local Commutative Algebra (Code: SS 5A), **Paul C. Roberts** and **Anurag K. Singh**, University of Utah, and **Sandra M. Spiroff**, University of Mississippi.

Logic and Analysis (Code: SS 36A), **Jeremy Avigad**, Carnegie Mellon University, **Ulrich W. Kohlenbach**, Technische Universität Darmstadt, and **Henry Towsner**, University of California Los Angeles (AMS-ASL).

Mathematical Modeling in Environmental Economics (Code: SS 49A), **Natali Hritonenko**, Prairie View A&M University, and **Yuri Yatsenko**, Houston Baptist University.

Mathematical Techniques in Musical Analysis (Code: SS 19A), **Robert W. Peck**, Louisiana State University, and **Thomas M. Fiore**, University of Michigan at Dearborn.

Mathematics Related to Feynman Diagrams (Code: SS 25A), **Victor H. Moll**, Tulane University, and **Olivier Espinosa**, Universidad Santa Maria, Valparaiso.

Mathematics and Education Reform (Code: SS 39A), **William H. Barker**, Bowdoin College, **William G. McCallum**, University of Arizona, and **Bonnie S. Saunders**, University of Illinois at Chicago (AMS-MAA-MER).

Mathematics of Computation: Algebra and Number Theory (Code: SS 11A), **Gregor Kemper**, Technische Universität München, **Michael J. Mossinghoff**, Davidson College, and **Igor E. Shparlinski**, Macquarie University (AMS-SIAM).

Mathematics of Computation: Differential Equations, Linear Algebra, and Applications (Code: SS 52A), **Susanne C. Brenner**, Louisiana State University, and **Chi-Wang Shu**, Brown University (AMS-SIAM).

The Mathematics of Modeling Multiscale Heterogeneous Media (Code: SS 51A), **Robert P. Lipton** and **Tadele A. Mengesha**, Louisiana State University.

Measures of Entanglement of Macromolecules and Their Applications (Code: SS 57A), **Isabel K. Darcy**, University of Iowa, **Kenneth C. Millett**, University of California, Santa Barbara, **Eric J. Rawdon**, University of St. Thomas, and **Mariel Vazquez**, San Francisco State University.

Multivariable Operator Theory (Code: SS 13A), **Ronald G. Douglas**, Texas A&M University, and **Gelu F. Popescu**, University of Texas at San Antonio.

New Topics in Graph Theory (Code: SS 9A), **Ralucca Gera**, Naval Postgraduate School, and **Eunjeong Yi**, Texas A&M University at Galveston.

New Trends in Theory and Applications of Evolution Equations (Code: SS 34A), **Guoping Zhang** and **Gaston N'Guerekata**, Morgan State University, **Wen-Xie Ma**, University of South Florida, and **Yi Li**, University of Iowa.

Noncommutative Harmonic Analysis and Dynamic Systems (Code: SS 41A), **Tao Mei**, University of Illinois, Urbana-Champaign, and **Alan D. Wiggins**, University of Michigan at Dearborn.

Nonlinear Evolution Equations, Analysis, and Geometry (Code: SS 43A), **Ralph Saxton**, University of New Orleans, and **Feride Tiglay**, Ecole Polytechnique Fédérale de Lausanne.

Nonlinear Waves and Integrable Systems (Code: SS 55A), **Gino Biondini**, State University of New York at Buffalo, and **Barbara Prinari**, University of Colorado at Colorado Springs. (AMS-SIAM)

Quadratic Forms in Algebra and Geometry (Code: SS 16A), **Jorge F. Morales**, Louisiana State University, and **Anne Queguiner-Mathieu**, Université de Paris 13.

Research in Mathematics by Undergraduates and Students in Post-Baccalaureate Programs (Code: SS 22A), **Darren A. Narayan**, **Bernard Brooks**, and **Jobby Jacob**, Rochester Institute of Technology, and **Jacqueline A. Jensen**, Sam Houston State University (AMS-MAA-SIAM).

Self-Organization in Human, Biological, and Artificial Systems (Code: SS 64A), **Andrea L. Bertozzi**, University of California Los Angeles.

Set-Valued Optimization and Variational Problems (Code: SS 62A), **Akhtar A. Khan**, Rochester Institute of Technology, and **Miguel Sama**, Universidad Nacional de Educacion a Distancia, Madrid.

Stochastic Analysis and Mathematical Physics: A Session in Honor of the 80th Birthday of Len Gross (Code: SS 18A), **Bruce K. Driver**, University of California at San Diego, **Maria Gordina**, University of Connecticut, and **Todd Kemp**, Massachusetts Institute of Technology and University of California at San Diego.

Stochastic Analysis and Random Phenomena (Code: SS 29A), **Ambar N. Sengupta** and **P. Sundar**, Louisiana State University.

Stochastic, Fractional, and Hybrid Dynamic Systems with Applications (Code: SS 17A), **A. S. Vatsala**, University of Louisiana at Lafayette, and **G. S. Ladde**, University of South Florida.

Structure Theory for Matroids and Graphs (Code: SS 45A), **Bogdan Oporowski** and **James G. Oxley**, Louisiana State University.

Structured Models in Ecology, Evolution, and Epidemiology (Code: SS 50A), **Linda J. S. Allen** and **Lih-Ing W. Roeger**, Texas Tech University.

Structured Models in Ecology, Evolution, and Epidemiology: Periodicity, Extinction, and Chaos (Code: SS 59A), **Linda J. S. Allen** and **Lih-Ing W. Roeger**, Texas Tech University.

Theory and Application of Stochastic Differential Equations and Stochastic Partial Differential Equations (Code: SS 27A), **Armando Arciniega**, University of Texas at San Antonio, **Edward J. Allen**, Texas Tech University, **Sivapragasam Sathananthan**, Tennessee State University, and **Mahmoud Anabtawi**, American University of Sharjah.

Time Scales: Theory and Applications (Code: SS 8A), **Billy Jackson**, University of Northern Colorado, and **Joan Hoffacker**, Clemson University.

Transseries and Ordered Exponential Fields (Code: SS 32A), **Gerald A. Edgar** and **Ovidiu Costin**, The Ohio State University, and **Lou P. van den Dries**, University of Illinois, Urbana-Champaign.

von Neumann Algebras (Code: SS 48A), **Richard D. Burstein**, Vanderbilt University, and **Remus Nicoara**, University of Tennessee, Knoxville.

Wavelets, Tilings, and Iterated Function Systems (Code: SS 26A), **Palle E. Jorgensen**, University of Iowa, **David R. Larson**, Texas A&M University, and **Gestur Olafsson**, Louisiana State University.

Statesboro, Georgia

Georgia Southern University

March 12–13, 2011

Saturday – Sunday

Meeting #1068

Southeastern Section
Associate secretary: Matthew Miller
Announcement issue of *Notices*: January 2011
Program first available on AMS website: January 27, 2011
Program issue of electronic *Notices*: March 2011
Issue of *Abstracts*: To be announced

Deadlines

For organizers: August 12, 2010
For consideration of contributed papers in Special Sessions: November 23, 2010
For abstracts: January 20, 2011

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Jason A. Behrstock, Lehman College (CUNY), *Title to be announced.*

Gordana Matic, University of Georgia, *Title to be announced.*

Jeremy T. Tyson, University of Illinois at Urbana-Champaign, *Title to be announced.*

Brett D. Wick, Georgia Institute of Technology, *Title to be announced.*

Special Sessions

Advances in Biomedical Mathematics (Code: SS 4A), **Yangbo Ye**, University of Iowa, and **Jiehua Zhu**, Georgia Southern University.

Applied Combinatorics (Code: SS 2A), **Hua Wang**, Georgia Southern University, **Miklos Bona**, University of Florida, and **Laszlo Szekely**, University of South Carolina.

Categorical Topology (Code: SS 9A), **Frederic Mynard**, Georgia Southern University, and **Gavin Seal**, EPFL, Lausanne.

Fractals and Tilings (Code: SS 3A), **Ka-Sing Lau**, The Chinese University of Hong Kong, **Sze-Man Ngai**, Georgia Southern University, and **Yang Wang**, Michigan State University.

Geometric Group Theory (Code: SS 7A), **Xiangdong Xie**, Georgia Southern University, **Jason A. Behrstock**, Lehman College, CUNY, and **Denis Osin**, Vanderbilt University.

Geometric Mapping Theory in Euclidean and Non-Euclidean Spaces (Code: SS 11A), **Jeremy Tyson**, University of Illinois at Urbana-Champaign, **David A. Herron**, University of Cincinnati, and **Xiagdong Xie**, Georgia Southern University.

Harmonic Analysis and Applications (Code: SS 5A), **Dmitriy Bilyk**, University of South Carolina, **Laura De Carli**, Florida International University, **Alex Stokolos**, Georgia Southern University, and **Brett Wick**, Georgia Institute of Technology.

Harmonic Analysis and Partial Differential Equations (Code: SS 1A), **Paul A. Hagelstein**, Baylor University, **Alexander Stokolos**, Georgia Southern University, **Xiaoyi Zhang**, IAS Princeton and University of Iowa, and **Shijun Zheng**, Georgia Southern University.

Homological Methods in Commutative Algebra (Code: SS 6A), **Alina C. Iacob**, Georgia Southern University, and **Adela N. Vraciu**, University of South Carolina.

Matrix Theory and Numerical Linear Algebra (Code: SS 8A), **Richard S. Varga**, Kent State University, and **Xiezhang Li**, Georgia Southern University.

Sparse Data Representations and Applications (Code: SS 10A), **Alexander Petukhov** and **Alex Stokolos**, Georgia Southern University, **Ahmed Zayed**, DePaul University, and **Inna Kozlov**, Holon Institute of Technology, Department of Computer Science.

Symplectic and Poisson Geometry (Code: SS 12A), **Yi Lin**, Georgia Southern University, **Alvaro Pelayo**, Washington

University, St. Louis, and **Francois Ziegler**, Georgia Southern University.

Iowa City, Iowa

University of Iowa

March 18–20, 2011

Friday – Sunday

Meeting #1069

Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: January 2011
Program first available on AMS website: February 5, 2011
Program issue of electronic *Notices*: March 2011
Issue of *Abstracts*: To be announced

Deadlines

For organizers: August 18, 2010
For consideration of contributed papers in Special Sessions: November 30, 2010
For abstracts: January 25, 2011

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Mihai Ciucu, Indiana University, *Title to be announced.*

David Damanik, Rice University, *Title to be announced.*

Kevin Ford, University of Illinois Urbana-Champaign, *Title to be announced.*

Chiu-Chu Liu, Columbia University, *Title to be announced.*

Special Sessions

Analytic Number Theory (Code: SS 5A), **Yangbo Ye**, University of Iowa.

Commutative Ring Theory (Code: SS 6A), **Daniel D. Anderson**, University of Iowa, and **David F. Anderson**, University of Tennessee Knoxville.

Geometric Commutative Algebra and Applications (Code: SS 7A), **David Anderson**, University of Washington, and **Julianna Tymoczko**, University of Iowa.

Global and P-adic Representation Theory (Code: SS 3A), **Muthukrishnan Krishnamurthy**, **Philip Kutzco**, and **Yangbo Ye**, University of Iowa.

Modelling, Analysis and Simulation in Contact Mechanics (Code: SS 1A), **Weimin Han**, University of Iowa, and **Mircea Sofonea**, University of Perpignan.

Recent Developments in Nonlinear Evolution Equations (Code: SS 4A), **Yinbin Deng**, Central China Normal University, **Yong Yu** and **Yi Li**, University of Iowa, and **Shuangjie Peng**, Central China Normal University.

Representations of Algebras (Code: SS 2A), **Frauke Bleher**, University of Iowa, and **Calin Chindris**, University of Missouri.

Worcester, Massachusetts

College of the Holy Cross

April 9–10, 2011

Saturday – Sunday

Meeting #1070

Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: February 2011
Program first available on AMS website: March 10, 2011
Program issue of electronic *Notices*: April 2011
Issue of *Abstracts*: To be announced

Deadlines

For organizers: September 9, 2010
For consideration of contributed papers in Special Sessions: December 21, 2010
For abstracts: February 15, 2011

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Vitaly Bergelson, Ohio State University, *Title to be announced.*

Kenneth M. Golden, University of Utah, *Title to be announced.*

Walter D. Neumann, Columbia University, *Title to be announced.*

Natasa Sesum, University of Pennsylvania, *Title to be announced.*

Special Sessions

Complex Analysis and Banach Algebras (Code: SS 1A), **John T. Anderson**, College of the Holy Cross, and **Alexander J. Izzo**, Bowling Green State University.

Las Vegas, Nevada

University of Nevada

April 30 – May 1, 2011

Saturday – Sunday

Meeting #1071

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: February 2011
Program first available on AMS website: March 17, 2011
Program issue of electronic *Notices*: April 2011
Issue of *Abstracts*: To be announced

Deadlines

For organizers: September 30, 2010
For consideration of contributed papers in Special Sessions: January 1, 2011
For abstracts: March 8, 2011

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Elizabeth Allman, University of Alaska, *Title to be announced.*

Danny Calegari, University of California Santa Barbara, *Title to be announced.*

Hector Ceniceros, Stanford University, *Title to be announced.*

Tai-Ping Liu, Stanford University, *Title to be announced.*

Special Sessions

Advances in Modeling, Numerical Analysis and Computations of Fluid Flow Problems (Code: SS 2A), **Monika Neda**, University of Nevada Las Vegas.

Geometric PDEs (Code: SS 1A), **Matthew Gursky**, Notre Dame University, and **Emmanuel Hebey**, Université de Cergy-Pontoise.

Multilevel Mesh Adaptation and Beyond: Computational Methods for Solving Complex Systems (Code: SS 4A), **Pengtao Sun**, University of Nevada Las Vegas, and **Long Chen**, University of California Irvine.

Partial Differential Equations Modeling Fluids (Code: SS 5A), **Quansen Jiu**, Capital Normal University, Beijing, China, and **Jiahong Wu**, Oklahoma State University.

Recent Advances in Finite Element Methods (Code: SS 3A), **Jichun Li**, University of Nevada Las Vegas.

Ithaca, New York

Cornell University

September 10–11, 2011

Saturday – Sunday

Meeting #1072

Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: June 2011
Program first available on AMS website: July 28, 2011
Program issue of electronic *Notices*: September 2011
Issue of *Abstracts*: To be announced

Deadlines

For organizers: February 10, 2011
For consideration of contributed papers in Special Sessions: May 24, 2011
For abstracts: July 19, 2011

Winston-Salem, North Carolina

Wake Forest University

September 24–25, 2011

Saturday – Sunday

Meeting #1073

Southeastern Section
Associate secretary: Matthew Miller
Announcement issue of *Notices*: June 2011
Program first available on AMS website: August 11, 2011
Program issue of electronic *Notices*: September 2011
Issue of *Abstracts*: To be announced

Deadlines

For organizers: February 24, 2011
For consideration of contributed papers in Special Sessions: June 7, 2011
For abstracts: August 2, 2011

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Benjamin B. Brubaker, Massachusetts Institute of Technology, *Title to be announced.*

Shelly Harvey, Rice University, *Title to be announced.*

Allen Knutson, Cornell University, *Title to be announced.*

Seth M. Sullivant, North Carolina State University, *Title to be announced.*

Lincoln, Nebraska

University of Nebraska-Lincoln

October 14–16, 2011

Friday – Sunday

Meeting #1074

Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: August 2011
Program first available on AMS website: September 1, 2011
Program issue of electronic *Notices*: October 2011
Issue of *Abstracts*: To be announced

Deadlines

For organizers: March 14, 2011
For consideration of contributed papers in Special Sessions: June 28, 2011
For abstracts: August 23, 2011

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Lewis Bowen, Texas A&M University, *Title to be announced.*

Emmanuel Candes, Stanford University, *Title to be announced* (Erdős Memorial Lecture).

Alina Cojocaru, University of Illinois at Chicago, *Title to be announced.*

Michael Zieve, University of Michigan, *Title to be announced.*

Salt Lake City, Utah

University of Utah

October 22–23, 2011

Saturday – Sunday

Meeting #1075

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: August 2011
Program first available on AMS website: September 8, 2011
Program issue of electronic *Notices*: October 2011
Issue of *Abstracts*: To be announced

Deadlines

For organizers: March 22, 2011
For consideration of contributed papers in Special Sessions: July 5, 2011
For abstracts: August 30, 2011

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Graeme Milton, University of Utah, *Title to be announced.*

Lei Ni, University of California San Diego, *Title to be announced.*

Igor Pak, University of California Los Angeles, *Title to be announced.*

Monica Visan, University of California Los Angeles, *Title to be announced.*

Port Elizabeth, Republic of South Africa

Nelson Mandela Metropolitan University

November 29 – December 3, 2011

Tuesday – Saturday

Meeting #1076

First Joint International Meeting between the AMS and the South African Mathematical Society.
Associate secretary: Matthew Miller
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

Boston, Massachusetts

John B. Hynes Veterans Memorial Convention Center, Boston Marriott Hotel, and Boston Sheraton Hotel

January 4–7, 2012

Wednesday – Saturday
Joint Mathematics Meetings, including the 118th Annual Meeting of the AMS, 95th 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), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: October 2011
Program first available on AMS website: November 1, 2011
Program issue of electronic *Notices*: January 2012
Issue of *Abstracts*: Volume 33, Issue 1

Deadlines

For organizers: April 1, 2011
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Honolulu, Hawaii

University of Hawaii

March 3–4, 2012

Saturday – Sunday
Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: March 2012
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 3, 2011
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Tampa, Florida

University of South Florida

March 10–11, 2012

Saturday – Sunday
Southeastern Section
Associate secretary: Matthew Miller
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: March 2012
Issue of *Abstracts*: To be announced

Deadlines

For organizers: August 10, 2011
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Washington, District of Columbia

George Washington University

March 17–18, 2012

Saturday – Sunday
Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: March 2012
Issue of *Abstracts*: To be announced

Deadlines

For organizers: August 17, 2011
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Lawrence, Kansas

University of Kansas

March 30 – April 1, 2012

Friday – Sunday
Central Section
Associate secretary: Georgia Benkart
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

San Diego, California

San Diego Convention Center and San Diego Marriott Hotel and Marina

January 9–12, 2013

Wednesday – Saturday
Joint Mathematics Meetings, including the 119th Annual Meeting of the AMS, 96th 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), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: October 2012
Program first available on AMS website: November 1, 2012
Program issue of electronic *Notices*: January 2012
Issue of *Abstracts*: Volume 34, Issue 1

Deadlines

For organizers: April 1, 2012
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Alba Iulia, Romania

June 27–30, 2013

Thursday – Sunday
Associate secretary: Robert J. Daverman
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: To be announced
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Baltimore, Maryland

Baltimore Convention Center, Baltimore Hilton, and Marriott Inner Harbor

January 15–18, 2014

Wednesday – Saturday
Joint Mathematics Meetings, including the 120th Annual Meeting of the AMS, 97th 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, with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Matthew Miller
Announcement issue of *Notices*: October 2013
Program first available on AMS website: November 1, 2013
Program issue of electronic *Notices*: January 2013
Issue of *Abstracts*: Volume 35, Issue 1

Deadlines

For organizers: April 1, 2013
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

San Antonio, Texas

Henry B. Gonzalez Convention Center and Grand Hyatt San Antonio

January 10–13, 2015

Saturday – Tuesday
Joint Mathematics Meetings, including the 121st Annual Meeting of the AMS, 98th 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 of Symbolic Logic, with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: October 2014
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: January 2015
Issue of *Abstracts*: Volume 36, Issue 1

Deadlines

For organizers: April 1, 2014
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Seattle, Washington

Washington State Convention & Trade Center and the Sheraton Seattle Hotel

January 6–9, 2016

Wednesday – Saturday
Joint Mathematics Meetings, including the 122nd Annual Meeting of the AMS, 99th 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 of Symbolic Logic, with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: October 2015
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: January 2016
Issue of *Abstracts*: Volume 37, Issue 1

Deadlines

For organizers: April 1, 2015
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Atlanta, Georgia

Hyatt Regency Atlanta and Marriott Atlanta Marquis

January 4–7, 2017

Wednesday – Saturday
Joint Mathematics Meetings, including the 123rd Annual Meeting of the AMS, 100th 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 of Symbolic Logic, with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: October 2016
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: January 2017
Issue of *Abstracts*: Volume 38, Issue 1

Deadlines

For organizers: April 1, 2016
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Meetings and Conferences of the AMS

Associate Secretaries of the AMS

Western Section: Michel L. Lapidus, Department of Mathematics, University of California, Surge Bldg., Riverside, CA 92521-0135; e-mail: lapidus@math.ucr.edu; telephone: 951-827-5910.

Central Section: **Georgia Benkart**, University of Wisconsin-Madison, Department of Mathematics, 480 Lincoln Drive, Madison, WI 53706-1388; e-mail: benkart@math.wisc.edu; telephone: 608-263-4283.

Eastern Section: **Steven H. Weintraub**, Department of Mathematics, Lehigh University, Bethlehem, PA 18105-3174; e-mail: steve.weintraub@lehigh.edu; telephone: 610-758-3717.

Southeastern Section: **Matthew Miller,** Department of Mathematics, University of South Carolina, Columbia, SC 29208-0001, e-mail: miller@math.sc.edu; telephone: 803-777-3690.

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 can be found at** www.ams.org/meetings/.

Meetings:

2010

October 2–3	Syracuse, New York	p. 1054
October 9–10	Los Angeles, California	p. 1055
November 5–7	Notre Dame, Indiana	p. 1056
November 6–7	Richmond, Virginia	p. 1058
December 15–18	Pucon, Chile	p. 1062

2011

January 5–8	New Orleans, Louisiana Annual Meeting	p. 1063
March 12–13	Statesboro, Georgia	p. 1065
March 18–20	Iowa City, Iowa	p. 1066
April 9–10	Worcester, Massachusetts	p. 1066
April 30–May 1	Las Vegas, Nevada	p. 1066
September 10–11	Ithaca, New York	p. 1067
September 24–25	Winston-Salem, North Carolina	p. 1067
October 14–16	Lincoln, Nebraska	p. 1067
October 22–23	Salt Lake City, Utah	p. 1068
November 29–December 3	Port Elizabeth, Republic of South Africa	p. 1068

2012

January 4–7	Boston, Massachusetts Annual Meeting	p. 1068
March 3–4	Honolulu, Hawaii	p. 1069
March 10–11	Tampa, Florida	p. 1069
March 17–18	Washington, DC	p. 1069
March 30–April 1	Lawrence, Kansas	p. 1069

2013

January 9–12	San Diego, California Annual Meeting	p. 1069
June 27–30	Alba Iulia, Romania	p. 1069

2014

January 15–18	Baltimore, Maryland Annual Meeting	p. 1070

2015

January 10–13	San Antonio, Texas Annual Meeting	p. 1070

2016

January 6–9	Seattle, Washington Annual Meeting	p. 1070

2017

January 4–7	Atlanta, Georgia Annual Meeting	p. 1070

Important Information Regarding AMS Meetings

Potential organizers, speakers, and hosts should refer to page 92 in the January 2010 issue of the *Notices* for general information regarding participation in AMS meetings and conferences.

Abstracts

Speakers should submit abstracts on the 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. Visit http://www.ams.org/cgi-bin/abstracts/abstract.pl. Questions about abstracts may be sent to abs-info@ams.org. Close attention should be paid to specified deadlines in this issue. Unfortunately, late abstracts cannot be accommodated.

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